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NASA PROGRAM PLANNING IN SPACE SCIENCES

DECEMBER 1962

PREPARED

BY

OFFICE OF SPACE SCIENCES

This document has been prepared by the discipline-oriented subcommittees of the Space Sciences Steering Committee. It contains the approved NASA program in space sciences as of 1 December 1962.

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INTRODUCTION

This document has been prepared by the discipline-oriented Subcommittees of the Space Sciences Steering Committee. It contains the approved NASA program in space sciences as of 1 December 1962.

The document has been prepared to serve primarily as an aid in budget preparation and as a basis for future program planning.

Funds for data analysis will be provided to each space flight experimenter after his spacecraft has been placed into a suitable trajectory and satisfactory data are being received from his experiment for analysis.

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ASTRONOMY

OBJECTIVES:

A primary objective of the astronomy program is to extend conventional astronomical observations to the wavelengths which reach the vicinity of the earth, but do not penetrate the earth's atmosphere to the ground, and to exploit the improved seeing obtainable above the earth's atmosphere. This can be done by placing instruments in artificial earth satellites where they will be above the absorbing and distorting influences of the earth's atmosphere. A second objective of the program is to use rockets and satellites to apply astronomical techniques to studies of the gravitational fields of the earth and other planets and of the nature of gravity itself.

The astronomy program includes the following:

---Extension to the entire electromagnetic spectrum of the traditional and current techniques of ground-based astronomy.

---In situ measurements of the gravitational fields of the members of the solar system; in situ determinations of the structure and composition of small bodies in the solar system; and experiments designed to improve our understanding of the nature of gravity. Investigation of the major planets and their satellites is the responsibility of the planetology program but overlaps the astronomy area.

---Theoretical and laboratory research necessary to provide the basis for a proper interpretation of data obtained from the observational parts of the program.

Other areas normally included in classical astronomy, such as an investigation of the nature of the moon and planets, studies of the magnetic fields and atomic constituents in interplanetary space, are omitted since they are covered in other programs. It is important to maintain a close coordination in the planning and conduct of all these programs to give proper attention to the various interrelationships and the broad picture.

The observations in the various wave lengths from gamma rays through the visible region to the radio wave lengths will provide a wealth of data hitherto unavailable. The data will contribute to our understanding of the composition and structure of and processes going on in stars, in interstellar space, and in our own and other galaxies.

A study of the gravitational fields of the earth, moon and planets will supply information on the density of the planets, on the variations of density with depth, and on the stresses in the interiors of the planets. This information in turn will give clues as to their past thermal histories.

TECHNIQUES AND INSTRUMENTS:

Available:

Photometric and spectrometric techniques suitable for astronomical applications are available for the gamma ray, X-ray, ultraviolet, and infrared regions of the spectrum. Radio receivers for the detection and measurement of long wave cosmic radio waves are already in use. Stabilized, pointed, and programmable rockets have been developed for both solar and stellar problems.

Observations of the orbits of artificial satellites have been used to give information concerning the gravitational field of the earth. This technique can be applied to other bodies of the solar system when artificial satellites can be placed into orbits around them and are observed accurately.

Under Development:

At present the emphasis continues on instrumentation for use in the ultraviolet, gamma ray, X-ray, and radio regions of the spectrum. Spectrometers for the gamma ray regions and radio receivers for the millimeter and sub-millimeter wave lengths are also being developed. Stabilized and programmable orbiting satellites for use as astronomical observatories are under development. Ultraviolet image tubes and imaging X-ray optics are under development for the Orbiting Astronomical Observatories and Advanced Orbiting Solar Observatories.

PROJECTS AND TASKS:

Satellites

PROJECT DESIGNATION:	Orbiting Solar Observatory (OSO B) (S-17)
VEHICLE:	Thor-Delta
DATE/SITE:	1Q63/AMR
ORBIT:	480 km ; 30° inclination
EXPECTED LIFETIME:	6 months - 1 year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	J. L. Mitchell
EXPERIMENTER:	K. L. Hallam, GSFC W. A. White, GSFC Robert Young, GSFC John Mangus, GSFC
PARAMETER:	Stellar and nebular UV spectra from 900 to 3800 Å

Satellites (Contd.)

PROJECT DESIGNATION: S-17 (Contd.)

EXPERIMENT: Examine sky for stellar and nebular sources emitting in the wave length regions 900-2000 Å and 1800-3800 Å. The experiment is considered a precursor to a similar experiment to be flown on an OAO.

TECHNIQUE: Employ an objective grating spectrograph which uses the rotation of the wheel of the satellite with an azimuth grating for spatial scanning. Pulse counting is employed.

INSTRUMENT: Stellar spectrophotometer

STATUS: Funded by Geophysics & Astronomy Programs through flight hardware.

DISCIPLINES: Astronomy

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EXPERIMENTER: E. P. Ney, Univ. of Minnesota
W. F. Huch, Univ. of Minnesota
R. Maas, Univ. of Minnesota

PARAMETER: Intensity and degree of polarization of zodiacal light at 1750 Å and 8500 Å.

EXPERIMENT: Direct measurement of the distribution and spectral characteristics of zodiacal light.

TECHNIQUE: Scan celestial sphere using precession of spacecraft spin axis. Instruments look 90° apart above interference from atmospheric polarization and airglow.

Satellites (Contd.)

PROJECT DESIGNATION:	S-17 (Contd.)
INSTRUMENT:	Two sets of photomultipliers. Each set has one visible and one IR sensitive photomultiplier with polaroid filters.
STATUS:	Funded through flight hardware
DISCIPLINES:	Astronomy (prime) Planetary Atmospheres

Satellites (Contd.)

PROJECT DESIGNATION:	Orbiting Astronomical Observatory (OAO) (S-18)
VEHICLE:	Atlas-Agena B
DATE/SITE:	1964/AMR
ORBIT:	Circular; 800 km altitude; low inclination
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	A. H. Sures
EXPERIMENTER:	A. Code, Univ. of Wisconsin
PARAMETER:	Broad band photometric studies of stellar energy distribution in selected portions of the sky in the region 800 - 3000 Å.
EXPERIMENT:	To determine stellar energy distribution of selected stars in the UV and to check that the energy distribution is not intrinsically variable. To measure emission line intensities of diffuse nebulae.
TECHNIQUE:	Observations of several hundred stars of all spectral types
INSTRUMENT:	(1) A multicolor filter photometer system using four 8 inch telescopes; (2) a multi-color filter photometer for nebulae using a 16 inch telescope; (3) two auxiliary scanning spectrometers

Satellites (Contd.)

PROJECT DESIGNATION: S-18 (Contd.)

STATUS: Funded, by Goddard, for prototype, flight hardware, data evaluation

DISCIPLINES: Astronomy

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EXPERIMENTER: F. Whipple, Smithsonian Astrophysical Observatory
R. Davis

PARAMETER: Stellar UV radiation in ranges 3000-1700 Å; 2000-1050Å; and 1500-1050Å

EXPERIMENT: To survey the entire sky in the UV spectrum in ranges 3000-1700 Å, 2000-1050 Å, and 1500-1050 Å.

TECHNIQUE: Record the brightnesses of about 20,000 hot stars, spectral type A5 and earlier. Map the form and brightness characteristics of faint nebulae.

INSTRUMENT: The equipment will be three high-resolution telescopes (Schwarzschild cameras) and a slitless spectroscope. The detectors at the focal point of the telescopes will be ultraviolet-sensitive image forming devices (Uvicons)

STATUS: Funded, by Goddard, for prototype, hardware, and data evaluation

DISCIPLINES: Astronomy

Satellites (Contd.)

PROJECT DESIGNATION:	Eccentric Orbiting Geophysical Observatory (EGO-1) (S-49)
VEHICLE:	Atlas-Agena B
DATE/SITE:	4Q63/AMR
ORBIT:	Perigee 280 km; Apogee 110,000 km; inclination 31°; period approximately 42 hours
EXPECTED LIFETIME:	1 year with 70% probability
HEADQUARTERS CONTACT :	L. J. Cahill, Jr., Program Scientist
Alternate :	C. D. Ashworth, Acting Program Manager
EXPERIMENTER:	F. T. Haddock, Univ. of Michigan
PARAMETER:	Solar and galactic noise in the 2 to 4 megacycle per second frequency band
EXPERIMENT:	Measure the dynamic radio spectra of solar bursts and determine the cosmic noise intensity. The first will give the electron density gradients and electron-ion collision frequencies in the solar corona at distances out to tens of solar radii; in addition, these data will be correlated with geophysical events.

Satellites (Contd.)

PROJECT DESIGNATION: EGO (S-49) (Contd.)

TECHNIQUE: The sweep-frequency electrically-timed receiver measures the radio noise incident upon the 30-foot antenna. A solid-state intense noise source intermittently calibrates the gain of the receiver over the receiver frequency band. A reactance bridge intermittently measures the capacitance of the antenna to check erection and indirectly measure the ambient electron density. All measurements and calibrations will be made at intervals around the satellite orbit.

INSTRUMENT: Sweep-frequency transistorized receiver, a single 30-foot erectable antenna, and associated equipment

STATUS: Funded by the Office of Geophysics and Astronomy through FY 1963 for prototype and flight hardware

DISCIPLINES: Astronomy (prime)
Solar Physics

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EXPERIMENTER: K. Hallam, GSFC
C. L. Wolff, GSFC
S. P. Wyatt, Univ. of Illinois

PARAMETER: Low-resolution isophotes of the anti-solar and Moulton point directions measuring infrared brightness, and degree of polarization

Satellites (Contd.)

PROJECT DESIGNATION:	EGO (S-49) (Contd.)
EXPERIMENT:	Investigation of Gegenschein
TECHNIQUE:	Photomultiplier scan in the visible and infrared using Polaroid filter and depending upon spacecraft stabilization
INSTRUMENT:	Photomultiplier
STATUS:	Funded for flight instrumentation
DISCIPLINES:	Astronomy (prime) Planetary Atmospheres

PROJECT DESIGNATION:	Polar Orbiting Geophysical Observatory (POGO-1) (S-50)
VEHICLE:	Thor-Agena D
DATE/SITE:	1964/PMR
ORBIT:	Perigee, 260 km; Apogee, 920 km; inclination 82° to 90°; period, approximately 90 minutes

Satellites (Contd.)

PROJECT DESIGNATION:	POGO (S-50) (Contd.)
EXPECTED LIFETIME:	1 year with 70% probability
HEADQUARTERS CONTACT :	R. F. Fellows, Program Scientist
Alternate :	C. D. Ashworth, Acting Program Manager
EXPERIMENTER:	F. T. Haddock, Univ. of Michigan
PARAMETER:	Measure cosmic noise at two fixed frequencies in the range between 2 and 4 Mc/s
EXPERIMENT:	Map the brightness distribution of cosmic radio noise over the sky. At present ground observations are limited to about 10 Mc/s and higher so maps at 2 to 4 Mc/s are expected to show significant changes from available maps.
TECHNIQUE:	One DeHavilland antenna 30 to 60 feet long is extended from a solar experiment package (SOEP) after orbit is achieved. Two fixed frequency receivers located in the SOEP will share the antenna. The SOEP also contains a capacity measuring device for determining antenna series capacity, a receiver gain calibration system, and the logic for switching between them. All measurements and calibrations will be made at intervals around the orbit.

Satellites (Contd.)

PROJECT DESIGNATION:	POGO (S-50) (Contd.)
INSTRUMENT:	Two spot frequency receivers, a 30 to 60 foot antenna, and associated equipment
STATUS:	Funded by the Office of Geophysics & Astronomy through FY 1963 for prototype and flight hardware
DISCIPLINES:	Astronomy

PROJECT DESIGNATION:	Orbiting Solar Observatory (OSO C) (S-57)
VEHICLE:	Delta
DATE/SITE:	4Q63/AMR
ORBIT:	Circular 300 km
EXPECTED LIFETIME:	One year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	J. L. Mitchell
EXPERIMENTER:	W. L. Kraushaar, MIT
PARAMETER:	Extra-solar gamma-rays with energies above 100 Mev
EXPERIMENT:	Search for γ-ray sources among such likely candidates as the Crab Nebula, Cygnus A, Virgo Cluster, Sun, etc.

PROJECT DESIGNATION:	S-57 (Contd.)
TECHNIQUE:	Using γ-ray detectors measure the integral along the line of sight of the product of cosmic ray flux and matter density
INSTRUMENT:	γ-ray convertors, Cerenkov counters, plastic scintillation counters, and photomultipliers
STATUS:	Funded through prototype by Geophysics & Astronomy Programs Office
DISCIPLINES:	Astronomy (prime) Solar Physics

Satellites (Contd.)

PROJECT DESIGNATION:	Orbiting Astronomical Observatory (OAO) (S-58)
VEHICLE:	Atlas-Agena D
DATE/SITE:	1965/AMR
ORBIT:	Circular, 800 km altitude; 32° inclination
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	A. H. Sures
EXPERIMENTER:	J. Milligan, GSFC
PARAMETER:	Obtain absolute spectrophotometric data on selected stars and nebulae in the range 1000 - 4000Å with 2Å resolution
EXPERIMENT:	Studies to determine composition and properties of early (type A & B) stars, as well as properties of variable stars and peculiar B stars.
TECHNIQUE:	Observation of several thousand stars
INSTRUMENT:	The optical system will employ a relatively fast 36" Cassegrain telescope with a large aperture spectrophotometer. Six photomultipliers will be used in a pulse-counting mode for data recovery.
STATUS:	To provide prototype and hardware. Partially funded to date
DISCIPLINES:	Astronomy

Satellites (Contd.)

PROJECT DESIGNATION:	Orbiting Astronomical Satellite (OAO) (S-68)
VEHICLE:	Atlas-Agena D
DATE/SITE:	1966/AMR
ORBIT:	Circular, 800 km altitude, 32° inclination
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	A. H. Sures
EXPERIMENTER:	L. Spitzer, Princeton Univ.
PARAMETER:	Quantitative spectrometer observations of the absorption spectrum of interstellar gas in the range 800Å - 3000Å with 0.1Å resolution
EXPERIMENT:	This is a study of the composition and physical condition of the clouds of interstellar gas and dust. Since most interstellar atoms absorb only in the far UV, observations of these UV lines are required.
TECHNIQUE:	The optical system will consist of a Cassegrain reflecting telescope feeding the entrance slit of a concave-grating spectrometer. The primary of the F/3 telescope will be 32 inches in diameter. The entrance slit and concave grating of the spectrograph are fixed, and photo-cells behind exit slits will scan the spectrum.

Satellites (Contd.)

PROJECT DESIGNATION:	OAO (S-68) (Contd.)
INSTRUMENT:	Cassegrain reflecting telescope; concave-grating spectrometer; photocells
STATUS:	Contracted, by Goddard, for design study, prototype, and flight hardware; partially funded to date.
DISCIPLINES:	Astronomy

Interest In
Satellites

S-17 (OSO B); Thor-Delta; 1963 (1Q)/AMR; 480 km, 30°;
N. G. Roman, Program Scientist:

EXPERIMENTER: C. P. Leavitt, Univ. of New Mexico

PARAMETER: High energy γ rays, 50 Mev and up

EXPERIMENT: Determine the direction of arrival and the approximate energy spectrum of cosmic ray γ radiation

TECHNIQUE: The γ rays are converted in the lead convertor after passing through the anticoincidence counter. The resulting fast electrons are detected in the Cerenkov counter after which they dissipate their energy in the lead glass Cerenkov counter. The anticoincidence counter enables counts from charged particles to be rejected.

INSTRUMENT: Lead glass Cerenkov counter

STATUS: Funded by Geophysics & Astronomy Programs through flight hardware

DISCIPLINES: Solar Physics (prime)
Astronomy

Orbiting Solar Observatory (OSO C) (S-57); Delta; 4Q63/AMR;
Circular 300 km; N. G. Roman, Program Scientist:

EXPERIMENTER: C. B. Neel, Ames Res. Center
G. G. Robinson, Ames Res. Center

Interest In
Satellites (Contd.)

S-57 (Contd.)

PARAMETER:	Intensity of Earth-reflected solar radiation in the wave lengths 1000Å to 30 microns
EXPERIMENT:	Measure spectral intensity of Earth-reflected solar energy over wave length region from 1000Å to 4 microns. In addition it is proposed to extend the measurements into the infrared up to about 30 microns to obtain data on the direct radiation from the Earth.
TECHNIQUE:	Photometric sensors would be mounted on the periphery of the rotating wheel to measure spectral distributions of radiant energy. The location of the detectors permits determination of the angular distribution of reflection radiation as horizon to horizon scan occurs. Momentary looks at the Sun provide calibration.
INSTRUMENT:	Photomultiplier tubes
STATUS:	Funded through Geophysics & Astronomy Programs for flight hardware
DISCIPLINES:	Planetary Atmospheres (prime) Astronomy

Interest In
Satellites (Contd.)

PROJECT DESIGNATION:	S-52 (International Satellite)
VEHICLE:	Scout
DATE/SITE:	3Q1963/Wallops Island, Va.
ORBIT:	Perigee 370 km; Apogee 1800 km; inclination 51°
EXPECTED LIFETIME:	One year
HEADQUARTERS CONTACT :	R. F. Fellows
Alternate :	R. E. Halpern
EXPERIMENTER:	F. G. Smith, Cambridge Univ., England
PARAMETER:	Galactic radio noise in frequency range, 0.75 Mc to 3.0 Mc
EXPERIMENT:	Mapping of galactic radio noise in above frequency range, and investigation of ionospheric effects of these frequencies.
TECHNIQUE:	Reception of signals on satellite
INSTRUMENT:	Dipole antenna and receiver
STATUS:	Funded by U.K.
DISCIPLINES:	Ionospheres & Radio Physics (prime) Astronomy

Geoprobes and Sounding Rockets (Contd.)

NASA NO.: 4.37

VEHICLE: Aerobee

DATE/SITE: 1Q63/Wallops Island

TRAJECTORY: 200 km

HEADQUARTERS
CONTACT : N. G. Roman
Alternate : J. R. Holtz

EXPERIMENTER: T. Stecher, GSFC
J. Milligan, GSFC

PARAMETER: Stellar spectra in region 1300-4000A

EXPERIMENT: Measure spectra of hot stars in the winter sky

TECHNIQUE: Auto-scanning objective grating spectrophotometer

INSTRUMENT: Four objective grating spectrophotometers

STATUS: Funded by GSFC through data reduction

DISCIPLINES: Astronomy

NASA NO.: 4.50, 4.51

VEHICLE: Aerobee 150A

DATE/SITE: 2Q63/Wallops Island

TRAJECTORY: 200 km

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.50, 4.51 (Contd.)

HEADQUARTERS
CONTACT : N. G. Roman
Alternate : J. R. Holtz

EXPERIMENTER: J. Rogerson, Princeton Univ.

PARAMETER: Stellar spectra of selected stars

EXPERIMENT: Observe stellar spectra by pointing a spectrometer at the hot star γ Pegasi to study its ultraviolet radiation with moderate dispersion. Wavelengths to be studied are 3230 Å to 1730 Å in first order with a resolution of 2 Å, and 1615 Å to 865 Å in second order with resolution of 1 Å.

TECHNIQUE: Payload is inertially pointed to the desired star and then servo-controlled. An objective grating telescope is precisely pointed to target and grating turns to scan desired spectral region.

INSTRUMENT: Detectors: An EMI photomultiplier for first range (3230 to 1730 Å). Bendix magnetic photomultiplier for lower range (1615 to 865 Å).

STATUS: Funded by Geophysics and Astronomy Programs through flight hardware

DISCIPLINES: Astronomy

Geoprobes and Sounding Rockets (Contd.)

NASA NO.:	4.70
VEHICLE:	Aerobee
DATE/SITE:	1Q63/Wallops Island
TRAJECTORY:	200 km
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	J. R. Holtz
EXPERIMENTER:	P. C. Fisher, Lockheed Missiles & Space Company
PARAMETER:	Soft X-rays
EXPERIMENT:	X-ray mapping of night sky in the region about 1 Å to 100 Å
TECHNIQUE:	Collimated gas filled counters are used for detecting each photon and obtaining a measure of its energy
INSTRUMENT:	Soft X-ray detectors and proportional counters
STATUS:	Funded through flight hardware by Geophysics and Astronomy Programs Office
DISCIPLINES:	Astronomy

Other Flight Experiments

PROJECT DESIGNATION:	X-15 Scientific Program
VEHICLE:	X-15
DATE/SITE:	1964/FRC
TRAJECTORY:	80 km (approx.)
DURATION:	20 minutes (approx.)
HEADQUARTERS CONTACT :	E. J. Ott
Alternate :	J. A. Martin (RA)
EXPERIMENTER:	A. Code, Univ. of Wisconsin
PARAMETER:	Sky brightness
EXPERIMENT:	Measure relative brightness of sky and earth background
TECHNIQUE:	Photometer looks aft during X-15 flight and sees earth, earth-sky, and sky successively
INSTRUMENT:	Photometer
STATUS:	Funded by Geophysics & Astronomy Programs through flight
DISCIPLINES:	Astronomy

PROJECT DESIGNATION:	X-15
VEHICLE:	X-15 No. 2 airplane

Other Flight Experiments (Contd.)

PROJECT DESIGNATION:	X-15 (Contd.)
DATE/SITE:	Indefinite; FRC
TRAJECTORY:	Max altitude varies; 80 km is a currently typical value
DURATION:	(a) Flight time approx. 20 min. (b) At "top" of ballistic trajectory approx. 2 min.
HEADQUARTERS CONTACT :	E. J. Ott
Alternate :	J. A. Martin (RA)
EXPERIMENTER:	A. D. Code, Univ. of Wisconsin T. Houek, Univ. of Wisconsin T. Bless, Univ. of Wisconsin J. McNall, Univ. of Wisconsin D. Schroeder, Univ. of Wisconsin
PARAMETER:	Stellar UV radiation in the region about 1800-4200Å
EXPERIMENT:	Photographic photometry over a 10° star field in the UV of bright, early type stars
TECHNIQUE and INSTRUMENT:	Use four cameras with reflecting optics and UV filters to record stellar brightness on UV photographic film. The cameras to be mounted on a gyro stabilized platform. Three of the cameras are designed to have passes of $\pm$ 150Å and are responsive to 2100, 2600, and 4200Å respectively. The fourth employs an objective grating to record the stellar spectra in the region 1800-3000Å.

Other Flight Experiments (Contd.)

PROJECT DESIGNATION: X-15 (Contd.)

STATUS: Funded by Geophysics & Astronomy Programs through data reduction

DISCIPLINES: Astronomy

Supporting Research

AREA OF INVESTIGATION:	Image tubes
TITLE:	Research on image converters for Orbiting Astronomical Observatory
PRINCIPAL INVESTIGATOR:	J. Burns
ORGANIZATION:	Univ. of Chicago
CONTRACT NUMBER:	NsG 276-62
TIME PERIOD:	1 June 1962 - 31 May 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$33,907
TECHNICAL MONITOR:	E. J. Ott
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Investigation of needs of astronomers regarding image tubes; study of materials to determine their suitability for such devices.

AREA OF INVESTIGATION:	Atomic transition probabilities
TITLE:	Wave functions and transition probabilities for light atoms
PRINCIPAL INVESTIGATOR:	L. Greene
ORGANIZATION:	Haverford College
ADDRESS:	Haverford, Pa.

Supporting Research (Contd.)

CONTRACT NUMBER:	NsG 287
TIME PERIOD:	1 Sept. 1962 - 31 Aug. 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$11,184
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	J. R. Gill
DESCRIPTION:	Investigate wave functions and transition probabilities for light atoms

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AREA OF INVESTIGATION:	Solid state physics
TITLE:	Emission, conductivity and luminescence of some solids
PRINCIPAL INVESTIGATOR:	William Pong
ORGANIZATION:	Univ. of Hawaii
CONTRACT NUMBER:	NsG 328-63
TIME PERIOD:	1 Oct. 1962 - 30 Sept. 1964
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$95,000
TECHNICAL MONITOR:	E. J. Ott
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Investigate emission, conductivity, and luminescence properties of solid materials.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Gamma rays
TITLE:	Cosmic gamma ray investigation with Earth satellites
PRINCIPAL INVESTIGATOR:	W. Kraushaar T. W. Clark
ORGANIZATION:	Massachusetts Inst. of Technology
CONTRACT NUMBER:	NASw-37 (Amd. 3)
TIME PERIOD:	1 March 1962 - 28 Feb. 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$50,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	E. J. Ott
DESCRIPTION:	Detect gamma rays and study their energies and direction of arrival

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Radiation physics
TITLE:	Far UV radiation physics
PRINCIPAL INVESTIGATOR:	R. Madden
ORGANIZATION:	National Bureau of Standards
CONTRACT NUMBER:	R-73
TIME PERIOD:	1 Nov. 1962 - 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$100,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	J. R. Gill
DESCRIPTION:	Investigate the physical properties of light sources and detectors in the far UV and soft X-ray regions and develop radiometric standards in the same spectral regions.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Optical instrumentation
TITLE:	Construction of 35 ft vacuum spectrograph
PRINCIPAL INVESTIGATOR:	K. Kessler
ORGANIZATION:	National Bureau of Standards
ADDRESS:	Washington, D. C.
CONTRACT NUMBER:	S-7964G
TIME PERIOD:	1 Sept. 1960 - 30 Dec. 1962
FUNDED BY:	GSFC
AMOUNT:	$150,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	E. J. Ott
DESCRIPTION:	Design and construct vacuum spectrograph

AREA OF INVESTIGATION:	Radio Astronomy
TITLE:	"Radio experiments in space"
PRINCIPAL INVESTIGATOR:	F. T. Haddock
ORGANIZATION:	University of Michigan
ADDRESS:	Ann Arbor, Michigan
CONTRACT NUMBER:	NsG-181 (Suppl 1)

Supporting Research (Contd.)

TIME PERIOD:	1 Aug. 1962 - 31 July 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$133,770
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Conduct research on space probe techniques for possible measurements of electromagnetic phenomena
DISCIPLINES:	Astronomy (prime) Ionospheres & Radio Physics

AREA OF INVESTIGATION:	Spectroscopy
TITLE:	High precision spectroscopy
PRINCIPAL INVESTIGATOR:	K. L. Andrew
ORGANIZATION:	Purdue Research Foundation, Lafayette, Indiana
CONTRACT NUMBER:	NsG 301-63
TIME PERIOD:	1 Sept. 1962 - 31 Aug. 1964
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$100,000

Supporting Research (Contd.)

TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	J. R. Gill
DESCRIPTION:	High precision spectroscopy with application to the study of atomic spectra of the carbon group and to secondary standards in the vacuum ultraviolet and the development of computer methods of data analysis

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AREA OF INVESTIGATION:	Interstellar medium
TITLE:	Properties of interstellar dust
PRINCIPAL INVESTIGATOR:	J. Greenberg
ORGANIZATION:	Rensselaer Polytechnic Inst.
CONTRACT NUMBER:	NsG 113-61
TIME PERIOD:	1 Nov. 1960 - 31 Oct. 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$66,900
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	E. J. Ott
DESCRIPTION:	Investigate properties of the interstellar dust

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Optical materials
TITLE:	Properties of multilayer optical filters
PRINCIPAL INVESTIGATOR:	W. Baumeister
ORGANIZATION:	Univ. of Rochester
CONTRACT NUMBER:	NsG 308-63
TIME PERIOD:	1 Sept. 1962 - 31 Aug. 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$16,817
TECHNICAL MONITOR:	E. J. Ott
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Investigate the properties and design criteria of multilayer optical filters

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AREA OF INVESTIGATION:	Solid state physics
TITLE:	Experimental research on optical and electronic properties of solids
PRINCIPAL INVESTIGATOR:	R. E. Hopkins
ORGANIZATION:	Univ. of Rochester
CONTRACT NUMBER:	NASw 107 (Amd. 2)
TIME PERIOD:	9 Aug. 1961 - 31 Aug. 1963

Supporting Research (Contd.)

FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$200,000
TECHNICAL MONITOR:	E. J. Ott
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Experimental research on optical and electronic properties of solid materials

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AREA OF INVESTIGATION:	Interstellar gas
TITLE:	Collisions of particles in interstellar gas
PRINCIPAL INVESTIGATOR:	James Joseph
ORGANIZATION:	St. John's Univ.
ADDRESS:	Jamaica, New York
CONTRACT NUMBER:	NsG 171-61
TIME PERIOD:	1 June 1961 - 31 May 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$39,400
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	J. R. Gill
DESCRIPTION:	Theoretical research on the collisions of particles in the interstellar gas

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Zodiacal light & airglow
PRINCIPAL INVESTIGATOR:	F. E. Roach
ORGANIZATION	NBS
ADDRESS:	Boulder, Colorado
CONTRACT NUMBER:	R-18
TIME PERIOD:	1 April 1961 - 31 March 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$25,000
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Support of University of Hawaii-University of Colorado research on zodiacal light and airglow. In cooperation with University of Hawaii (NsG-135)
DISCIPLINES:	Astronomy (prime) Planetary Atmospheres

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	"Zodical light and airglow"
PRINCIPAL INVESTIGATOR:	W. R. Steiger

Supporting Research (Contd.)

ORGANIZATION:	University of Hawaii
CONTRACT NUMBER:	NsG-135
TIME PERIOD:	1 April 1961 - 31 March 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$120,039
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Study on zodiacal light selected lines in the airglow spectrum In cooperation with NBS Boulder (R-18)
DISCIPLINES:	Astronomy (prime) Planetary Atmospheres

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Stellar atmospheres
TITLE:	Steady state interaction of matter and radiation in stellar atmospheres
PRINCIPAL INVESTIGATOR:	R. Wildt
ORGANIZATION:	Yale Univ.
CONTRACT NUMBER:	NsG 82-60 (Suppl. 1)
TIME PERIOD:	1 July 1961 - 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$55,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	J. R. Gill
DESCRIPTION:	Theoretical studies of the steady state interaction between radiation and matter in stellar atmospheres in order to shed some light upon the adequacy of the current interpretations of stellar absorption spectra and corrections arrived at by employing the hypothesis of "local thermodynamic equilibrium".

AREA OF INVESTIGATION:	Celestial mechanics
TITLE:	Theoretical study of periodic motion and stability in the restricted problem of three bodies.

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	J. H. Bartlett
ORGANIZATION:	Univ. of Illinois
CONTRACT NUMBER:	NsG 280
TIME PERIOD:	1 Aug. 1962 - 31 July 1965
FUNDED BY:	Lunar & Planetary Programs (FY 62)
AMOUNT:	$48,916
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	All possible orbits of a particle with small mass under the gravitational attraction of two heavy bodies will be classified and the stability of such motions will be determined.

AREA OF INVESTIGATION:	Celestial Mechanics
TITLE:	Research on problems of satellite and planetary motion
PRINCIPAL INVESTIGATOR:	Dirk Brouwer
ORGANIZATION:	Yale University
ADDRESS:	New Haven, Conn.
CONTRACT NUMBER:	NsG-29 (Amd. 1.)
TIME PERIOD:	1 Aug. 1962 - 1 Aug. 1964
FUNDED BY:	Lunar & Planetary Programs

Supporting Research (Contd.)

AMOUNT:	$342,500
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Research on problems of satellite and planetary motion

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AREA OF INVESTIGATION:	Ultraviolet astronomy
TITLE:	Design, construction, and testing of a satellite spectrometer
PRINCIPAL INVESTIGATOR:	Lyman Spitzer
ORGANIZATION:	Princeton University
ADDRESS:	Princeton, New Jersey
CONTRACT NUMBER:	NASr-42 (Amd. 1 & 2)
TIME PERIOD:	15 April 1961 - 30 April 1962 plus no cost extensions to 31 Oct. 1962 and 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$100,000
TECHNICAL MONITOR:	J. E. Kupperian
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Design, construct and test a prototype temperature-compensated rugged high-resolution scanning spectrometer suitable for use in the OAO spacecraft to be fabricated by the Grumman Aircraft Corp.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	UV stellar radiation
TITLE:	Ultraviolet stellar spectrophotometry
PRINCIPAL INVESTIGATOR:	A. D. Code
ORGANIZATION:	University of Wisconsin
ADDRESS:	Madison, Wisconsin
CONTRACT NUMBER:	NASw-66 (Amd. 3)
TIME PERIOD:	15 June 1962 - 31 Dec. 1962
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$181,537.89
TECHNICAL MONITOR:	E. J. Ott
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Stellar spectra-photometry in the far UV, including preliminary design studies of a satellite-borne telescope and consideration of data recovery and processing problems.

AREA OF INVESTIGATION:	Communications
TITLE:	Study of interference of communication satellites with radio astronomy
PRINCIPAL INVESTIGATOR:	Phillip Rice

Supporting Research (Contd.)

ORGANIZATION:	National Bureau of Standards, CRPL
ADDRESS:	Boulder, Colo.
CONTRACT NUMBER:	R-67
TIME PERIOD:	19 June 1962 - 31 May 1964
FUNDED BY:	Communications Programs, Office of Applications
AMOUNT:	$65,000
TECHNICAL MONITOR:	A. N. Andrus (FC)
ALTERNATE CONTACT:	R. Burke (FC)
DESCRIPTION:	Investigate interference to radio astronomy observations due to operation of communications satellite systems

Interest In
Supporting Research

AREA OF INVESTIGATION:	Planetary Astronomy
TITLE:	Lunar & Planetary 60 inch telescope
PRINCIPAL INVESTIGATOR:	G. P. Kuiper
ORGANIZATION:	University of Arizona
ADDRESS:	Tucson, Arizona
CONTRACT NUMBER:	NASr-82
TIME PERIOD:	21 Aug. 1962 - 20 Aug. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$375,000
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Construction of a 60-inch lunar and planetary telescope.
DISCIPLINES:	Planetology (prime) Astronomy Planetary Atmospheres

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AREA OF INVESTIGATION:	Planetary Astronomy
TITLE:	Infrared spectroscopy applied to planets and stars
PRINCIPAL INVESTIGATOR:	A. B. Meinel
ORGANIZATION:	University of Arizona
ADDRESS:	Tucson, Arizona

Interest In
Supporting Research (Contd.)

CONTRACT NUMBER:	NsG-223
TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1962
FUNDED BY:	Lunar & Planetary Programs
AMOUNT	$67,601
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Research in planetary and stellar spectroscopy, including studies of the IR spectra of diatomic molecules, and of techniques for the detection and analysis of extremely tenuous planetary atmospheres
DISCIPLINES:	Planetary Atmospheres (prime) Astronomy

Supporting Research

AGENCY	AREA	LEVEL OF EFFORT (FY 63)	PRINCIPAL INVESTIGATORS
Ames Research Center	Astronomy	$200,000	J. Miller G. Augason
Goddard Space Flight Center	Astronomy	$133,600	A. Boggess L. Dunkelman J. Milligan
	Astrophysics	$135,600	A. L. Levine
Jet Propulsion Laboratory	Astronomy	$40,000	H. Spinrad

SOLAR PHYSICS

OBJECTIVES:

The Sun is the main source of energy that reaches the surface of the Earth. It emits energetic particles and electromagnetic radiation of all wave lengths. The Sun is the main source of the energy that generates the atmospheric phenomena upon which man's life is dependent. Near the Earth's surface this interaction produces both long-range climatological factors and daily movements of weather systems. The Sun is the star nearest to the Earth, and as such furnishes the best source for the study of the physics of the stars.

The importance of the Earth-Sun relationship to mankind is just as great as the phenomena that occur on the Earth's surface itself because, in general, both are closely interrelated. In practice the Earth's atmosphere, while vital to life, is a severe hindrance to a scientific study of the Sun. The atmosphere is opaque or only semi-transparent to most regions of the electromagnetic spectrum and it scatters or absorbs much of the radiation that enters into it. Energetic particle radiations from the Sun are largely stopped, and cannot be studied from the Earth's surface.

Effective studies of solar physics require that all measurements and observations be made from above the Earth's atmosphere. The NASA program in Solar Physics makes use of rockets, balloons, aircraft, probes, and satellites to make observations to achieve this result. The studies will greatly expand our knowledge of the Sun.

TECHNIQUES AND INSTRUMENTS:

Available:

Geiger tubes, scintillation counters, and ionization

chambers are available to scan the ultraviolet, the X-ray, and the gamma ray spectra of the Sun, to scan the surface of the Sun, and to study the radiations emanating from the Sun and the solar corona. Spectrographs for use in the visible and ultraviolet regions are available. The glancing angle grating spectrometer permits measurements of electromagnetic radiation into the soft X-ray region. A stable platform has been developed for the Orbiting Solar Observatory which can point to within one minute of arc. This instrument platform may be operated in fixed pointing or scanning modes as desired. Ground-based high frequency radio telescopes are available for observing the Sun through the appropriate windows in the Earth's atmosphere.

Geiger counters, ionization chambers, scintillation counters, Cerenkov counters, and solid state devices used separately or in combination such as with telescopes are available for studying the particle radiation from the Sun. Recoverable nuclear emulsions are another tool for the study of solar cosmic rays. Related devices are also available for studying the low energy plasmas that appear to be ejected by the Sun. Magnetic fields at the Sun's surface can be studied, but not with complete satisfaction, by means of the Zeeman effect in the electromagnetic radiation emitted by the Sun. The experiments to study the energetic particle radiation from the Sun are described in the Particles and Fields section of this document.

Under Development:

An advanced version of an Orbiting Solar Observatory, with a fine pointing capability of ± 5 seconds of arc to the center of the Sun or any desired offset position within a 40 minutes of arc square centered on the center of the Sun and coarse offset pointing of ± 1 minute of arc within a 10 degrees of arc square centered on the center of the Sun is being developed. A generation of electromagnetic and energetic particle detectors with sufficient sensitivity to make use of this improved OSO is also being developed.

Image tubes sensitive to the ultraviolet are being developed for use on the first Orbiting Astronomical Observatory. Great emphasis is being placed on achieving ruggedness and reliability. Since much of the solar energy is emitted in the ultraviolet and since the Earth's atmosphere is opaque to these wave lengths such image tubes are essential if we are to obtain a true picture of the Sun.

PROJECTS AND TASKS:

Satellites

PROJECT DESIGNATION: Orbiting Solar Observatory (S-17)

VEHICLE: Thor-Delta

DATE/SITE: 1Q63/AMR

ORBIT: Circular, 480 $\pm$ 80 km altitude; inclination 30°

EXPECTED LIFETIME: 6 months

HEADQUARTERS CONTACT : N. G. Roman
Alternate : J. L. Mitchell

EXPERIMENTER: W. Liller, Harvard Univ.
Leo Goldberg, Harvard Univ.

PARAMETER: Synoptic measurements of solar ultraviolet radiation (500 to 1500Å)

EXPERIMENT: Solar ultraviolet spectrophotometric measurements in the region 500 - 1500Å

TECHNIQUE: Ultraviolet solar scanning

INSTRUMENT: UV solar scanning spectrometer

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Solar Physics

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EXPERIMENTER: K. Frost, GSFC
E. Rothe, GSFC
William White, GSFC
Joseph Thornwall, GSFC

Satellites (Contd.)

PROJECT DESIGNATION: S-17 (Contd.)

PARAMETER: Low energy gamma rays in the region 100 kev to 700 kev

EXPERIMENT: Search for solar γ ray flux in the region 100 kev to 700 kev and if found monitor its behavior in time and attempt a correlation with solar activity.

TECHNIQUE: By means of the revolutions of the wheel portion of the satellite look at the solar disc once every two seconds. In particular the Sun is observed for three successive rotations then the data are processed for three successive rotations. Once every two minutes a measurement is made looking 120° away from the Sun for three successive revolutions followed by data processing as before. This cycle is repeated.

INSTRUMENT: Anti-coincident shielded γ ray spectrometer

STATUS: Funded through data analysis by Geophysics and Astronomy

DISCIPLINES: Solar Physics

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EXPERIMENTER: Christopher P. Leavitt, U. of New Mexico

PARAMETER: Study of high energy gamma rays (50 Mev and greater)

Satellites (Contd.)

PROJECT DESIGNATION: S-17 (Contd.)

EXPERIMENT: Detect the incident proportion of the high energy cosmic primary radiation and determine the angular and energy distribution.

TECHNIQUE: Measure the energy of each incident gamma ray through the conversion of a large fraction of its energy into fast electrons. To insure directional response and improve energy resolution it will be necessary to convert the photons before they enter the counter and require coincidence between the pulse produced by the conversion electrons in an auxiliary counter and the Cerenkov pulse. Use of anticoincidence counter to rule out charged primaries.

INSTRUMENT: Lead glass Cerenkov counter

STATUS: Funded by Geophysics & Astronomy Programs through flight hardware

DISCIPLINES: Solar Physics (prime)
Astronomy

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EXPERIMENTER: T. Chubb, Naval Res. Lab.

PARAMETER: Solar X-ray emission

EXPERIMENT: Pinhole scan of Sun in wave length regions of 8-20Å, 44-60Å. Monitoring of X-ray bursts in prominences in wave lengths of 2-8Å, 8-20Å, and 44-60Å

Satellites (Contd.)

PROJECT DESIGNATION: S-17 (Contd.)

TECHNIQUE: Use of Geiger counters to measure X-rays during solar events and to scan solar surface

INSTRUMENT: Geiger counters

STATUS: Funded by Geophysics & Astronomy Programs

DISCIPLINES: Solar Physics

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EXPERIMENTER: R. Tousey, Naval Res. Lab.
D. Purcell, Naval Res. Lab.

PARAMETER: Solar UV emission

EXPERIMENT: Synoptic ultraviolet scanning measurements in the regions 304Å and 584Å and in the Lyman alpha wave length of 1215Å.

TECHNIQUE and INSTRUMENT: Use scanning UV photometers

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Solar Physics

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EXPERIMENTER: R. Tousey, Naval Res. Lab.

PARAMETER: Structure of corona

Satellites (Contd.)

PROJECT DESIGNATION:	S-17 (Contd.)
EXPERIMENT:	White light coronagraph measurements to study the structure of the outer solar atmosphere and its relation to the interplanetary medium.
TECHNIQUE and INSTRUMENT:	Use white light coronagraph
STATUS:	Funded by GSFC through flight hardware
DISCIPLINES:	Solar Physics

Satellites (Contd.)

PROJECT DESIGNATION:	Orbiting Solar Observatory (OSO) (S-57) (Pointed Section)
VEHICLE:	Delta
DATE/SITE:	4Q63/AMR
ORBIT:	Circular 300 km
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	J. L. Mitchell
EXPERIMENTER:	H. E. Hinteregger, AFCRL
PARAMETER:	Solar extreme UV photon fluxes (1300-60Å)
EXPERIMENT:	Measure solar flux and its variations in this range to study the Sun and its effects on the Earth's atmosphere.
TECHNIQUE:	Point monochromator accurately at the solar disc for relatively long periods of time
INSTRUMENT:	Monochromator
STATUS:	Funded through flight by Geophysics and Astronomy Programs through GSFC.
DISCIPLINES:	Solar Physics

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EXPERIMENTER:	W. M. Neupert, GSFC; W. A. White, GSFC W. E. Behring, GSFC; J. C. Lindsay, GSFC

Satellites (Contd.)

PROJECT DESIGNATION: S-57 (Contd.) (Pointed Section)

PARAMETER: Solar spectrum 1-400Å

EXPERIMENT: Measure the electromagnetic radiation from the total Sun observing spectrometrically in the regions 1-3.8, 3.6-8.4, 8.2-25, and 25-400Å and by ion chambers in the regions 1-8 and 10-20Å

TECHNIQUE: Measure solar electromagnetic radiation using both the Sun's rotation and correlation with ground-based observations to locate the source of radiation on the solar disc.

INSTRUMENT: Spectrometers and X-ray ion-chambers

STATUS: Funded through flight by Geophysics and Astronomy Programs.

DISCIPLINES: Solar Physics

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EXPERIMENTER: H. Friedman, NRL
T. A. Chubb, NRL

PARAMETER: Solar X-rays

EXPERIMENT: Distinguish between emissions from a thermally excited coronal plasma and the Bremsstrahlung X-rays produced by fast electrons injected into a relatively low-temperature corona

Satellites (Contd.)

PROJECT DESIGNATION: S-57 (Contd.) (Pointed Section)

TECHNIQUE: Instruments scan wave lengths from 1-8Å about once every 5 minutes

INSTRUMENT: Bragg crystal spectrometer with Geiger counter detector

STATUS: Funded by GSFC for S-57 flight payload

DISCIPLINES: Solar Physics

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EXPERIMENTER: T. A. Chubb (C), NRL
R. Tousey (T), NRL

PARAMETER:
(C) Solar X-ray 2-8, 8-20, 44-60Å
(T) White light corona
(T) Solar UV

EXPERIMENT: (package)
(C) Map X-ray sources on the Sun. Monitor solar X-ray bursts. Search for X-ray from prominences high above solar limb.
(T) Map intensity of white light corona of artificially eclipsed Sun. Scan the solar disk in 8-20 and 44-60Å UV light.

TECHNIQUE:
(C) Use Geiger counters to measure X-rays during solar events and to scan solar surface.
(T) Use white light coronagraph.

Satellites (Contd.)

PROJECT DESIGNATION: S-57 (Contd.) (Pointed Section)

INSTRUMENT: (C) Geiger counters
(T) End window type photomultipliers; white light coronagraph with dispersing grating and UV photomultipliers

STATUS: Funded by Geophysics & Astronomy Programs through GSFC

DISCIPLINES: Solar Physics

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PROJECT DESIGNATION: S-57 (Wheel) (Contd.)

EXPERIMENTER: L. Peterson, Univ. of California, LaJolla

PARAMETER: X-ray bursts

EXPERIMENT: Study energy spectrum and time dependence of X-ray bursts from Sun in energy region 15 kev-600 kev, including X-rays from solar Bremsstrahlung.

TECHNIQUE: Monitor Sun a large fraction of the time and detect events with intensities as low as 0.1 photon/cm^2 at the Earth

INSTRUMENT: NaI scintillation counter with phoswich and pulse height analyzer

STATUS: Funded by Geophysics & Astronomy Programs through GSFC for flight

DISCIPLINES: Solar Physics

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Satellites (Contd.)

PROJECT DESIGNATION:	S-57 (Wheel) (Contd.)
EXPERIMENTER:	R. G. Teske, Univ. of Michigan
PARAMETER:	X-ray flux in range 8-20Å
EXPERIMENT:	Measure X-ray flux from 8-20Å emanating from visible solar hemisphere
TECHNIQUE:	Compare satellite observations with optical and radio aspect of solar disk
INSTRUMENT:	Two gas-filled ionization chambers with suitable window material
STATUS:	Funded by Geophysics and Astronomy Programs through GSFC.
DISCIPLINES:	Solar Physics

Interest In Satellites

The following experiments are of interest to the Solar Physics discipline.

Eccentric Orbiting Geophysical Observatory (EGO-1) (S-49); Atlas-Agena B; 4Q1963/AMR; 280 km, 110,000 km, 31°, period approximately 42 hours; L. J. Cahill, Program Scientist:

EXPERIMENTER: F. T. Haddock, Univ. of Michigan

PARAMETER: Solar and galactic noise in the 2 to 4 megacycle per second frequency band.

EXPERIMENT: Measure the dynamic radio spectra of solar bursts and determine the cosmic noise intensity. The first will give the electron density gradients and electron-ion collision frequencies in the solar corona at distances out to tens of solar radii; in addition, these data will be correlated with geophysical events.

TECHNIQUE: The sweep-frequency electrically-timed receiver measures the radio noise incident upon the 30-foot antenna. A solid-state intense noise source intermittently calibrates the gain of the receiver over the receiver frequency band. A reactance bridge intermittently measures the capacitance of the antenna to check erection and indirectly measure the ambient electron density. All measurements and calibrations will be made at intervals around the satellite orbit.

Interest In
Satellites (Contd.)

EGO (S-49) (Contd.)

INSTRUMENT: Sweep-frequency transistorized receiver, a single 30-foot erectable antenna, and associated equipment

STATUS: Funded by the Office of Geophysics & Astronomy through FY 1963 for prototype and flight hardware

DISCIPLINES: Astronomy (prime)
Solar Physics

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EXPERIMENTER: K. A. Anderson, Univ. of Calif., Berkeley

PARAMETER: Solar cosmic rays

EXPERIMENT: Measure solar cosmic ray protons and solar X-rays to assist in studying emissions from solar flares and propagation to the earth (protons 3-30 Mev).

TECHNIQUE: Detection of protons and X-rays using scintillation detectors. Energy measurement by shielding and pulse height analysis.

INSTRUMENT: Scintillation type detector

STATUS: Funded by GSFC through hardware

DISCIPLINES: Particles & Fields (prime)
Solar Physics

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Interest In
Satellites (Contd.)

EGO (S-49) (Contd.)

EXPERIMENTER:	T. L. Cline, GSFC E. W. Hones, IDA
PARAMETER:	Low energy positrons and gamma rays
EXPERIMENT:	To detect and measure positrons (0-3 Mev) in the trapped particle belts and in interplanetary space and to monitor solar proton bursts (30 kev to 1.2 Mev)
TECHNIQUE:	Detection of gamma ray pair from positron annihilative
INSTRUMENT:	Double gamma ray spectrometer
STATUS:	Funded by GSFC through flight hardware.
DISCIPLINES:	Particles & Fields (prime) Solar Physics

S-50 (POGO); Thor-Agena; 1964/PMR; 500-1000 km near circular polar orbit; inclination 87°; R. F. Fellows, Program Scientist:

EXPERIMENTER:	W. R. Webber, University of Minnesota
PARAMETER:	Cosmic rays
EXPERIMENT:	Measure rigidity and charge spectrum of solar and galactic cosmic rays in order to study origin and modulation mechanisms of cosmic radiation.
TECHNIQUE:	Charged particle detection and energy measurement by energy loss in Cerenkov-scintillation telescope.

Interest In
Satellites (Contd.)

S-50 (POGO) (Contd.)

INSTRUMENT: Scintillation, Cerenkov detector

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Solar Physics

Orbiting Solar Observatory (OSO) (S-57); Delta; 4Q1963/AMR; 300 km circular; N. G. Roman, Program Scientist:

EXPERIMENTER: E. M. Hafner, Univ. of Rochester
M. F. Kaplon, Univ. of Rochester

PARAMETER: Solar and galactic cosmic rays

EXPERIMENT: To measure charge and energy spectra of particles of energies > 3.3 Mev/nucleon

TECHNIQUE: Detector unidirectionally sensitive to relativistic particles ($\beta \geq 0.72$) which would discriminate between protons ($Z = 1$), alpha particles ($Z = 2$), and the L group of nuclei ($3 \leq Z \leq 5$), the M group of nuclei ($6 \leq Z \leq 9$) and the H group ($Z \geq 10$). The detector will also be sensitive to all charged particles received corresponding to $\beta \geq 0.35$ for protons and correspondingly higher β for higher charged particles.

INSTRUMENT: Counter telescope with scintillators and Cerenkov radiators

STATUS: Funded through flight hardware

DISCIPLINES: Particles & Fields (prime)
Solar Physics

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Interest In
Satellites (Contd.)

S-57 (OSO) (Contd.)

EXPERIMENTER: W. L. Kraushaar, MIT

PARAMETER: Gamma rays

EXPERIMENT: Search for γ ray sources among such likely candidates as the Crab Nebula, Cygnus A, Virgo Cluster, Sun, etc.

TECHNIQUE: Using γ ray detectors measure the integral along the line of sight of the product of cosmic ray flux and matter density

INSTRUMENT: γ ray convertors, Cerenkov counters; plastic scintillation counters, and photomultipliers

STATUS: Funded through prototype by Geophysics & Astronomy Programs

DISCIPLINES: Astronomy (prime)
Solar Physics

Interplanetary Monitoring Probe (IMP) S-74a, S-74b, S-74c; Thor-Delta; 1963, 1964/AMR; 200 km, 300,000 km, 31°; L. J. Cahill, Program Scientist:

EXPERIMENTER: G. P. Serbu, GSFC

PARAMETER: Plasma

EXPERIMENT: Measure thermal ions and electrons, 0-10 ev

TECHNIQUE: Planar trap collection of thermal particles

INSTRUMENT: Planar trap ion-electron detector

Interest In
Satellites (Contd.)

IMP (S-74a, S-74b, S-74c) (Contd.)

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Ionospheres & Radio Physics (prime)
Particles & Fields
Solar Physics

Geoprobes and Sounding Rockets

NASA No.: 4.22

VEHICLE: Aerobee

DATE/SITE: May 1963/Wallops Island

TRAJECTORY: 200 km

HEADQUARTERS CONTACT : N. G. Roman

EXPERIMENTER: W. Liller, Harvard Univ.

PARAMETER: Solar UV spectrum and instrument

EXPERIMENT: Make another flight test of solar UV experiment for S-17 satellite. To measure intensity of radiation coming from the Sun in the 500-1500Å wave length region.

TECHNIQUE: Direct solar radiation is focused by a concave mirror at the entrance of the slit of the Johnson Onake type spectrometer. By rotating the concave diffraction grating the spectrum is scanned across a photomultiplier.

INSTRUMENT: Spectrograph

STATUS: Funded by Geophysics & Astronomy Programs through data reduction

DISCIPLINES: Solar Physics

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.24

VEHICLE: Aerobee

DATE/SITE: 4Q1963/Wallops Island

TRAJECTORY: 200 km

HEADQUARTERS CONTACT : N. G. Roman
Alternate : E. J. Ott

EXPERIMENTER: W. A. Rense, Univ. of Colorado

PARAMETER: Solar spectrum 50 - 1500Å

EXPERIMENT: Measure the energy of the solar spectrum between about 50 and 1500 Å

TECHNIQUE: Scan spectrum in region 50 - 1500 Å utilizing a plane grating concave mirror grazing incidence spectrograph

STATUS: Funded by Geophysics & Astronomy Programs through flight hardware (NASr-86)

DISCIPLINES: Solar Physics

NASA No.: 4.61, 4.62

VEHICLE: Aerobee

DATE/SITE: 1Q1963/White Sands

TRAJECTORY: 200 km

HEADQUARTERS CONTACT : N. G. Roman

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.61, 4.62 (Contd.)

EXPERIMENTER: D. M. Packer, NRL
J. D. Purcell, NRL
M. J. Koomen, NRL
R. Tousey, NRL

PARAMETER: (A) Extended solar corona
(B) Solar UV radiation

EXPERIMENT: (A) Measure intensity and structure of solar corona in white light out to about 10 solar radii.
(B) Scan solar disc in three extreme UV wave lengths viz., 304Å (HeII), 584Å (HeI), and 1216Å

TECHNIQUE: (A) Utilize a motor-driven scanning mechanism to observe the extended corona
(B) Utilize a motor-driven scanning mechanism to move small aperture detectors across target

INSTRUMENT: (A) White light coronagraph
(B) Spectroheliograph with Bendix capillary photomultipliers

STATUS: Funded by Geophysics & Astronomy Programs through flight hardware

DISCIPLINES: Solar Physics

NASA No.: 4.77

VEHICLE: Aerobee

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.77 (Contd.)

DATE/SITE: 2Q1963/White Sands

TRAJECTORY: 200 km

HEADQUARTERS
CONTACT : N. G. Roman
Alternate : J. R. Holtz

EXPERIMENTER: K. Hallam, GSFC
C. Wolff, GSFC

PARAMETER:
(A) Solar radiation 1100-3500Å
(B) Solar corona
(C) Solar radiation Lyman-alpha

EXPERIMENT: Three experiments:
(A) Detect and measure solar radiation in the region 1100-3500Å to obtain an accurate spectrum of the solar continuum from the center of the Sun.
(B) Experimental studies of the extended (many solar radii) solar corona in the visible wave lengths to determine coronal structure and intensity distribution.
(C) Photograph entire solar disc in the light of Lyman- α (1216Å).

TECHNIQUE: Use rocket pointing control to lock instrument on center of solar disc.
(A) Grating moves to scan spectrum at center of Sun.
(B) and (C) Cameras are programmed to provide several exposure times.

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.77 (Contd.)

INSTRUMENT: (A) UV spectrophotometer
(B) Wide angle coronagraph
(C) Objective grating spectroheliograph

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Solar Physics ( )

Interest In
Other Flight Experiments

The following experiments are of interest to the Solar Physics discipline.

Low energy solar and galactic cosmic rays; balloon; 1963, Ft. Churchill; 40 km altitude; L. J. Cahill, Program Scientist:

EXPERIMENTER:	K. A. Anderson, Univ. of Calif., Berkeley
PARAMETER:	Low energy cosmic rays
EXPERIMENT:	Low energy protons will be measured in order to understand the production and propagation of solar protons.
TECHNIQUE:	Charged particle detectors above the atmosphere.
INSTRUMENT:	Cerenkov, scintillation, and solid state detectors will be used.
STATUS:	Funded by Geophysics & Astronomy Programs through March 1963
DISCIPLINES:	Particles & Fields (prime) Solar Physics

Monitoring of galactic and solar cosmic rays; balloon; 1963/ Minneapolis and locations in Canada; 40 km at wind velocity; L. J. Cahill, Program Scientist:

EXPERIMENTER:	W. R. Webber, Univ. of Minnesota J. R. Winckler, Univ. of Minnesota R. Arnoldy, Univ. of Minnesota
PARAMETER:	Galactic and solar cosmic rays

Interest In
Other Flight Experiments (Contd.)

Monitoring of galactic and solar cosmic rays (Contd.)

EXPERIMENT:	This experiment is designed to measure the charge and energy spectra of cosmic rays at several geomagnetic latitudes during the solar minimum period. This experiment is closely correlated with rocket and satellite experiments conducted at the Univ. of Minnesota under the same grant.
TECHNIQUE:	Balloon-borne particle detectors at the top of the atmosphere
INSTRUMENT:	A newly-developed Cerenkov-scintillation telescope is to be employed.
STATUS:	Funded by Geophysics and Astronomy Programs through FY 1965.
DISCIPLINES:	Particles & Fields (prime) Solar Physics

Supporting Research

AREA OF INVESTIGATION:	X-rays
TITLE:	Study of physics of ultra-soft X-rays
PRINCIPAL INVESTIGATOR:	R. Wyckoff
ORGANIZATION:	Univ. of Arizona
CONTRACT NUMBER:	NsG 120-61 (Suppl. 1)
TIME PERIOD:	1 May 1962 - 30 April 1965
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$100,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	J. R. Gill
DESCRIPTION:	Investigation of the generation and detection of ultra-long wave length X-rays and quantitative studies of their interactions with matter

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Solar UV
TITLE:	Solar UV studies
PRINCIPAL INVESTIGATOR:	William Rense
ORGANIZATION:	University of Colorado
CONTRACT NUMBER:	NASr 86
TIME PERIOD:	15 Nov. 1961 - 30 Nov. 1964
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$250,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	E. J. Ott
DESCRIPTION:	Investigate spectrographically, in space environment, the solar UV radiations (Sounding rocket flight 4.24 US)

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Solar Physics
TITLE:	Solar patrol at Dominion Observatory
PRINCIPAL INVESTIGATOR:	V. Gaizauskas
ORGANIZATION:	Dominion Observatory
ADDRESS:	Ottawa, Canada
CONTRACT NUMBER:	NsG 320
TIME PERIOD:	1 Oct. 1962 - 31 March 1964
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$29,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	J. R. Gill
DESCRIPTION:	Monitoring of the solar chromosphere

AREA OF INVESTIGATION:	UV instrumentation
TITLE:	Design and construct high-speed, high-resolution spectrograph
PRINCIPAL INVESTIGATOR:	H. McAllister
ORGANIZATION:	Univ. of Hawaii
CONTRACT NUMBER:	NASr-5
TIME PERIOD:	1 Jan. 1961 - 31 Dec. 1962

Supporting Research (Contd.)

FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$39,905
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	E. J. Ott
DESCRIPTION:	Design, construct, and test a prototype, high-speed, high-resolution, rocket stigmatic spectrograph useful in the region 1000-3000Å.

AREA OF INVESTIGATION:	Solar Physics
TITLE:	Monitoring solar activity and investigating related solar phenomena
PRINCIPAL INVESTIGATOR:	Richard A. Miller
ORGANIZATION:	Manila Observatory
CONTRACT NUMBER:	NsG 288
TIME PERIOD:	1 Sept. 1962 - 31 Aug. 1965
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$90,000
TECHNICAL MONITOR:	J. R. Gill
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Ground-based investigation of solar phenomena and solar monitoring

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Supporting Research (Contd.)

AREA OF INVESTIGATION:	Solar Physics
TITLE:	Support and augment NBS-CRPL activities in solar monitoring
PRINCIPAL INVESTIGATOR:	A. Shapley, V. Lincoln
ORGANIZATION:	National Bureau of Standards
ADDRESS:	Boulder, Colorado
CONTRACT NUMBER:	W11 391 3
TIME PERIOD:	1 Aug. 1962 - 31 July 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$100,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	E. J. Ott
DESCRIPTION:	Maintain a network for collection of current data on solar flares and associated phenomena and on various kinds of ionospheric and magnetic disturbances, CRPL (NBS) will furnish NASA, on request, data produced by this network. Essentially real time alerts on events of major interest are to be provided.

AREA OF INVESTIGATION:	Solar Physics
TITLE:	Physical conditions in limb flares and active solar prominences

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	H. Zirin, J. Warwick
ORGANIZATION:	University Corp. for Atmospheric Research (High Altitude Observatory)
ADDRESS:	Boulder, Colorado
CONTRACT NUMBER:	NsG 92 60 (Suppl. 1&2)
TIME PERIOD:	20 June 1962 - 19 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$150,000
TECHNICAL MONITOR:	N. G. Roman
ALTERNATE CONTACT:	E. J. Ott
DESCRIPTION:	Research on new techniques by which to investigate solar phenomena with application to observations from space vehicles

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AREA OF INVESTIGATION:	Solar Physics
TITLE:	Prototype rocket-borne spectrograph and associated study
PRINCIPAL INVESTIGATOR:	T. D. Violett
ORGANIZATION:	Western State College of Colorado
ADDRESS:	Gunnison, Colorado
CONTRACT NUMBER:	NsG 311

Supporting Research (Contd.)

TIME PERIOD:	19 Sept. 1962 - 19 Mar. 1964
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$35,000
TECHNICAL MONITOR:	J. R. Gill
ALTERNATE CONTACT:	N. G. Roman
DESCRIPTION:	Investigate techniques for rocket-borne spectrographic studies of the solar UV spectrum in the range 950-1050A, and the use of a prototype instrument for laboratory studies of the absorption of such radiation by nitrogen and oxygen.

AREA OF INVESTIGATION:	Theoretical analysis of solar flare data
TITLE:	Research on physics of solar flares
PRINCIPAL INVESTIGATOR:	J. W. Warwick and R. G. Athay
ORGANIZATION:	University of Colorado
ADDRESS:	Boulder, Colo.
CONTRACT NUMBER:	NsG-136 (Amd. 1)
TIME PERIOD:	1 April 1962 - 31 March 1963
FUNDED BY:	Goddard Space Flight Center
AMOUNT:	$45,000

Supporting Research (Contd.)

TECHNICAL MONITOR:	F. B. McDonald, GSFC
DESCRIPTION:	Research on the physics of solar flares and the relationships of solar corpuscular emissions to optical and radio features of the Sun. Extension for development of prediction criteria required for Apollo.

AREA OF INVESTIGATION:	Theoretical analysis of astrophysics
TITLE:	Physics of stellar interiors
PRINCIPAL INVESTIGATOR:	Vernon W. Hughes
ORGANIZATION:	Yale University
ADDRESS:	New Haven, Conn.
CONTRACT NUMBER:	NsG-163 (Suppl. 1)
TIME PERIOD:	1 July 1962 - 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$46,000
TECHNICAL MONITOR:	A. Levine, GSFC
DESCRIPTION:	Theoretical research in relativity, cosmology and the physics of stellar interiors.

Supporting Research

AGENCY	AREA	LEVEL OF EFFORT (FY 63)	PRINCIPAL INVESTIGATORS
Goddard Space Flight Center	Solar Physics	$457,400	J. Gilbert J. C. Lindsay

PLANETARY ATMOSPHERES

DEFINITION:

The Planetary Atmospheres discipline covers the NASA research on the atmospheres of the Earth, the other planets, and the Moon. Also treated are ensembles of gases and particulate matter found in space, including comets, meteors, and meteorites. Studies of the Earth's atmosphere within the planetary atmospheres discipline are concentrated in the region above that treated by synoptic meteorological techniques, and they share with meteorology a mutual interest in the ozone layer at approximately 30 km. At this time studies of the atmospheres of other planets are directed at those of Mars and Venus and include all aspects of these atmospheres.

OBJECTIVES:

The principal objectives of the program are to determine and understand the origins, evolution, nature, spatial distribution, and chemical and dynamical behavior of the atmospheres of the Earth, planets, Moon, comets and the Sun, and their relations to the medium of interplanetary space.

Description:

The study of the Earth's atmosphere is primarily concerned with the region of the atmosphere above approximately 30 km. Aside from the variations in moisture content, temperature and pressure as altitude increases, a significant departure from sea level characteristics occurs at about 30 km where ozone dominates the behavior of this region of the atmosphere. Here, the behavior and characteristics of the atmosphere are determined by a trace constituent not

significant at lower levels. Another significant region begins at a somewhat higher altitude where the bottom of the ionosphere, the D-layer, makes its appearance. The characteristics of the ionosphere are greatly affected by the free ions and electrons which are present. Interactions with electromagnetic energy occur that are not present at lower altitudes. In recent years, the use of the word "aeronomy" to describe the study of the chemistry and physics of this and higher regions has become quite commonplace and is used to emphasize the differences in the atmosphere and the techniques of investigation that must be used for these upper regions.

Solar electromagnetic energy is the major energy input to planetary atmospheres. Energetic particles, electromagnetic and gravitational forces, and micrometeorite bombardments are lesser factors; but are not so insignificant that they can be neglected. The effects of energy inputs are apparent in the weather phenomena of the lower atmosphere and in various ionospheric phenomena at higher altitudes. Daily, seasonal, and solar cycle dependencies have been observed and studied, as well as the effects of solar flares and the ensuing swarms of solar protons. The complexity of the phenomena and physical limitations in the ability to perform "in situ" measurements are such that investigations of the upper atmosphere are a considerable distance from being synoptic in extent. Despite the paucity of accumulated observations, however, we have arrived at some understanding of the phenomena of the upper atmosphere.

Considerable progress has been made in measuring the extent and approximate composition of the Earth's atmosphere. Even here, however, the bulk of our knowledge concerns the temperate and auroral latitudes, and few measurements have been made in the equatorial or polar regions. Also, progress has been made in understanding the theory of the variation of composition (molecular or atomic weight) with altitude as controlled by gravitational forces, diffusion, temperature, and solar energy. Quantitative verification, however, especially for the polar regions, remains as a goal of the next few years.

Information about the atmospheres of Mars and Venus has been limited to that obtained by ground-based optical and radio astronomy. These methods are now being extended by observations made from high altitude balloons and aircraft, and from planetary flyby missions. The first opportunity for "in situ" measurements of the atmospheres of Mars or Venus will not be before 1965. Early acquisition of new experimental data of the atmospheres of Mars and Venus, either from astronomical or from "in situ" measurements, will be of tremendous value in helping to decide among the various competing theories attempting to account for the characteristics of the atmospheres of these two planets.

The Earth's Atmosphere:

In recent years the investigation of the Earth's atmosphere has proceeded vigorously enough to provide rough models of the principal characteristics and properties to several thousand kilometers altitude. The physical structure (i.e. pressure, density, and temperature) and the chemical composition of neutral and ionic species have been determined in a general way, but variations in the upper atmosphere with time and geographical position remain quantitatively unknown. The importance of "trace" constituents in determining the characteristics of certain regions is recognized, and acceptable theories have been developed that account for their presence, i.e. the ozone layer centered near 30 km in altitude, the presence of NO^+ ion at higher altitudes, and the presence of O^+ still higher.

Our detailed knowledge of the above, however, is quite inadequate in respect to time and geographical variations. This knowledge must be acquired before it will be possible to understand the exact processes involved in the response of the atmosphere to incident solar energy.

Structure of the Atmosphere:

The basic parameters of atmospheric structure are pressure, density, and temperature. Rocket probes must be

used for measurements of density from maximum balloon altitudes of about 35 km to satellite altitudes around 200 km although heavy, low drag satellites could be used to somewhat lower altitudes. From 200 km to over 1500 km, atmospheric drag on satellites provides our main source of air density information. Temperatures can be calculated from vertical density distributions if one knows or assumes the molecular weight of the atmosphere over the regions of interest.

Composition of the Earth's Atmosphere:

A knowledge of the composition of the upper atmosphere is of fundamental importance due to the dominating role exerted by minority components not significant at lower altitudes. For instance, the absorption of solar radiation by ozone is a major source of heating in the 50 km region of the atmosphere, and the role of the D-layer of the ionosphere appears to be largely determined by the minor constituent, nitric oxide. The absorption of solar energy and the ensuring ionization and chemical reactions determine the characteristics of the upper atmosphere. The present picture of the neutral composition of the atmosphere is that of a mixture predominantly of nitrogen and oxygen molecules to about 100 km, where atomic oxygen begins to appear as a significant constituent. The concentration of atomic oxygen increases with altitude to approximately 1000 km where helium appears and occupies a significant role to about 2,500 km. Above this altitude hydrogen is predominant and the neutral atmosphere extends upward until it becomes undistinguishable from the interplanetary medium.

Similar to the variation of neutral species with altitude, the identity of the dominating ion varies with altitude, beginning with NO^+ in the D-layer to O^+ in the middle and upper regions of the ionosphere. At much higher altitudes, He^+ and H^+ appear in turn, and H^+ finally becomes dominant.

Atmospheric Motion:

The energy absorbed by the upper atmosphere from solar radiation and other sources including cosmic rays and tidal

forces, produces ionization processes, heating effects and a variety of motions. Equatorial and polar electrojets are manifestations of this energy input. Somewhat below about the 120 km level, regions of intense shear and turbulence have been found. These may represent the boundaries between turbulent mixing and diffusion processes. The coupling mechanisms between the upper atmosphere and the lower atmosphere are not yet well understood.

Photochemistry:

The aurora and airglow are manifestations of the production of excited states of atomic and molecular species in the atmosphere from interactions with solar energy, energetic particle fluxes, or artificially introduced reactive chemical species. Thus, they are sensitive indicators of the species present in the atmosphere and of the reactions occurring. Aurora and airglow observations in the visible spectrum have been conducted from the ground for many years. Some understanding has been achieved of the distribution of the atomic oxygen greenline (5577Å), but the altitude and latitude dependence of the atomic oxygen redline (6300Å) is very poorly known. It is extremely likely that the ultraviolet region contains the major portion of the auroral and day airglow emissions. Detailed studies of day and night ultraviolet airglow will be of tremendous value in elucidating atmospheric processes and composition.

The Atmosphere of the Moon:

Present thinking and theories indicate that the Moon lacks any appreciable atmosphere. However, the extent and characteristics of any atmosphere and the identification of the ionic and neutral species present are of considerable theoretical interest.

Atmosphere of Venus:

The atmosphere of Venus is especially interesting. A study of its properties, both physical and chemical, may

provide important information concerning the history of the solar system. Knowledge of the characteristics of the atmosphere also is required for the design of spacecraft which will be operating in the atmosphere or landing on the planet's surface. If the surface temperature is of the order of 600°K, as seems very likely now, equipment for the study of the lower atmosphere and surface must be designed to operate at high temperatures.

A study of the ultraviolet spectrum of the planet's atmospheric night-sky emission and daytime emission and absorption will give information on the presence of traces of ozone, molecular oxygen and nitrogen, atomic oxygen, and water vapor. Some of these observations may be made from high-altitude balloons, rockets, Earth satellites and ground-based observatories.

The strength of the magnetic field and the presence or absence of a substantial belt of trapped radiation are of considerable scientific and technical importance. A weak magnetic field might permit the presence of a more highly ionized upper atmosphere than on the Earth. This degree of ionization would affect the problem of maintaining communications between a probe and the Earth.

Atmosphere of Mars:

The chemical and physical characteristics of the Mars' atmosphere are of great interest in their own right and with respect to possible life forms indigenous to the planet. Of special interest is an investigation to determine whether the planet's surface is protected from ultraviolet radiation.

The presence or absence of a magnetic field and the existence of an ionosphere and particle belts should be determined.

Interplanetary Space:

Experimental studies of the interplanetary medium will

contribute significantly to our knowledge of the Sun's physical properties and of the processes through which the Sun affects the planets. For example, measurements, in interplanetary space, of the magnetic fields, plasmas and energetic corpuscular radiation should provide a great deal of this information. It is known that these entities, found in interplanetary space, are produced or affected by the Sun and that they are responsible for numerous phenomena observed at the Earth.

Interplanetary and Atmospheric Dust:

Dust and meteors entering planetary atmospheres may have a measurable effect upon them by contributing minor constituents to the composition and by ionizing or supplying ionizing atoms to affect planetary ionospheres. It has been suggested that meteoric dust is the major cause for the characteristic pattern of worldwide rainfall. Interplanetary dust, as observed from measurements of the zodiacal light and possibly the Gegenschein, is a major constituent of the interplanetary space. The distribution, composition, physical structure, and dynamics of dust in the interplanetary space should be determined. The mechanisms and chemistry for the creation and growth of dust are also of fundamental astrophysical interest in studying the origin of the solar system.

Comets:

It is generally considered that a comet is a conglomerate of frozen gases and dust of low molecular or atomic weight constituents. Comets are accompanied by gaseous envelopes or atmospheres as a result of solar heating. Studies of the coma and tail are of considerable interest for the clues found concerning the composition of the comet. It is considered possible that comets may be the natural nuclei of stars and planets.

TECHNIQUES AND INSTRUMENTS AVAILABLE:

A wide variety of instruments and techniques are used or are being developed for use in investigations of the atmospheres of the Earth and other planets. The most important of these instruments and techniques are listed below.

The temperature of the atmosphere has been and is being measured by (a) thermistors at relatively low altitudes; (b) the speed of sound by exploding grenades; (c) by spectroscopic methods from the broadening of lines and bands of atmospheric emission, or fluorescence of released gases; and, (d) by the velocity distribution function of ions, electrons, or neutral particles. Temperature is also determined by (a) the distribution of pressure using the hydrostatic equation; (b) with the Rayleigh equation to determine Mach number using a pitot-static pressure gage configuration; and, (c) from the scale height determined from electron or ion distribution with altitude.

The density of the atmosphere is measured (a) with pressure or density gages taking into account the aerodynamic and kinetic effects of the rocket or satellite; (b) from the diffusion rate of released gases; (c) from drag spheres with accelerometers; (d) from the drag of satellites in orbit; (e) from the relative absorption of solar radiation by the atmosphere; and, (f) from the degree of scattering of radiation by the gas. Density is also obtained by comparison of the distribution of the ionic components at altitudes above the E-region and in the exosphere.

Pressure is measured by gages such as the Alphatron, the Bayard-Alpert gage, the ionization gage, the omegatron and mass spectrometers, the Redhead gage, and the diaphragm gage. It is also determined by using the hydrostatic equation and the distribution functions for temperature or density.

Composition of the atmosphere is determined by

(a) various neutral and ion mass spectrometers using magnetic dispersion, with the RF mass spectrometer, and the Massenfilter; (b) optical-spectral studies of the airglow or induced fluorescence; (c) chemical reactions on special surfaces or catalytic agents; and, (d) the use of chemical additions to induce reactions which yield compositional information.

Motions in the atmosphere are studied (a) by tracking spheres, chaff, or other light objects; (b) by measuring the effect on the sound wave front from a grenade explosion; (c) by observing long persistent meteors, trails or tracking the ionization trails of meteors and sporadic ionization using radar methods; (d) by releasing gases at twilight and photographing the gases in fluorescence; (e) from the photometric mapping of airglow and aurora; (f) from the photography of the chemiluminescence of released gases at night; and, (g) by a special configuration of pressure gages on the rocket.

The photochemistry of the atmosphere is studied by means of wide and narrow band photometers and prism or grating spectrometers, and by releasing chemical reagents in the atmosphere.

The interplanetary and atmospheric dust is studied by observing comets and zodiacal light, by observing meteors and by collecting dust using rockets and aircraft. Interplanetary dust is studied from space vehicles by detecting various interactions of dust with surfaces such as the vibration, the light emitted from the impact, the ionization resulting from the impact, the penetration through thin films, the induced magnetic or electrical effects; and measurement of direct damage such as penetration of pressurized cells, breaking wire grids, or strain gauges, and discharging thin film capacitors.

UNDER DEVELOPMENT:

Improved mass spectrometers for determining neutral and ion composition, including the Massenfilter; higher sensitivity RF mass spectrometers; and, lightweight magnetic dispersion mass spectrometers are under development. Likewise, extended range pressure gages to 10^{-13} torr, ruggedized pressure gages, and necessary laboratory calibration facilities are also being developed. Optical instrumentation under development includes ultraviolet spectrometers and photometers for airglow and auroral studies, and light-scattering methods for density and particulate matter distribution. Various reagent gases and condensed materials for use in composition and wind measurements are also being investigated. Microwave radiometers are being developed for the investigation of the atmospheres of Mars and Venus.

PROJECT AND TASKS:

Satellites

PROJECT DESIGNATION:	Atmospheric Structure Satellite (S-6)
VEHICLE:	Delta
DATE/SITE:	1Q1963/AMR
ORBIT:	Perigee 250 km; Apogee 800 km; maximum inclination 51°
EXPECTED LIFETIME:	Three months
HEADQUARTERS CONTACT :	R. F. Fellows, Program Scientist
Alternate :	E. Ehrlich, Project Officer

Satellites (Contd.)

PROJECT DESIGNATION: S-6 (Contd.)

EXPERIMENTER: R. Horowitz, NASA Hqs.
G. Newton, GSFC

PARAMETER: Variations in gauge pressure from 10^{-6} to 10^{-10} mmHg.

EXPERIMENT: Measurement of atmospheric density, pressure and temperature as a function of altitude, time of day, geographic location, and geophysical phenomena.

TECHNIQUE: Direct measurement of atmospheric density and pressure using suitable detectors mounted on a spinning satellite.

INSTRUMENT: Two Bayard-Alpert ionization gauges
Two Redhead ionization gauges

STATUS: Funded through second Qtr. CY 63

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres and Radio Physics

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EXPERIMENTER: C. Reber, GSFC

PARAMETER: Neutral composition of the atmosphere at masses 4, 14, 16, 18, 28, and 32 AMU.

EXPERIMENT: Measurement of partial densities of each of the above noted masses as a function of time of day, geographic location, and geophysical phenomena. Gas kinetic temperatures will be computed.

Satellites (Contd.)

PROJECT DESIGNATION:	S-6 (Contd.)
TECHNIQUE:	Direct measurement of the distribution of the neutral gas species using a mass spectrometer mounted on a spinning satellite.
INSTRUMENT:	Double-focusing sector neutral gas mass spectrometer
STATUS:	Funded through second Qtr. CY 63
DISCIPLINES:	Planetary Atmospheres (prime) Ionospheres and Radio Physics

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PROJECT DESIGNATION:	S-52 (International Satellite)
VEHICLE:	Scout
DATE/SITE:	3Q1963/Wallops Island, Va.
ORBIT:	Perigee 370 km; Apogee 1800 km; inclination angle 51°
HEADQUARTERS CONTACT :	R. F. Fellows, Program Officer
Alternate :	R. E. Halpern, Project Officer
EXPERIMENTER:	R. Frith, Air Ministry, London K. H. Stewart, Air Ministry, London
PARAMETER:	Intensity of solar ultraviolet absorption by ozone
EXPERIMENT:	Measure the distribution of atmospheric ozone at twilight

Satellites (Contd.)

PROJECT DESIGNATION:	S-52 (Contd.)
TECHNIQUE:	Absorption of solar radiation by ozone at twilight used to measure the total ozone content as a function of altitude and latitude
INSTRUMENT:	Photo-cells and scanning spectrometer set for the ozone absorption bands
STATUS:	Experiments and spacecraft funded by British
DISCIPLINES:	Planetary Atmospheres

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EXPERIMENTER:	R. C. Jennison, Univ. of Manchester, England
PARAMETER:	Rate of hole formation in thin metallic film
EXPERIMENT:	Measure the impact rate, distribution, and effects of micrometeorites
TECHNIQUE:	Thin foil element penetrated by micrometeorites transmits sunlight. Frame of foil is movable.
INSTRUMENT:	Optical detection
STATUS:	Experiments & spacecraft funded by British
DISCIPLINES:	Planetary Atmospheres

Satellites (Contd.)

PROJECT DESIGNATION:	Italian - NASA Cooperative Program
VEHICLE:	Scout
DATE/SITE:	1964
ORBIT:	Circular, equatorial, altitude between 150-300 km
EXPECTED LIFETIME:	Several weeks to several months
HEADQUARTERS CONTACT :	R. F. Fellows, Program Scientist
Alternate :	R. D. Ginter, Project Manager
EXPERIMENTER:	Italian Space Commission
PARAMETER:	Atmospheric density, temperature, and ion content
EXPERIMENT:	Determine the atmospheric density in the equatorial region and the variations from solar heating and other geophysical phenomena
TECHNIQUE:	Drag data and direct measurement
INSTRUMENT:	Drag data by means of concentric spheres connected by strain gages, ion probe
STATUS:	NASA provides vehicle and back-up, funded through 2Q63. Italian Space Commission provides satellite and launch platform.
DISCIPLINES:	Planetary Atmospheres

Satellites (Contd.)

PROJECT DESIGNATION:	EGO (S-49)
VEHICLE:	Atlas-Agena B
DATE/SITE:	CY 1963/AMR
ORBIT:	Perigee 270 km; Apogee 110,000 km; inclination 31°
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	L. Cahill, Program Scientist
Alternate :	D. Ashworth, Project Officer
EXPERIMENTER:	P. W. Mange, Naval Res. Lab.
PARAMETER:	Intensity of scattered Lyman-alpha radiation
EXPERIMENT:	Determination of the distribution of neutral hydrogen in the geocorona
TECHNIQUE:	Ion chambers mounted to look in various directions from stabilized vehicle measuring the scattering of Lyman-α radiation from the Sun due to neutral hydrogen
INSTRUMENT:	Ion chambers
STATUS:	Funded for flight instrumentation
DISCIPLINES:	Planetary Atmospheres

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Satellites (Contd.)

PROJECT DESIGNATION: EGO (S-49) (Contd.)

EXPERIMENTER: W. M. Alexander, GSFC
C. W. McCracken, GSFC

PARAMETER: Impact parameters such as vibration, and ion formation from micrometeorite collision

EXPERIMENT: Measurement of the mass and density distribution of cosmic dust near the Earth; velocity distribution and radiants of cosmic dust

TECHNIQUE: Composite cosmic dust detection system; oriented on spacecraft; detecting ion plasma and acoustic pulses

INSTRUMENT: Microphones, plasma detectors and velocity discriminator

STATUS: Funded for flight instrumentation

DISCIPLINES: Planetary Atmospheres

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EXPERIMENTER: H. Taylor, GSFC
N. W. Spencer, GSFC

PARAMETER: Density of positive ions in mass range from 1 to 50 AMU and from 10 to 10^5 ions per cc

EXPERIMENT: Direct measurement of the distribution of exospheric ionic composition

Satellites (Contd.)

PROJECT DESIGNATION: EGO (S-49) (Contd.)

TECHNIQUE: On-board spectrometer to give direct readings. By varying the retarding potential of tube and by adjusting the gain of amplifier, entire range is covered.

INSTRUMENT: Ruggedized RF ion mass spectrometer

STATUS: Funded for flight instrumentation

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres and Radio Physics

PROJECT DESIGNATION: POGO (S-50)

VEHICLE: Thor-Agena D

DATE/SITE: CY 1964/PMR

ORBIT: Perigee 260 km; Apogee 920 km; polar orbit

EXPECTED LIFETIME: 1 year

HEADQUARTERS CONTACT : R. F. Fellows, Program Scientist
Alternate : D. Ashworth, Project Officer

EXPERIMENTER: H. Taylor, GSFC
H. C. Brinton, GSFC

PARAMETER: Measurement of atmospheric positive ion composition and density in range 1-45 AMU. Total ion current also measured.

Satellites (Contd.)

PROJECT DESIGNATION:	POGO (S-50) (Contd.)
EXPERIMENT:	Direct measurement of ion composition and density as function of altitude, geographic location, time of day, season, and geophysical phenomena
TECHNIQUE:	Appropriate voltage programming of grids of RF ion mass spectrometer
INSTRUMENT:	Ruggedized RF ion mass spectrometer
STATUS:	Being funded in 1962 and 1963 for flight
DISCIPLINES:	Planetary Atmospheres (prime) Ionospheres and Radio Physics

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EXPERIMENTER:	L. M. Jones, Univ. of Michigan E. J. Schaefer, Univ. of Michigan
PARAMETER:	Neutral species and positive ions in range 0 to 40 AMU
EXPERIMENT:	To obtain neutral and ionic composition of atmosphere as a function of altitude, geographic location, time of day, season, and geophysical phenomena
TECHNIQUE:	Using one sensor, program to measure neutral, then to look at ions. Utilize two mass ranges 0 - 6 AMU and 0 - 40 AMU.
INSTRUMENT:	Paul Massenfilter spectrometer tube

Satellites (Contd.)

PROJECT DESIGNATION: POGO (S-50) (Contd.)

STATUS: Being funded in 1962 and 1963 for flight

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres and Radio Physics

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EXPERIMENTER: P. M. Mange, U.S. Naval Res. Lab.
T. A. Chubb, U.S. Naval Res. Lab.
H. Friedman, U.S. Naval Res. Lab.

PARAMETER: To measure Lyman-alpha and far UV airglow measurements between 1230 and 1350Å

EXPERIMENT: To accurately record the spatial and time variations of Lyman-α night sky glow, and to record intensities in 1230 to 1350Å emissions

TECHNIQUE: Direct measurement of UV airglow emission, and of the Lyman-α

INSTRUMENT: Ion chambers having appropriate response

STATUS: Being funded in 1962 and 1963 for flight

DISCIPLINES: Planetary Atmospheres

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EXPERIMENTER: J. Blamont, Univ. of Paris
E. Reed, GSFC

PARAMETER; Airglow emission at 6300Å, 5577Å, 2500Å, 5893Å, 4860Å, and 3914Å

Satellites (Contd.)

PROJECT DESIGNATION:	POGO (S-50) (Contd.)
EXPERIMENT:	To measure the intensity of the airglow emissions
TECHNIQUE:	Direct measurement of airglow emission using onboard sensors
INSTRUMENT:	Appropriate photomultiplier and wide and narrow pass band filter combinations
STATUS:	Being funded in 1962 and 1963 for flight
DISCIPLINES:	Planetary Atmospheres

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EXPERIMENTER:	W. M. Alexander, GSFC C. W. McCracken, GSFC O. E. Berg, GSFC L. Secretan, GSFC
PARAMETER:	To measure amount of dust particles in 10^{-13} to 10^{-9} gm range
EXPERIMENT:	To measure flux, momentum, and mass of dust particles in 10^{-13} to 10^{-9} gm range in the zodiacal light
TECHNIQUE:	To directly measure from outside the atmosphere of the Earth the distribution and selected physical parameters of dust particles in the zodiacal light.
INSTRUMENT:	Combined electrostatic piezoelectric microphone detector
STATUS:	Being funded in 1962 and 1963 for flight
DISCIPLINES:	Planetary Atmospheres

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Satellites (Contd.)

PROJECT DESIGNATION: POGO (S-50) (Contd.)

EXPERIMENTER: G. P. Newton, GSFC

PARAMETER: Variations in gage pressure in range from about 10^{-5} to 10^{-10} mmHg

EXPERIMENT: To measure directly atmospheric density as a function of altitude, latitude, time of day, season, and geophysical phenomena

TECHNIQUE: Direct measurement of RAM pressure using sensor coupled to the atmosphere by an orifice

INSTRUMENT: Bayard-Alpert type ionization gauge

STATUS: Being funded in 1962 and 1963 for flight

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres and Radio Physics

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EXPERIMENTER: C. A. Barth, JPL
L. Wallace, Yerkes Observatory

PARAMETER: Intensity of upper atmosphere's UV spectra 1100Å to 3400Å

EXPERIMENT: To measure with 10 Angstrom resolution the Earth's ultraviolet spectra caused by the aurora, day glow, twilight glow, and night glow

TECHNIQUE: High resolution scan in the UV

Satellites (Contd.)

PROJECT DESIGNATION:	POGO (S-50) (Contd.)
INSTRUMENT:	Scanning UV spectrophotometer
STATUS:	Being funded in 1962 and 1963 for flight
DISCIPLINES:	Planetary Atmospheres

PROJECT DESIGNATION:	Micrometeoroid Satellite (S-55b)
VEHICLE:	Scout
DATE/SITE:	4Q1962/Wallops Island
ORBIT:	Perigee 750 km; Apogee 1000 km; inclination 52°
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	C. T. D'Aiutolo
Alternate :	M. Dubin
EXPERIMENTER:	A. G. Beswick and G. L. Smith, LRC
PARAMETER:	Impact rate of micrometeorites
EXPERIMENT:	Determine number of impacts in or greater than momentum ranges of 1.0 gm-cm/sec; 0.1 gm-cm/sec; and 0.01 gm-cm/sec.
TECHNIQUE:	Piezoelectric detectors of differing sensitivity

Satellites (Contd.)

PROJECT DESIGNATION: S-55b (Contd.)

INSTRUMENT: Piezoelectric impact detectors

STATUS: Funded for flight by the Office of Advanced Research and Technology

DISCIPLINES: Planetary Atmospheres

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EXPERIMENTER: C. A. Gurtler, Langley Res. Center
G. L. Smith, Langley Res. Center

PARAMETER: Penetration rate and damage from micrometeoroids

EXPERIMENT: Determine the lifetime under micrometeoroid impacts of the pressurization of cylindrically-shaped containers

TECHNIQUE: Influx rate of micrometeoroids determined from rate of penetration and loss of pressure of 160 cells

INSTRUMENT: Pressurized cylindrically-shaped cells

STATUS: Funded for flight by the Office of Advanced Research and Technology

DISCIPLINES: Planetary Atmospheres

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EXPERIMENTER: E. H. Davison, Lewis Res. Center
C. C. Conger, Lewis Res. Center

PARAMETER: Penetration rate and damage from micrometeoroids

Satellites (Contd.)

PROJECT DESIGNATION: S-55b (Contd.)

EXPERIMENT: Determine rate of penetration of 300-micron and 150-micron stainless steel foil from breaking of strain gages backing the foil

TECHNIQUE: Determine rate of penetration from breaking of strain gages backing the foil

INSTRUMENT: Strain gages covered with stainless steel foil

STATUS: Funded for flight by the Office of Advanced Research and Technology

DISCIPLINES: Planetary Atmospheres

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EXPERIMENTER: L. Secretan, GSFC

PARAMETER: Lifetime of individual wire grids

EXPERIMENT: Determine rate of destruction of wire grid impact detectors by micrometeoroids

TECHNIQUE: Closely wound fine wire; continuity interrupted from impacts from micro-meteoroids

INSTRUMENT: Wire grid impact detectors

STATUS: Funded for flight by the Office of Advanced Research and Technology

DISCIPLINES: Planetary Atmospheres

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Satellites (Contd.)

PROJECT DESIGNATION:	S-55b (Contd.)
EXPERIMENTER:	L. Secretan, GSFC
PARAMETER:	Intensity of light transmission through opaque coating as function of time
EXPERIMENT:	Determine micrometeoroid abrasive rate on opaque coatings
TECHNIQUE:	Through thinly-coated, opaque, exposed surface monitor solar light transmission with cadmium-sulfide cell
INSTRUMENT:	Cadmium-sulfide cell
STATUS:	Funded for flight by the Office of Advanced Research and Technology
DISCIPLINES:	Planetary Atmospheres

PROJECT DESIGNATION:	Rigidized Passive Communications Satellite (A-12)
VEHICLE:	Thor-Agena
DATE/SITE:	1Q1963/PMR
ORBIT:	1000 km circular
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT:	M. Dubin

Satellites (Contd.)

PROJECT DESIGNATION:	A-12 (Contd.)
EXPERIMENTER:	W. J. O'Sullivan, Langley Res. Center
PARAMETER:	Drag deceleration and other orbit perturbations of Echo A-12
EXPERIMENT:	Measure the atmospheric density and scale height as a function of time and altitude
TECHNIQUE:	Orbit data, using the Minitrack and Baker-Nunn tracking systems, analyzed to obtain atmospheric density and scale height
INSTRUMENT:	Orbit tracking
STATUS:	Funded (Communications Satellite Program) and through support of SAO by NASA
DISCIPLINES:	Planetary Atmospheres

Satellites (Contd.)

PROJECT DESIGNATION:	Orbiting Solar Observatory (OSO C) (S-57) (Wheel experiment)
VEHICLE:	Delta
DATE/SITE:	4Q63/AMR
TRAJECTORY:	Circular 300 km
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	J. L. Mitchell
EXPERIMENTER:	C. B. Neel, Ames Res. Center G. G. Robinson, Ames Res. Center
PARAMETER:	Intensity of Earth-reflected solar radiation in the wave lengths 1000Å to 30 microns
EXPERIMENT:	Measure spectral intensity of Earth-reflected solar energy over wave length region from 1000Å to 4 microns. In addition it is proposed to extend the measurements into the infrared up to about 30 microns to obtain data on the direct radiation from the Earth.
TECHNIQUE:	Photometric sensors would be mounted on the periphery of the rotating wheel to measure spectral distributions of radiant energy. The location of the detectors permits determination of the angular distribution of reflection radiation as horizon to horizon scan occurs. Momentary looks at the sun provide calibration.

Satellites (Contd.)

PROJECT DESIGNATION:	S-57 (Wheel experiment) (Contd.)
INSTRUMENT:	Photomultiplier tubes
STATUS:	Funded through Geophysics & Astronomy Programs for flight hardware
DISCIPLINES:	Planetary Atmospheres (prime) Astronomy

Interest In Satellites

The following experiments are of interest to the Planetary Atmospheres discipline.

Atmospheric Structure Satellite (S-6); Delta; 1Q1963/AMR; 250 km, 800 km, 51°; R. F. Fellows, Program Scientist:

EXPERIMENTER:	N. W. Spencer, GSFC L. Brace, GSFC
PARAMETER:	Electron densities from approximately 10^3 per c.c. to 4×10^6 per c.c.
EXPERIMENT:	Measure distribution of electron temperature and density
TECHNIQUE:	Langmuir probe method for determining the distribution function of electrons from analyses of the Volt-ampere curve
INSTRUMENT:	Swept voltage electron probe
STATUS:	Funded 2Q1963
DISCIPLINES:	Ionospheres and Radio Physics (prime) Planetary Atmospheres

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Orbiting Solar Observatory (S-17); Delta; 1Q1963/AMR; 500 km; 33°; N. G. Roman, Program Officer:

EXPERIMENTER:	E. P. Ney, Univ. of Minnesota W. F. Huch, Univ. of Minnesota R. Maas, Univ. of Minnesota
PARAMETER:	Intensity, and degree of polarization of zodiacal light at 4750Å and 8500Å.

Interest In
Satellites (Contd.)

OSO (S-17) (Contd.)

EXPERIMENT:	Direct measurement of the distribution and spectral characteristics of zodiacal light
TECHNIQUE:	Scanning of zodiacal light with photometers above interference from atmospheric polarization and air glow.
INSTRUMENT:	Photomultiplier photometers with filters and polaroid detectors
STATUS:	Funded for flight instrumentation
DISCIPLINES:	Astronomy (prime) Planetary Atmospheres

EGO (S-49); Atlas-Agena B; 1963/AMR; 270 km, 110,000 km; 31°;
L. Cahill, Program Scientist:

EXPERIMENTER:	K. Hallam, GSFC C. L. Wolff, GSFC S. P. Wyatt, Univ. of Illinois
PARAMETER:	Low-resolution isophotes of the anti-solar and Moulton point directions measuring infrared brightness, and degree of polarization
EXPERIMENT:	Investigation of Gegenschein
TECHNIQUE:	Photomultiplier scan in the visible and infrared using Polaroid filter and depending upon spacecraft stabilization

Interest In
Satellites (Contd.)

S-49 (Contd.)

INSTRUMENT: Photomultiplier

STATUS: Funded for flight instrumentation

DISCIPLINES: Astronomy (prime)
Planetary Atmospheres

POGO (S-50); Thor-Agena D; 1964/PMR; 260 km, 920 km, polar orbit; F. R. Fellows, Program Scientist:

EXPERIMENTER: R. Bourdeau, GSFC

PARAMETER: Electron temperature (800 to 3000 K); ion or neutral gas temperature (800 to 3000 K) charged particle density (10^3 to 5×10^6)

EXPERIMENT: To measure the parameters listed above as a function of altitude, geographic location, time of day, season, and geophysical phenomena

TECHNIQUE: To properly program on-board retarding potential analyzer

INSTRUMENT: Retarding potential analyzer, planar geometry

STATUS: Being funded in 1962 & 1963 for flight

DISCIPLINES: Ionospheres and Radio Physics (prime)
Planetary Atmospheres

Space Probes

PROJECT DESIGNATION:	Mariner II
VEHICLE:	Atlas-Agena B
DATE/SITE:	Launched 27 August 1962 from AMR
TRAJECTORY:	Venus fly by
EXPECTED LIFETIME:	Closest approach to Venus on 14 Dec. 1962
HEADQUARTERS CONTACT :	F. Kochendorfer
Alternate :	G. Reiff
EXPERIMENTER:	A. Barrett, MIT A. E. Lilley, Harvard Univ. J. Copeland, Ewen Knight Corp. D. E. Jones, JPL
PARAMETER:	Atmospheric and surface temperature
EXPERIMENT:	Measure Venus surface brightness temperature and temperature at intermediate level in Venus atmosphere
TECHNIQUE:	Microwave energy at 19 mm and 13.5 mm received by scanning Venus may be interpreted to give temperature
INSTRUMENT:	Microwave radiometer
STATUS:	Funded by Lunar and Planetary Programs through flight instrument
DISCIPLINES:	Planetary Atmospheres (prime) Planetology

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Space Probes (Contd.)

PROJECT DESIGNATION: Mariner II

EXPERIMENTER: L. D. Kaplan, JPL
G. Neugebauer, JPL
C. Sagan, UCBerkeley

PARAMETER: Atmospheric and surface temperatures

EXPERIMENT: Determine Venus atmospheric temperatures and map cloud coverage.

TECHNIQUE: Infrared energy received by scanning Venus may be interpreted to give temperature. Measurements at 10.4 micron CO_2 band and 8.4 micron window.

INSTRUMENT: Infrared radiometer

STATUS: Funded by Lunar and Planetary Programs through flight instrument

DISCIPLINES: Planetary Atmospheres (prime)
Planetology
Ionospheres & Radio Physics

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EXPERIMENTER: W. M. Alexander, GSFC

PARAMETER: Intensity and frequency of micrometeorite impacts in interplanetary space and near Venus

EXPERIMENT: Measure mass and number distributions of cosmic dust in ecliptic; also structural and velocity information.

Space Probes (Contd.)

PROJECT DESIGNATION:	Mariner II (Contd)
TECHNIQUE:	Detection of micrometeorite impacts
INSTRUMENT:	Crystal microphone
STATUS:	Funded by Geophysics and Astronomy through flight instrument
DISCIPLINES:	Planetary Atmospheres (prime) Planetology

PROJECT DESIGNATION:	Rangers 6 through 9
VEHICLE:	Atlas-Agena B
DATE/SITE:	First flight in third quarter CY 63, later flight schedules not firm
TRAJECTORY:	Lunar impact
EXPECTED LIFETIME:	66 hour trajectory to impact
HEADQUARTERS CONTACT :	N. W. Cunningham, Program Chief
Alternate:	W. Jakobowski, Program Engineer
EXPERIMENTER:	W. M. Alexander, GSFC
PARAMETER:	Dust particle flux in cislunar space.
EXPERIMENT:	Dust particle experiment for Ranger impactors

Space Probes (Contd.)

PROJECT DESIGNATION:	Rangers 6 through 9 (Contd)
TECHNIQUE:	Particles hit acoustical plate and are recorded by microphone and counted
INSTRUMENT:	Micrometeorite detector
STATUS:	Flight instrument built with Lunar & Planetary Program funds
DISCIPLINES:	Planetary Atmospheres (prime) Planetology

Geoprobes and Sounding Rockets

NASA No.:	None
VEHICLE:	ARCAS, LOKI II, and HASP
DATE/SITE:	CY 1963 (about 100 flights per year), Wallops Island, Va., Cape Canaveral, Fla., Ft. Churchill, Canada, etc.
TRAJECTORY:	Under 80 km
HEADQUARTERS CONTACT :	W. C. Spreen
Alternate :	M. Dubin
EXPERIMENTER:	H. B. Tolefson, MSFC W. W. Vaughn, MSFC A. Taiani, MSFC H. N. Murrow, LRC
PARAMETER:	Winds, wind shear, temperature, density of the atmosphere
EXPERIMENT:	NASA support of Project IRIG. Synoptic measuring program using small rockets in the altitude range from 30 to 80 km to map the structure of the atmosphere above balloon altitudes.
TECHNIQUE:	Synoptic firings of small rockets from six or more sites
INSTRUMENT:	Chaff, falling spheres, parachutes with thermistors
STATUS:	Funded through the Meteorological Programs. Some work also done under Saturn vehicle development program.
DISCIPLINES:	Planetary Atmospheres (prime) Meteorology

Geoprobes and Sounding Rockets (Contd.)

NASA No.: None

VEHICLE: ARCAS (3)

DATE/SITE: 1963/New Zealand

TRAJECTORY: 80 km

HEADQUARTERS CONTACT : R. F. Fellows
Alternate : J. Holtz

EXPERIMENTER: P. Gregory, Univ. of New Zealand

PARAMETER: Winds, wind shears, D region radio scattering characteristics

EXPERIMENT: Measure correlation with RF radar information of shears and turbulence in the 60 to 90 km region

TECHNIQUE: Release particles from rocket and photograph time-dependent dispersion to determine winds and shears

INSTRUMENT: Particle disperser and photographic equipment

STATUS: Three ARCAS rockets furnished, 1962

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

NASA No.: 4.30

VEHICLE: Aerobee

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.30 (Contd.)

DATE/SITE: 1Q63/White Sands

TRAJECTORY: 200 km

HEADQUARTERS
CONTACT : M. Dubin
Alternate : J. R. Holtz

EXPERIMENTER: R. Skolnik, GSFC
A. Boggess, GSFC

PARAMETER: Lyman-alpha nebulosity of Earth

EXPERIMENT: Make directional and altitude survey of Earth's Lyman-α nebulosity to 250 km to determine directional isophotes vs altitude of Lyman-α scattered by Hydrogen in Earth's upper atmosphere.

TECHNIQUE: Six Lyman-α photometers are oriented in different directions on a spin controlled rocket to scan

INSTRUMENT: Lyman-α photometer

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Planetary Atmospheres

NASA No.: 1.14 and 4.85

VEHICLE: Aerobee 100 and Aerobee-Hi

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 1.14 and 4.85 (Contd.)

DATE/SITE: 1962 and 1Q1963/White Sands Proving Ground, New Mexico and Wallops Island, Va.

TRAJECTORY: To 150 km

HEADQUARTERS CONTACT : R. Moore
Alternate : M. Dubin

EXPERIMENTER: C. A. Barth, JPL

PARAMETER: Spectrum of dayglow and atmospheric composition

EXPERIMENT: Determination of the altitude variation of the dayglow fluorescence spectrum in region from 2000 to 3400Å and atmospheric composition in the chemosphere.

TECHNIQUE: Measurement of the ultraviolet spectrum of dayglow as a function of altitude

INSTRUMENT: Ebert-Fastie spectrometer with solar blind photomultipliers

STATUS: Funded for two (2) rocket flights

DISCIPLINES: Planetary Atmospheres

NASA No.: 4.73, 4.75, 4.76

VEHICLE: Aerobee Hi

DATE/SITE: 1963/Wallops Island, Va., and Ft. Churchill, Canada

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.73, 4.75, 4.76 (Contd.)

TRAJECTORY: To 250 km

HEADQUARTERS CONTACT : M. Dubin
Alternate : R. F. Fellows

EXPERIMENTER: W. Fastie, Johns Hopkins Univ.
G. H. Dieke, Johns Hopkins Univ.

PARAMETER: Airglow spectrum 1000 to 2400 Å, and atmospheric airglow

EXPERIMENT: Determination of the spectrum of the day and night airglow in the ultraviolet and the effects of latitude & energetic particle excitations. Determination of atmospheric composition and reaction mechanisms.

TECHNIQUE: Direct measurement of spectrum of the airglow and atmospheric fluorescence

INSTRUMENT: Fastie-Ebert spectrometer, photometers

STATUS: Funded to mid-63

DISCIPLINES: Planetary Atmospheres

NASA No.: 4.83, 4.84

VEHICLE: Aerobee-Hi

DATE/SITE: 1963/Wallops Island, Va., and White Sands, New Mexico

TRAJECTORY: To 200 km

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.83, 4.84 (Contd.)

HEADQUARTERS CONTACT : M. Dubin
Alternate : R. F. Fellows

EXPERIMENTER: L. Dunkelman, GSFC
J. P. Hennes, GSFC

PARAMETER: Spectral distribution and absolute intensity of the airglow from 1700 Å to 3200 Å.

EXPERIMENT: Determine airglow intensities as a function of altitude and derive composition (O_3, O_2, and O concentrations) and atomic and molecular reaction conditions. Extend techniques to Mars, Venus, and Jupiter.

TECHNIQUE: Measurement of altitude distribution of the night airglow with a spectrophotometer using a stable despun platform

INSTRUMENT: Spectrophotometer with photomultiplier and filters

STATUS: Funded 1963

DISCIPLINES: Planetary Atmospheres

NASA No.: To be assigned

VEHICLE: Aerobee-Hi

DATE/SITE: 1964

Geoprobes and Sounding Rockets (Contd.)

NASA No.: To be assigned (Contd.)

TRAJECTORY: To 200 km

HEADQUARTERS CONTACT : M. Dubin
Alternate : R. Moore

EXPERIMENTER: L. Dunkelman, GSFC
R. Fowler, GSFC

PARAMETER: Spectral distribution of Venus, Mars, and Jupiter in the range from 1000 Å to 3200 Å.

EXPERIMENT: Determine the composition, albedo, and airglow condition of the atmospheres of Venus, Mars and Jupiter by ultraviolet spectroscopy.

TECHNIQUE: Spectral analysis of fluorescence and scattered light of the planetary atmospheres

INSTRUMENT: Spectrophotometer on pointed rocket

STATUS: Funded through FY 1963

DISCIPLINES: Planetary Atmospheres

NASA No.: To be assigned

VEHICLE: Aerobee-Hi

DATE/SITE: 1963/White Sands Proving Ground, N. M.

TRAJECTORY: To 200 km

Geoprobes and Sounding Rockets (Contd.)

NASA No.: To be assigned (Contd.)

HEADQUARTERS
CONTACT : C. D'Aiutolo
Alternate : M. Dubin

EXPERIMENTER: R. W. Hopko, LRC
W. H. Kinard, LRC

PARAMETER: Micrometeorite penetration rates and hypervelocity effects

EXPERIMENT: Measurement of actual micrometeorite penetration rate and depth on a large area paraglider detector; determination of effects by analysis of recovered detectors. (Study paraglider performance).

TECHNIQUE: Rocket launching of large paraglider covered with micrometeorite detectors. Paraglider is recovered.

INSTRUMENT: Capacitance, multilayer penetration detectors on recoverable paraglider

STATUS: Funded by OART

DISCIPLINES: Planetary Atmospheres

NASA No.: 6.06, 6.07, 6.08

VEHICLE: Aerobee 300

DATE/SITE: 1963/Wallops Island, Va., 1964 (2)

TRAJECTORY: To 400 km

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 6.06, 6.07, 6.08 (Contd.)

HEADQUARTERS CONTACT : M. Dubin
Alternate : R. Horowitz

EXPERIMENTER: L. H. Brace, GSFC

PARAMETER: Pressure, partial pressures, density, temperature, ion and electron density, ion and electron temperature.

EXPERIMENT: Determine altitude profile of atmospheric structure parameters and ionic content and determine function of diurnal, seasonal, or latitude dependence.

TECHNIQUE: Series of rocket firing of ejected packages containing a combination of instruments.

INSTRUMENT: Pressure gauges, Omegatron ion probe

STATUS: Funded for FY 1963

DISCIPLINES: Planetary Atmospheres

NASA No.: 14.08, 14.09

VEHICLE: Nike-Apache

DATE/SITE: 1963/Wallops Island, Va. and Ft. Churchill, Canada

TRAJECTORY: To 200 km

HEADQUARTERS CONTACT : M. Dubin
Alternate : R. Horowitz

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.08, 14.09 (Contd.)

EXPERIMENTER: E. Schaefer, Univ. of Michigan
L. M. Jones, Univ. of Michigan

PARAMETER: Atmospheric composition-relative and absolute concentrations of neutral and ionic constituents for each SMU.

EXPERIMENT: Determination of the chemical and ionic composition of the atmosphere and the generation and loss mechanisms of atmospheric constituents. Measurement of atmospheric structure variations as affected by solar radiation and particle bombardment.

TECHNIQUE: Measurements of the altitude profile of composition and determination of diurnal and latitude variations

INSTRUMENT: Paul Massenfilter mass spectrometer

STATUS: Funded through 1963

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

NASA No.: 14.22 - 14.25

VEHICLE: Nike-Apache

DATE/SITE: 1963/Wallops Island, Va. and Ft. Churchill, Canada

TRAJECTORY: To 150 km

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.22 - 14.25 (Contd.)

HEADQUARTERS CONTACT : M. Dubin
Alternate : R. Horowitz

EXPERIMENTER: J. Horvath, Univ. of Michigan

PARAMETER: Pressure, temperature, density and winds to 140 km

EXPERIMENT: Investigation of atmospheric structure parameters especially for diurnal dependence above 100 km

TECHNIQUE: Pitot-static configuration of pressure gauges on rocket probes, to determine pressure, and derive density, temperature and winds.

INSTRUMENT: Pressure gauges

STATUS: Funded through Jan. 1963. Additional support under consideration

DISCIPLINES: Planetary Atmospheres

NASA No.: 14.26 - 14.29

VEHICLE: Nike-Apache (4)

DATE/SITE: 1963/Wallops Island, Va.; Ft. Churchill, Canada; Eglin AFB, Florida

TRAJECTORY: To 200 km

HEADQUARTERS CONTACT : M. Dubin
Alternate : R. Fellows

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.26 – 14.29 (Contd.)

EXPERIMENTER: E. R. Manring, Geophysics Corp. of Am.
J. E. Blamont, Univ. of Paris

PARAMETER: Wind velocity, shears, diffusion coefficient and temperature of the atmosphere, chemiluminescent and energetic particle excitation efficiencies.

EXPERIMENT: Investigation of the tidal and dynamo motions and current systems between 80 and 200 km altitude. Determination of latitude, seasonal and diurnal variation of atmospheric temperature and density

TECHNIQUE: Release of fluorescent (alkali) vapors in the atmosphere at twilight. Coordinated series of launchings from a global net of launching sites

INSTRUMENT: Photographic camera net, Fabay-Perot interferometers, absorption cells, and photometers

STATUS: Funded - to be continued 1963 - 1964

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

NASA No.: 14.102, 14.103

VEHICLE: Nike-Apache

DATE/SITE: 1963 (2)/ Wallops Island, Va.

TRAJECTORY: To 100 km

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.102, 14.103 (Contd.)

HEADQUARTERS
CONTACT : M. Dubin
Alternate : R. Fellows

EXPERIMENTER: A. E. Potter, LeRC

PARAMETER: Airglow; induced excitation of sodium, and hydroxyl

EXPERIMENT: Determination of chemical mechanism for airglow emissions

TECHNIQUES: Release of ozone below 100 km

INSTRUMENT: Photometers

STATUS: Funded

DISCIPLINES: Planetary Atmospheres

NASA No.: 14.110, 8.03

VEHICLE: Nike-Apache and Javelin

DATE/SITE: 1963/Wallops Island, Va.

TRAJECTORY: To 200 km, to 1000 km

HEADQUARTERS
CONTACT : M. Dubin
Alternate : F. Gracely

EXPERIMENTER: G. Sharp, Lockheed
D. McKibben, Lockheed

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.110, 8.03 (Contd.)

PARAMETER: Composition of ions, ion density, ion temperature

EXPERIMENT: Determination of composition, density, and energy distribution of the atmosphere to 1000 km

TECHNIQUE: Direct measurements with ion probes and mass spectrometers

INSTRUMENT: Paul Massenfilter, magnetic mass spectrometer, ion probe

STATUS: Funded for flight

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

NASA No.: 10.53-10.55; 10.58-10.61; 10.62,10.63; 10.71,10.73-10.75; 10.86-10.89

VEHICLE: Nike-Cajun

DATE/SITE: 1963 (17 rockets), Wallops Island, Va. and Ft. Churchill, Canada

TRAJECTORY: To 100 km

HEADQUARTERS CONTACT : W. C. Spreen
Alternate : M. Dubin

EXPERIMENTER: W. Nordberg, GSFC
W. Smith, GSFC

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 10.53-10.55; etc. (Contd.)

PARAMETER: Wind velocity and atmospheric temperature

EXPERIMENT: Measurement of wind and temperature profiles between 30 and 95 km to investigate seasonal, geographical, and diurnal patterns and their causes

TECHNIQUE: Trace sound ray paths from up to twelve grenade explosions in the 30 to 95 km altitude interval. Simultaneous firing of rockets from more than one site and time-spaced firings.

INSTRUMENT: Grenades in conjunction with ground array of acoustic detectors

STATUS: Funded through Meteorological program

DISCIPLINES: Planetary Atmospheres (prime)
Meteorology

NASA No.: To be assigned

VEHICLE: Nike-Cajun (2)

DATE/SITE: 1963/Wallops Island, Va.

TRAJECTORY: To 150 km

HEADQUARTERS
CONTACT : R. Fellows
Alternate : M. Dubin

Geoprobes and Sounding Rockets (Contd.)

NASA No.: To be assigned (Contd.)

EXPERIMENTER: R. Hord, LRC

PARAMETER: Chemiluminescent reaction rates, atmospheric motions

EXPERIMENT: Determination of atmospheric motion during darkness, and the study of chemiluminescent reaction efficiencies

TECHNIQUE: Release of reactive gases in the atmosphere

INSTRUMENT: Ground photography and photometers

STATUS: Funded for FY 63

DISCIPLINES: Planetary Atmospheres

NASA No.: To be assigned

VEHICLE: Nike-Cajun or other - Piggybacks

DATE/SITE: 1963 (between 2 and 20) Wallops Island
1963 (10) - Kwajalein

TRAJECTORY: To 130 km

HEADQUARTERS
CONTACT : M. Dubin
Alternate : W. C. Spreen

EXPERIMENTER: L. M. Jones, Univ. of Michigan
L. Peterson, Univ. of Michigan

Geoprobes and Sounding Rockets (Contd.)

NASA No.:	To be assigned (Contd.)
PARAMETER:	Atmospheric density, temperature and winds
EXPERIMENT:	Systematic measurements of atmospheric structure and its variations with time of day and season from 110 km and below, using sphere drag
TECHNIQUE:	Determination of atmospheric drag and lateral position by radar tracking a falling sphere
INSTRUMENT:	Mylar sphere and hi-power radar
STATUS:	Funded 1963
DISCIPLINES:	Planetary Atmospheres (prime) Meteorology

VEHICLE:	Saturn - SA-3, SA-4
DATE/SITE:	1963/Atlantic Missile Range
TRAJECTORY:	To 200 km
HEADQUARTERS CONTACT :	R. Fellows
EXPERIMENTER:	W. Vaughn, MSFC O. Holderer, MSFC
PARAMETER:	Atmospheric density

Geoprobes and Sounding Rockets (Contd.)

VEHICLE: SA-3, SA-4 (Contd.)

EXPERIMENT: Determine density-altitude profile

TECHNIQUE: Direct measurement

INSTRUMENT: Ionization gauges

STATUS: Funded

DISCIPLINES: Planetary Atmospheres

VEHICLE: Saturn

DATE/SITE: 1963/AMR

TRAJECTORY: To 150 km

HEADQUARTERS CONTACT : R. Fellows
Alternate : R. Miller

EXPERIMENTER: W. Johnson, MSFC

PARAMETER: Evaporation rates, chemiluminescent effects, rate of dispersion and comet simulation

EXPERIMENT: Study of chemical and ionic gaseous interactions by release of water in the atmosphere

TECHNIQUE: Water release with ground observations

INSTRUMENT: Radio and optical equipment

Geoprobes and Sounding Rockets (Contd.)

VEHICLE:	Saturn (Contd.)
STATUS:	Release experiments will be conducted during test launches of Saturn, when possible without impairing Saturn test objectives.
DISCIPLINES:	Planetary Atmospheres

Interest In

Geoprobes and Sounding Rockets

The following experiment is of interest to the Planetary Atmospheres discipline.

NASA No. 8.25, 8.26, 8.27; Argo D-4; 1963/Wallops; 800 km; E. R. Schmerling, Program Scientist:

EXPERIMENTER:	R. B. Bourdeau, GSFC N. W. Spencer, GSFC S. J. Bauer, GSFC H. A. Taylor, GSFC
PARAMETER:	Densities of ions and electrons, neutral densities, electron and ion temperatures
EXPERIMENT:	In conjunction with a separate, simultaneous measurement of solar flux, to measure the individual quantities which enter into the continuity equation. Some cross-checking with Topside Sounder data is also planned.
TECHNIQUE and INSTRUMENT:	CW propagation measurement Planar and spherical ion probes Retarding potential analyzer Ionization gauge
STATUS:	Funded by Geophysics & Astronomy Programs in FY 1963
DISCIPLINES:	Ionospheres & Radio Physics (prime) Planetary Atmospheres

Interest In
Other Flight Experiments

PROJECT DESIGNATION:	Stratoscope II
VEHICLE:	High altitude, free balloon
DATE/SITE:	1963/Palastine, Texas
TRAJECTORY:	25 km maximum altitude
DURATION:	About 12 hours
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	R. C. Moore
EXPERIMENTER:	M. Schwarzschild, Princeton University
PARAMETER:	Planets and star fields; IR spectrometry of Mars
EXPERIMENT:	Take high resolution photographs of planets and star fields. Make IR spectrometer observations of Mars.
TECHNIQUE:	Photography; spectrophotometry.
STATUS:	Funded by Bioscience Program (NASr-113) jointly with NSF, ONR for development and three flights
DISCIPLINES:	Planetology (prime) Planetary Atmospheres Biosciences

Supporting Research

AREA OF INVESTIGATION:	Atmospheric composition
TITLE:	A special investigation of rocket instrumentation packages for measuring the properties of the upper atmosphere
PRINCIPAL INVESTIGATOR:	L. M. Jones
ORGANIZATION:	Univ. of Michigan
ADDRESS:	Ann Arbor, Michigan
CONTRACT NUMBER:	NASw-138 (Amd. 4 and 5)
TIME PERIOD:	30 June 1962 - 31 Dec. 1962 plus no-cost extension to 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$180,000
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	N. Spencer, GSFC
DESCRIPTION:	Development of the Paul Massenfilter mass spectrometer for measuring the properties of the upper atmosphere and the conduct of flight tests to test the equipment and to obtain atmospheric composition data.

AREA OF INVESTIGATION:	Atmospheric composition
TITLE:	Magnetic mass spectrometer research
PRINCIPAL INVESTIGATOR:	A. Nier

Supporting Research (Contd.)

ORGANIZATION:	University of Minnesota
ADDRESS:	Minneapolis, Minnesota
CONTRACT NUMBER:	NsG-286
TIME PERIOD:	1 July 1962 - 30 June 1965
FUNDED BY:	Geophysics & Astronomy Programs and Lunar & Planetary Programs
AMOUNT:	$223,990
TECHNICAL MONITOR:	R. Moore
ALTERNATE CONTACT:	R. Horowitz
DESCRIPTION:	Experimental research on mass spectrometer techniques for the study of planetary atmospheres, including laboratory investigation of problems associated with measuring atomic oxygen, pumping systems, sampling problems and instrument design for both neutral and ionic species.

AREA OF INVESTIGATION:	UV spectra of the upper atmosphere
TITLE:	Rocket and laboratory experiments and analysis of the ultraviolet spectra of the upper atmosphere
PRINCIPAL INVESTIGATOR:	G. H. Dieke
ORGANIZATION:	Johns Hopkins University
ADDRESS:	Baltimore, Maryland

Supporting Research (Contd.)

CONTRACT NUMBER:	NsG-193
TIME PERIOD:	1 Aug. 1961 - 31 July 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$310,000
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	S. H. Depew, GSFC
DESCRIPTION:	Information is to be obtained on the UV spectrum of the upper atmosphere in the 1000-2400 angstroms wave length region. Instrumentation and spectrometers will be designed, constructed, and flown on rocket-launched vehicles. Data analysis and laboratory studies necessary for interpretation of the data will be carried out. Related fundamental spectroscopic techniques will be investigated.

AREA OF INVESTIGATION:	Vacuum ultraviolet spectroscopy
TITLE:	Spectra of trapped atoms and low molecular weight molecules
PRINCIPAL INVESTIGATOR:	A. M. Bass
ORGANIZATION:	National Bureau of Standards
ADDRESS:	Washington, D. C.
CONTRACT NUMBER:	R-64

Supporting Research (Contd.)

TIME PERIOD:	1 June 1962 - 31 May 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$24,000
TECHNICAL MONITOR:	R. Miller
ALTERNATE CONTACT:	L. Dunkelman, GSFC
DESCRIPTION:	Studies of the vacuum ultraviolet spectra of atoms and small molecules containing elements such as hydrogen, carbon, nitrogen, and oxygen. Emission and absorption spectra will be observed in both the gas and solid phase.

AREA OF INVESTIGATION:	Theory of spectra
TITLE:	Quantum mechanical calculations and studies on atomic systems of astrophysical interest
PRINCIPAL INVESTIGATOR:	F. A. Matsen C. W. Scherr
ORGANIZATION:	University of Texas
ADDRESS:	Austin, Texas
CONTRACT NUMBER:	NsG-263
TIME PERIOD:	1 June 1962 - 31 May 1963
FUNDED BY:	Geophysics & Astronomy Programs

Supporting Research (Contd.)

AMOUNT:	$35,040
TECHNICAL MONITOR:	R. F. Fellows
DESCRIPTION:	Calculations of ground and excited state energies and optical transition probabilities for mono and diatomic systems and the investigation of electron cross sections of astrophysical interest.

AREA OF INVESTIGATION:	Upper atmosphere chemical release studies
TITLE:	Chemical release studies
PRINCIPAL INVESTIGATOR:	H. D. Edwards
ORGANIZATION:	Georgia Inst. of Technology
ADDRESS:	Atlanta, Georgia
CONTRACT NUMBER:	NsG-304
TIME PERIOD:	Sept. 1962 - Sept. 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$93,555
TECHNICAL MONITOR:	R. F. Fellows
ALTERNATE CONTACT:	R. Miller
DESCRIPTION:	Laboratory and theoretical studies in the application of chemical release techniques to investigations of the upper atmosphere.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Chemistry of the upper atmosphere
TITLE:	Research in fundamental atom chemistry with application to the chemistry of the upper atmosphere
PRINCIPAL INVESTIGATOR:	P. Harteck
ORGANIZATION:	Rensselaer Polytechnic Institute
ADDRESS:	Troy, New York
CONTRACT NUMBER:	NsG-158
TIME PERIOD:	1 July 1961 - 30 June 1964
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$159,700
TECHNICAL MONITOR:	R. Fellows
ALTERNATE CONTACT:	R. Miller
DESCRIPTION:	The following investigations are being conducted: reactions of O-atoms and N-atoms with each other and also with nitrogen compounds; mechanism of ionization by nitrogen atoms and mechanism of de-excitation of excited nitrogen molecules; and studies of ortho-para systems of symmetrical molecules.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Atmospheric photochemistry
TITLE:	Laboratory and theoretical studies in the vacuum ultraviolet for the investigation of chemical physics of planetary atmospheres
PRINCIPAL INVESTIGATOR:	F. F. Marmo
ORGANIZATION:	Geophysics Corporation of America
ADDRESS:	Bedford, Massachusetts
CONTRACT NUMBER:	NASw-395
TIME PERIOD:	2 Feb. 1962 - 2 March 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$216,314
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	L. Dunkelman, GSFC
DESCRIPTION:	Laboratory and theoretical studies in the vacuum ultraviolet including the measurement of absorption spectra and ionization thresholds of possible constituents of planetary atmospheres, the mass analyses of photoionized products and studies of the chemical kinetics of planetary atmospheres.

AREA OF INVESTIGATION:	Atmospheric photochemistry
TITLE:	Photochemistry in the far UV

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	H. Austin Taylor
ORGANIZATION:	New York University
ADDRESS:	New York, New York
CONTRACT NUMBER:	NsG-217
TIME PERIOD:	1 Dec. 1961 - 30 Nov. 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$50,000
TECHNICAL MONITOR:	R. F. Fellows
DESCRIPTION:	A study of the quantum yields and reaction rates in nitric oxide photolysis as a function of pressure, of added nitrogen, of diluents and of wave lengths.

AREA OF INVESTIGATION:	Atmospheric structure
TITLE:	Standard and model atmospheres
PRINCIPAL INVESTIGATOR:	R. A. Minzner
ORGANIZATION:	Geophysics Corporation of America
ADDRESS:	Bedford, Massachusetts
CONTRACT NUMBER:	NASw-394
TIME PERIOD:	14 March 1962 - 13 March 1963
FUNDED BY:	Geophysics & Astronomy Programs

Supporting Research (Contd.)

AMOUNT:	$32,947
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	H. LaGow, GSFC
DESCRIPTION:	Atmospheric data are to be collected and studied with the objectives of studying and analyzing the average structure and variability of the Earth's atmosphere above the level routinely investigated by meteorological balloon techniques. Work will be carried out in conjunction with the U.S. Committee for Extension to the Standard Atmosphere.

AREA OF INVESTIGATION:	Meteorite recovery
TITLE:	Systematic in-flight photography and subsequent recovery of meteorites
PRINCIPAL INVESTIGATOR:	F. Whipple
ORGANIZATION:	Smithsonian Astrophysical Observatory
ADDRESS:	Boston, Massachusetts
CONTRACT NUMBER:	NsG-291
TIME PERIOD:	1 July 1962 - 31 Dec. 1963
FUNDED BY:	Bioscience Programs Lunar & Planetary Programs Geophysics & Astronomy Programs
AMOUNT:	$120,000 - Bio. $60,000 - L & P $59,500 - G & A
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	R. Moore

Supporting Research (Contd.)

DESCRIPTION: SAO will install and operate a network of stations in the lower Midwest U.S. covering an area of 10^6 square km with 13 or more stations. Meteors and fireballs of visual magnitude greater than -5 may be photographed by this network. From the photographic data, accurate trajectory and impact point of the meteorite-in-flight may be measured. The photographic measurements will improve the knowledge of luminous efficiency and the meteoritic ablation process as a function of velocity in the atmosphere. From trajectory data, field collection teams will investigate and attempt to recover the fall. The recovered meteorites will subsequently be analyzed in various scientific laboratories for composition, radioactive spallation products, and biochemical content.

AREA OF INVESTIGATION: Radar meteor studies

TITLE: Radar investigation of the variations in the rate of incidence of meteors on the Earth at high incident rates

PRINCIPAL INVESTIGATOR: C. Ellyett

ORGANIZATION: University of Canterbury

ADDRESS: Christchurch, New Zealand

Supporting Research (Contd.)

CONTRACT NUMBER:	NsG-219
TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1962
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$5,000
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	W. M. Alexander, GSFC
DESCRIPTION:	Radar studies of southern hemisphere meteors are to be made using a single transmitter at 69.5 Mc/sec and a system of three receivers. The study will determine the extent of occurrence of minor radiants. In particular, the distribution of the sporadic nature of these radiants is to be compared to the number of meteors in groupings or meteor streams.

AREA OF INVESTIGATION:	Interplanetary gas and dust
TITLE:	Theoretical studies on interplanetary gas and dust
PRINCIPAL INVESTIGATOR:	S. F. Singer and E. J. Opik
ORGANIZATION:	University of Maryland
ADDRESS:	College Park, Maryland
CONTRACT NUMBER:	NsG-58-60
TIME PERIOD:	1 Feb. 1960 - 31 Jan. 1963

Supporting Research (Contd.)

FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$97,000
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	W. M. Alexander, GSFC
DESCRIPTION:	Detailed theoretical studies of interplanetary dust and gas utilizing available data and newly acquired information from direct space probe measurements.

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	The meteorology of Mars and Venus
PRINCIPAL INVESTIGATOR:	George Ohring
ORGANIZATION:	Geophysics Corporation of America
ADDRESS:	Bedford, Massachusetts
CONTRACT NUMBER:	NASw-286
TIME PERIOD:	Oct. 1961 - Sept. 1962 plus no-cost extension to 6 January 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$59,942
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	J. M. Weldon

Supporting Research (Contd.)

DESCRIPTION:	Determination of average surface temperature of Mars from radiative equilibrium considerations. In addition, the effects of ozone heating, due to absorption of solar ultraviolet energy, on the temperature profile will be computed. The Venus investigations will be devoted primarily to an evaluation of available information and analysis of existing models of the atmosphere.

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Radiative energy transfer on entry into Mars and Venus
PRINCIPAL INVESTIGATOR:	William O. Davies
ORGANIZATION:	Armour Research Foundation
ADDRESS:	Chicago, Illinois
CONTRACT NUMBER:	NASr-65(01) (Amd 2)
TIME PERIOD:	30 Nov. 1962 - 31 Dec. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$63,589
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	J. M. Weldon

Supporting Research (Contd.)

DESCRIPTION:	Determination of the carbon dioxide emission intensity from the 43 micron band at high temperatures; similar determination in the 2.7 micron region. Investigation of the reaction rates of processes occurring behind shock waves in carbon dioxide nitrogen atmospheres.

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Theoretical investigation of the microwave properties of Venus
PRINCIPAL INVESTIGATOR:	A. H. Barrett
ORGANIZATION:	Mass. Inst. of Tech.
ADDRESS:	Cambridge, Mass.
CONTRACT NUMBER:	NsG-250
TIME PERIOD:	1 April 1962 - 31 March 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$28,550
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	R. C. Moore
DESCRIPTION:	Theoretical calculations on the microwave properties of planetary atmospheres, particularly of Venus, to insure proper interpretation of the microwave radiometric data from Mariner probes. This grant also provides funds for the principal investigator to fulfill his commitment as a tentative experimenter with the Mariner program.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Study of polarization of the decametre-wave radiation from Jupiter
PRINCIPAL INVESTIGATOR:	C. H. Barrow
ORGANIZATION:	Florida State University
ADDRESS:	Tallahassee, Florida
CONTRACT NUMBER:	NsG-224
TIME PERIOD:	1 Feb. 1962 - 31 Jan. 1965
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$75,409
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	R. C. Moore
DESCRIPTION:	Objectives of the research program include: (a) Measurement of the magnetic field of Jupiter by observing polarization in the 17 - 27 mc frequency range. (b) Establishing a model of the Jovian upper atmosphere. (c) Improving the theoretical explanations of the origin of the planet's radiation.

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Millimeter-wave converter studies
PRINCIPAL INVESTIGATOR:	R. J. Blanchard

Supporting Research (Contd.)

ORGANIZATION:	International Telephone and Telegraph Corporation
ADDRESS:	Nutley, New Jersey
CONTRACT NUMBER:	NASw-430
TIME PERIOD:	14 May 1962 - 14 Nov. 1962 plus no-cost extension to 19 Aug. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$83,783
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	R. C. Moore
DESCRIPTION:	Feasibility study composed of two parts: (1) A theoretical investigation of the converter principle as applied to the millimeter-wave length region. (2) Experimental work on selected components of a millimeter wave length converter.

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Submillimeter interference spectrometer
PRINCIPAL INVESTIGATOR:	W. K. Rivers, Jr.
ORGANIZATION:	Georgia Inst. of Technology
ADDRESS:	Atlanta, Georgia
CONTRACT NUMBER:	NsG-258

Supporting Research (Contd.)

TIME PERIOD:	1 May 1962 - 31 Oct. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$104,281
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	R. C. Moore
DESCRIPTION:	An advanced technical development program with the objectives of developing and evaluating a submillimeter interference spectrometer applicable to studies of the electromagnetic properties of materials as a function of wave length.

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Laboratory investigations of the composition and chemical behavior of the Venus atmospheres
PRINCIPAL INVESTIGATOR:	P. Harteck
ORGANIZATION:	Rensselaer Polytechnic Institute
ADDRESS:	Troy, New York
CONTRACT NUMBER:	NsG-261
TIME PERIOD:	1 Aug. 1962 - 31 July 1965
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$151,400

Supporting Research (Contd.)

TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	R. C. Moore
DESCRIPTION:	Simulated Venus atmosphere will be exposed to various types of radiation and then analyzed chemically, spectroscopically, and mass spectrometrically.

AREA OF INVESTIGATION:	Planetary Atmospheres
TITLE:	Radiometer development
PRINCIPAL INVESTIGATOR:	A. H. Barrett
ORGANIZATION:	Mass. Inst. of Technology
ADDRESS:	Cambridge, Mass.
CONTRACT NUMBER:	NASr-101
TIME PERIOD:	15 Feb. 1962 - 28 Feb. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$133,300
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	R. C. Moore
DESCRIPTION:	The work will consist of developing a microwave spectral line radiometer for taking simultaneous measurements from space probes of planetary atmospheres, over the 18-34 KMc range, using a single antenna. The present contract does not cover the construction of a packaged model for a specific probe.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Micrometeorite detection
TITLE:	Micrometeorite detection studies
PRINCIPAL INVESTIGATOR:	F. C. Todd
ORGANIZATION:	Oklahoma State University
CONTRACT NUMBER:	NASr-7 (Amd. 3)
TIME PERIOD:	1 Oct. 1962 - 30 Sept. 1963
FUNDED BY:	GSFC
AMOUNT:	$56,208
TECHNICAL MONITOR:	W. M. Alexander, GSFC
ALTERNATE CONTACT:	M. Dubin,
DESCRIPTION:	An analytical and limited experimental study of the mechanisms of impact, penetration and light emission for micrometeorites on an aluminum-coated photomultiplier

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AREA OF INVESTIGATION:	Collision theory
TITLE:	Studies in atomic impact theory
PRINCIPAL INVESTIGATOR:	Felix T. Smith
ORGANIZATION:	Stanford Research Institute
ADDRESS:	Menlo Park, California
CONTRACT NUMBER:	NASr-49 (07)

Supporting Research (Contd.)

TIME PERIOD:	15 April 1962 - 14 April 1963
FUNDED BY:	GSFC
AMOUNT:	$49,140
TECHNICAL MONITOR:	J. Gilbert, GSFC
ALTERNATE CONTACT:	R. F. Fellows
DESCRIPTION:	Conduct theoretical research on low energy electronic, ionic and atomic impact phenomena

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AREA OF INVESTIGATION:	Instrumentation
TITLE:	Mass spectrometer experimental research
PRINCIPAL INVESTIGATOR:	M. K. Testerman
ORGANIZATION:	University of Arkansas
ADDRESS:	Little Rock, Arkansas
CONTRACT NUMBER:	NsG-153
TIME PERIOD:	1 July 1962 - 30 June 1963
FUNDED BY:	GSFC
AMOUNT:	$30,434
TECHNICAL MONITOR:	H. A. Taylor, GSFC
ALTERNATE CONTACT:	R. Horowitz
DESCRIPTION:	Basic experimental research leading to improved cold electron sources and new types of velocity filter mass spectrometers.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Radio astronomy
TITLE:	An experimental investigation of the terrestrial atmosphere utilizing balloon-borne millimeter radiometers
PRINCIPAL INVESTIGATOR:	A. H. Barrett W. Graham R. P. Rafuse
ORGANIZATION:	Massachusetts Institute of Technology
ADDRESS:	Cambridge, Mass.
CONTRACT NUMBER:	NsG-264
TIME PERIOD:	1 May 1962 - 30 April 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$131,300
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	This experiment will determine the oxygen temperature at all altitudes between sea level and the maximum operating altitude of the balloon, obtain a line profile at higher altitudes which can be interpreted in terms of pressure and/or molecular constituents responsible for line broadening, and scan the Moon and Sun at peak altitude in wavelengths not observable from the Earth.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Planetary Astronomy
TITLE:	Infrared spectroscopy applied to planets and stars
PRINCIPAL INVESTIGATOR:	A. B. Meinel
ORGANIZATION:	University of Arizona
ADDRESS:	Tucson, Arizona
CONTRACT NUMBER:	NsG-223
TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1962
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$67,601
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Research in planetary and stellar spectroscopy, including studies of the IR spectra of diatomic molecules, and of techniques for the detection and analysis of extremely tenuous planetary atmospheres
DISCIPLINES:	Planetary Atmospheres (prime) Astronomy

AREA OF INVESTIGATION:	Astronomy for lunar and planetary investigations
TITLE:	The use of television techniques with telescopes above the atmosphere.

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	M. Schwarzschild
ORGANIZATION:	Princeton University
ADDRESS:	Princeton, New Jersey
CONTRACT NUMBER:	NsG 69 (Suppl 4)
TIME PERIOD:	1 July 62 - June 30 63
FUNDED BY:	Geophysics & Astronomy $200,000 Lunar & Planetary $200,000 Bioscience $100,000
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	J. M. Weldon
DESCRIPTION:	For some years to come astronomical instruments above the atmosphere, which promise to revolutionize the entire study of astronomy, will probably be unmanned. To send full information to the ground, television promises to be a most useful tool; both for pointing the instruments at stars, the moon, or planets, and for transmitting the research data to the ground. The purpose of this grant is to design and construct the needed instruments.
DISCIPLINES:	Planetology (prime) Planetary Atmospheres (prime) Bioscience

Interest In
Supporting Research

AREA OF INVESTIGATION:	Planetary astronomy
TITLE:	Lunar & planetary 60 inch telescope
PRINCIPAL INVESTIGATOR:	G. P. Kuiper
ORGANIZATION:	University of Arizona
ADDRESS:	Tucson, Arizona
CONTRACT NUMBER:	NASr-82
TIME PERIOD:	21 Aug. 1962 - 20 Aug. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$375,000
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Construction of a 60-inch lunar and planetary telescope
DISCIPLINES:	Planetology (prime) Astronomy Planetary Atmospheres

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AREA OF INVESTIGATION:	Planetary atmospheres
TITLE:	Zodiacal light and airglow
PRINCIPAL INVESTIGATOR:	Walter R. Steiger
ORGANIZATION:	University of Hawaii
CONTRACT NUMBER:	NsG-135

Interest In
Supporting Research (Contd.)

TIME PERIOD:	1 April 1961 - 31 March 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$120,039
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Study on zodiacal light selected lines in the airglow spectrum. In cooperation with NBS Boulder (R-18).
DISCIPLINES:	Astronomy (prime) Planetary Atmospheres

AREA OF INVESTIGATION:	Planetary atmospheres
TITLE:	Zodiacal light and airglow
PRINCIPAL INVESTIGATOR:	F. E. Roach
ORGANIZATION:	National Bureau of Standards
ADDRESS:	Boulder, Colo.
CONTRACT NUMBER:	R-18
TIME PERIOD:	1 April 1961 - 31 March 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$25,000
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Support of University of Hawaii-University of Colorado research on zodiacal light and airglow. In cooperation with U. Hawaii (NsG-135)
DISCIPLINES:	Astronomy (prime) Planetary Atmospheres

Supporting Research

AGENCY	AREA	LEVEL OF EFFORT (FY 63)	PRINCIPAL INVESTIGATORS
Ames Research Center	Planetary Atmospheres	$80,000	G. C. Augason J. H. Miller
Flight Research Center	Planetary Atmospheres	$20,000	M. A. Covington
Goddard Space Flight Center	Planetary Atmospheres	$1,055,300	W. M. Alexander B. Donn A. Levine J. Gilbert N. Spencer A. Temkin
Langley Research Center	Planetary Atmospheres	$75,000	R. Hord
Lewis Research Center	Planetary Atmospheres	$103,000	A. Potter
Jet Propulsion Laboratory	Planetary Atmospheres	$428,000	C. Barth F. Estabrook H. Ford R. L. Heacock L. Kaplan H. Trostle H. W. Washburn

IONOSPHERES AND RADIO PHYSICS

OBJECTIVES:

The earth's ionosphere is that part of the upper atmosphere which is sufficiently ionized to affect radio waves. Similar ionized regions are expected, in greater or lesser degrees, around the moon and planets, and in interplanetary space. The NASA program in Ionospheres and Radio Physics is concerned with investigating the nature, origin and behavior of these ionized regions, as well as their influence on radio waves.

DESCRIPTION:

The bulk properties of ionized regions which affect radio wave propagation consist of the density of the charged particles, their collision frequencies with one another and with neutral constituents, and the superposed magnetic and electric fields. The propagation paths, time-delay and dispersive effects are primarily determined by the electron density and magnetic field, while the attenuation is mainly controlled by the collisions of electrons with other particles. The fine structure of the ionized regions is responsible for the fading of radio signals and the scintillation effects observed on satellite and stellar sources. Thus, a detailed knowledge of these ionized regions is essential to an understanding of radio propagation phenomena, and conversely, radio propagation techniques can be used to determine the parameters which describe the ionized regions.

There are other phenomena of interest in these ionized regions not so directly connected with radio propagation. The thermal velocity distribution of the

ions determines the radio noise generated in situ as well as the spectrum of incoherent backscatter from powerful radio transmitters. Incoming particle streams interacting with the magnetic field and ionization can generate and amplify VLF signals. The special events associated with solar outbursts and high altitude nuclear explosions are important because the ionospheric effects provide a means of studying the causative phenomena, and also because of their influence on radio communications.

The parameters which describe the nature of the ionized regions depend in a very complicated way on time and position, because both the mechanisms of ion production and ion removal are time and position dependent. The solar radiation, which is responsible for the bulk of the ionization, varies with a roughly 11 year period; and the radiation absorbed at any given point in space varies, in addition, with time of day, season and position. The processes of ion removal depend partly on the bulk properties of the local atmosphere which control the recombination and diffusion of ions, and partly on the dynamic behavior of the atmosphere, which controls the transport of the ions towards and away from a given point.

At present, many of the phenomena briefly mentioned above are very imperfectly understood, and it is clear that the first step in achieving a proper understanding of them consists of measuring simultaneously the various parameters which control the ambient ionization as well as the fine structure. Concurrent with the direct investigation of the ionized regions, there is a need for both theoretical and experimental laboratory investigations of the processes which result in the production and recombination of ionization, the electrodynamic forces which displace the ionization, and the interactions with particle streams responsible for generation and amplification of electromagnetic energy.

Important gaps in our knowledge may be listed under the following categories:

1) Lack of factual data concerning primary ionospheric parameters.

2) Lack of data concerning parameters which influence ionized regions.

3) Lack of understanding of processes which occur in ionized regions.

Under the first category is included our lack of knowledge concerning the ionospheres of the planets, the gaps in our knowledge of the earth's ionosphere, particularly in polar regions and above the peak of the F2 layer, as well as a lack of details concerning ionizing solar flux and low energy particles in auroral regions.

Under the second category are the temperatures of ionized and neutral constituents, densities and composition of neutral constituents, bulk motions due to tidal and electrodynamic effects, and shear motions which could be responsible for sporadic E.

Under the third category are ionizing processes, the chemical reactions which result in the recombination of ionization, the phenomena which produce the observed seasonal changes, the nighttime ionosphere in polar regions, the equatorial distribution of electrons, and storm effects.

The regions of interest to the ionospheres program may be conveniently subdivided as follows:

1) The earth's D-region (50-80 km)

2) The bottomside (E, F1, and lower F2 regions) of the earth's ionosphere (80-300 km)

3) The topside of the earth's ionosphere (300-1,000 km)

4) The magnetosphere and the transition region between it and the interplanetary plasma (1,000-100,000 km)

5) The interplanetary plasma

6) The ionospheres of the other planets and of the moon.

TECHNIQUES AND INSTRUMENTS:

Available:

The oldest techniques for ionospheric research utilize the propagation of radio waves from the ground to the ionosphere and back. Sweep frequency soundings at vertical incidence provide useful propagation data, and enable electron density profiles to be obtained from the bottom of the E region to the peak of the F region. This determination is unambiguous when the profiles are monotonic, but there are ambiguities and difficulties in interpretation when valleys are present. Many sites are now available for synoptic studies, but some gaps exist in coverage, so that additional stations may be needed to support specific experiments. Variations of this technique, such as phase path measurements, intermodulation measurements and partial reflection measurements have been used on a much smaller scale, and are particularly useful for D and E regions. Observations at very low frequencies of whistlers, generated by lightning flashes and transmitters, provide integrated measurements approximately along magnetic field lines. These are particularly important for studying the magnetosphere.

Passive observations by ground-based receivers

(riometers) provide data on irregularities and D region absorption when receiving stellar and galactic sources. By using high gain antennas, synchrotron emission has also been observed from the radiation belts.

Another available technique utilizes the one-way propagation of radio signals from rockets or satellites. The rocket experiments are particularly suitable for unambiguous determinations of electron density and collision frequency with high resolution in an undisturbed ionosphere, but must be interpreted with increasing care as the vehicle reaches higher altitudes. Satellite observations yield primarily the electron content between vehicle and observer, and also provide some information on irregularities.

Another experimental procedure used is that of direct sampling of the ionosphere from space vehicles. Such experiments rely on radio telemetry of the data back to the ground, rather than on physical recovery of the data or of samples. Such techniques permit the measurement of those ionospheric variables which are so essential to an understanding of the fundamental ionospheric parameters. They are particularly useful in the study of anomalous or rapidly changing ionospheric conditions which disrupt communications, because propagation measurements are considerably more difficult to perform and to interpret quantitatively under such circumstances. The direct sampling techniques now in use include:

	Instrument	Primary Parameter
a.	Radio frequency impedance probe	Electron density
b.	Langmuir probe	Electron thermal velocity distribution, electron density

c.	Ion trap	Ion density
d.	Ion spectrometer	Ion mass distribution
e.	Gerdien condenser	D region ionization

UNDER DEVELOPMENT:

Several techniques are being developed to measure electron densities and other parameters above the F region peak (near 300 km). Ground-based incoherent backscatter measurements are beginning to provide quantitative data up to about 10,000 km, but there are still some features which need clarification. Space vehicle direct sampling techniques are being continuously refined. Simple VLF experiments have been flown successfully, and more sophisticated experiments are being developed. Satellite topside sounders show great promise, and the Alouette satellite (S-27) has shown how both the electron density at the satellite and the profile between the F region peak and the satellite can be obtained by a logical extension of the ground based ionosonde concept. Experiments are being developed to investigate cosmic as well as ionospheric noise. Also being developed is the concept of radio transmission between closely spaced vehicles to obtain electron densities (averaged between the intervening distance) with good accuracy and resolution at extreme altitudes.

PROJECTS AND TASKS:

Satellites

PROJECT DESIGNATION:	Atmospheric Structure Satellite (S-6)
VEHICLE:	Delta
DATE/SITE:	1st quarter 1963 at AMR
ORBIT:	Perigee 250 km; Apogee 800 km; maximum inclination 51°
EXPECTED LIFETIME:	Three months
HEADQUARTERS CONTACT :	R. F. Fellows, SGC, Program Scientist
Alternate :	E. Ehrlich, Project Officer
EXPERIMENTER:	N. W. Spencer, GSFC L. Brace, GSFC
PARAMETER:	Electron densities from approximately 10^3 per c.c. to 4×10^6 per c.c.
EXPERIMENT:	Measure distribution of electron temperature and density
TECHNIQUE:	Langmuir probe method for determining the distribution function of electrons from analyses of the volt-ampere curve
INSTRUMENT:	Swept voltage electron probe
STATUS:	Funded through 2 Q 63 for flight
DISCIPLINES:	Ionospheres and Radio Physics (prime) Planetary Atmospheres

Satellites (Contd.)

PROJECT DESIGNATION:	S-48, S-48a Fixed-Frequency Topside Sounder
VEHICLE:	Scout
DATE/SITE:	1Q63/PMR
ORBIT:	Inclination, 80°; Apogee, 1184 km; Perigee, 800 km
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	E. R. Schmerling, SGP, Program Scientist
Alternate :	M. J. Aucremanne, SGX, Project Officer
EXPERIMENTER:	R. W. Knecht, National Bureau of Standards S. Russell, Airborne Instruments Laboratory
PARAMETER:	Electron density profile, approximately 300 to 1000 km. Cosmic noise level in the 3- to 9- Mc frequency range. Electron density in neighborhood of satellite.
EXPERIMENT:	Measure electron density height profile by pulse delay. Measure ambient noise level. The experiment will map global distribution and investigate this as a function of time.
TECHNIQUE:	Soundings of the ionosphere from above. Group delay measurements on six fixed frequencies at 2.85, 3.72, 4.60, 5.67, 6.82, 8.57 Mc/s.
INSTRUMENT:	Ionosonde equipment of special design.

Satellites (Contd.)

PROJECT DESIGNATION: S-48, S-48a (Contd.)

STATUS: Funded by GSFC.

DISCIPLINES: Ionospheres & Radio Physics

PROJECT DESIGNATION: S-49, S-49a Eccentric Orbiting Geophysical Observatory (EGO)

VEHICLE: S-49, Atlas-Agena B; S-49a, Atlas-Agena B

DATE/SITE: S-49, 3Q63/AMR
S-49a, 4Q63/AMR

ORBIT: Inclination, 31°; Apogee 110,000 km; Perigee, 280 km

EXPECTED LIFETIME: 1 year

HEADQUARTERS CONTACT : L. J. Cahill, SGP, Program Scientist
Alternate : D. Ashworth, SGF, Program Manager

EXPERIMENTER: R. C. Sagalyn, AFCRL
M. Smiddy, AFCRL

PARAMETER: Densities of positively and negatively charged particles, energy distributions of these particles to 1 kev, and potential of vehicle with respect to the undisturbed plasma.

EXPERIMENT: Measurement of the above quantities as functions of position and time.

Satellites (Contd.)

PROJECT DESIGNATION: S-49, S-49a (Contd.)

TECHNIQUE: Two sensors, one for measurement of positively charged particles and one for negatively charged particles, each operated in at least three modes.

INSTRUMENT: Spherical three-electrode probe mounted on a boom.

STATUS: Funded through flight

DISCIPLINES: Ionospheres & Radio Physics (prime)
Particles & Fields

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EXPERIMENTER: E. C. Whipple, Jr., GSFC

PARAMETER: Densities and temperatures of charged particles of both polarities, information on ion masses, fluxes and directions of energetic particle beams, polarity and magnitude of vehicle potential.

EXPERIMENT: Measurement of the above quantities as functions of position and time

TECHNIQUE: Separation of particles according to their polarity and energy.

INSTRUMENT: Planar ion and electron trap

STATUS: Funded through flight

DISCIPLINES: Ionospheres & Radio Physics (prime)
Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION: S-49, S-49a (Contd.)

EXPERIMENTER: R. A. Helliwell, Stanford Univ.
L. H. Rorden, Stanford Research Inst.

PARAMETER: Noise and signal amplitudes as a function of time, location, and frequency in the range 0.2 - 100 Kc/s

EXPERIMENT: Mapping of VLF noise and field strengths of signals

TECHNIQUE: Continuous synoptic noise survey, continuous monitoring of sudden commencement VLF noise bursts, recording samples of broadband VLF noise, and propagation characteristics of VLF and LF signals originating on the ground.

INSTRUMENT: Antenna and three frequency-stepping receivers covering the range of 200 cps to 100 kc.

STATUS: Funded through flight

DISCIPLINES: Ionospheres & Radio Physics

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EXPERIMENTER: H. J. A. Chivers, CRPL
R. S. Lawrence, CRPL

PARAMETER: Electron content, scintillations

EXPERIMENT: Radio beacon experiment to permit the above parameters to be investigated as functions of position and time.

Satellites (Contd.)

PROJECT DESIGNATION:	S-49, S-49a (Contd.)
TECHNIQUE:	Faraday rotation, differential Doppler
INSTRUMENT:	40 Mc/s and 360 Mc/s transmitters with switched 200 Kc/s and 20 Kc/s modulation
STATUS:	Funded through flight
DISCIPLINES:	Ionospheres & Radio Physics

PROJECT DESIGNATION:	Polar Orbiting Geophysical Observatory (POGO) (S-50)
VEHICLE:	Thor-Agena D
DATE/SITE:	1964/PMR
ORBIT:	Perigee 260 km; Apogee 920 km; polar orbit
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	R. F. Fellows, SGC, Program Scientist
Alternate :	D. Ashworth, SGF, Program Manager
EXPERIMENTER:	R. A. Helliwell, Stanford University
PARAMETER:	Amplitudes, phases, and spectral composition of VLF signals in the range 0.2 - 100 Kc/s
EXPERIMENT:	A VLF noise and propagation experiment to map noise and investigate propagation conditions as functions of place and time

Satellites (Contd.)

PROJECT DESIGNATION: POGO (S-50) (Contd.)

TECHNIQUE: Compare amplitudes from transmitters at different positions to obtain information on ionospheric transmission coefficients. Phase and spectrum measurements to provide information on whistler ray paths.

INSTRUMENT: Loop antenna and VLF receiver, and two transmitters at different positions in orbit and on the ground.

STATUS: POGO experiments being funded in CY 1962 and CY 1963 for flight

DISCIPLINES: Ionospheres & Radio Physics

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EXPERIMENTER: M. G. Morgan, Dartmouth College
T. Laaspere, Dartmouth College

PARAMETER: Obtain the diurnal and latitude variations of the VLF spectra (high resolution) both in orbit and on the ground.

EXPERIMENT: Whistlers and VLF emissions. Investigation of whistler propagation and noise generation by simultaneous observations from the satellite and from the ground.

TECHNIQUE: Obtain high resolution samples of whistler spectra in conjunction with similar information from an existing chain of ground stations.

Satellites (Contd.)

PROJECT DESIGNATION:	POGO (S-50) (Contd.)
INSTRUMENT:	Loop antenna and wide-band receiver to cover the approximate range of 500-15,000 cps.
STATUS:	POGO experiments being funded in CY 62 and CY 63 for flight.
DISCIPLINES:	Ionospheres & Radio Physics

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EXPERIMENTER:	R. E. Bourdeau, GSFC
PARAMETER:	Charged particle density, ion temperature, electron temperature, and (to some extent) ion composition and ultraviolet solar flux.
EXPERIMENT:	Investigation of the distribution of above parameters in space and their variation with time.
TECHNIQUE:	Retarding potential analyzer for each parameter.
INSTRUMENT:	Two planar ion traps.
STATUS:	POGO experiments being funded in CY 62 and CY 63 for flight
DISCIPLINES:	Ionospheres & Radio Physics (prime) Planetary Atmospheres

Satellites (Contd.)

PROJECT DESIGNATION:	S-66, S-66a Polar Ionosphere Beacon
VEHICLE:	Scout
DATE/SITE:	S-66, 1Q63/PMR S-66a, 2Q63/PMR
ORBIT:	Inclination, $80^{\circ}/90^{\circ}$; Apogee, 960 km; Perigee, 960 km
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	E. R. Schmerling, SGP
Alternate :	M. J. Aucremanne, SGX
PARTICIPANTS:	University of Illinois; Pennsylvania State University; International participants; National Bureau of Standards; Stanford University
PARAMETER:	Total electron content; absorption; scintillation; possible addition of local electron density probes (cylindrical)
EXPERIMENT:	Provision of a multifrequency beacon, enabling electron content and scintillations to be studied on a nearly global basis.
TECHNIQUE:	Ground-based measurements of Faraday rotation, Doppler, and scintillations using observations of beacon transmitters carried by satellite.

Satellites (Contd.)

PROJECT DESIGNATION: S-66, S-66a (Contd.)

INSTRUMENT: S-66 beacon transmitters on frequencies of 20 Mc, 40 Mc, 41 Mc, 360 Mc plus Transit frequencies of 162 Mc and 324 Mc

STATUS: Funded through FY 63 for flight hardware

DISCIPLINES: Ionospheres & Radio Physics

PROJECT DESIGNATION: Interplanetary Monitoring Probe (IMP) (S-74a, S-74b, S-74c)

VEHICLE: Thor-Delta

DATE/SITE: 1963, 1964/AMR

TRAJECTORY: Apogee 300,000 km, Perigee 200 km, Inclination 31°

TIME PERIOD: 1 year

HEADQUARTERS CONTACT : L. J. Cahill, Jr., SGP, Program Scientist
Alternate : E. Ehrlich, SGX, Project Officer

EXPERIMENTER: G. P. Serbu, GSFC

PARAMETER: Plasma

EXPERIMENT: Measure thermal ions and electrons 0 to 10 ev

TECHNIQUE: Planar trap collection of thermal particles

Satellites (Contd.)

PROJECT DESIGNATION: IMP (S-74a, S-74b, S-74c) (Contd.)

INSTRUMENT: Planar trap ion-electron detector

STATUS: Funded by GSFC

DISCIPLINES: Ionospheres & Radio Physics (prime)
Solar Physics
Particles & Fields

PROJECT DESIGNATION: S-52 (International Satellite)

VEHICLE: Scout

DATE/SITE: 3Q1963/Wallops Island, Va.

ORBIT: Perigee 370 km; Apogee 1800 km; inclination 51°

HEADQUARTERS CONTACT : R. F. Fellows
Alternate : R. E. Halpern

EXPERIMENTER: F. G. Smith, Cambridge Univ., England

PARAMETER: Galactic radio noise in frequency range 0.75 Mc to 3.0 Mc

EXPERIMENT: Mapping of galactic radio noise in above frequency range, and investigation of ionospheric effects at these frequencies

TECHNIQUE: Reception of signals on satellite

INSTRUMENT: Dipole antenna and receiver

Satellites (Contd.)

PROJECT DESIGNATION:	S-52 (Contd.)
STATUS:	Funded by U.K.
DISCIPLINES:	Ionospheres & Radio Physics (prime) Astronomy

PROJECT DESIGNATION:	Italian - NASA Cooperative Program
VEHICLE:	Scout
DATE/SITE:	1964/Wallops Island, Va.
ORBIT:	Circular, equatorial, altitude between 150-300 km
EXPECTED LIFETIME:	Several weeks to several months
HEADQUARTERS CONTACT :	R. F. Fellows, Program Scientist
Alternate :	R. D. Ginter, Project Manager
EXPERIMENTER:	Italian Space Commission
PARAMETER:	Electron content and ducted propagation
EXPERIMENT:	Iono Beacon
TECHNIQUE:	20 Mc/s beacon frequency
INSTRUMENT:	20 Mc/s transmitter and ground-based receiver
STATUS:	NASA provides vehicle and back-up, funded through 2Q63. Italian Space Commission provides satellite and launch platform.
DISCIPLINES:	Ionospheres & Radio Physics

Interest in Satellites

The following experiments are of interest to the Ionospheres and Radio Physics discipline.

Atmospheric Structure Satellite (S-6); Delta; 1st. Qtr 1963/ AMR; 250 km; 800 km; 51°; R. F. Fellows, Program Scientist:

EXPERIMENTER: C. Reber, GSFC

PARAMETER: Neutral composition of the atmosphere at masses 4, 14, 16, 18, 28, and 32 AMU.

EXPERIMENT: Measurement of partial densities of each of the above noted masses as a function of time of day, geographic location, and geophysical phenomena. Gas kinetic temperatures will be computed.

TECHNIQUE: Direct measurement of the distribution of the neutral gas species using a mass spectrometer mounted on a spinning satellite.

INSTRUMENT: Double-focusing sector neutral gas mass spectrometer

STATUS: Funded

DISCIPLINES: Ionospheres & Radio Physics
Planetary Atmospheres (prime)

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EXPERIMENTER: R. Horowitz, NASA Headquarters
G. Newton, GSFC

PARAMETER: Variations in gauge pressure from 10^{-6} to 10^{-10} mmHg.

Interest in
Satellites (Contd)

Atmospheric Structure Satellite (S-6) (Contd)

EXPERIMENT:	Measurement of atmospheric density, pressure and temperature as a function of altitude, time of day, geographic location, and geophysical phenomena.
TECHNIQUE:	Direct measurement of atmospheric density and pressure using suitable detectors mounted on a spinning satellite.
INSTRUMENT:	Two Bayard-Alpert ionization gauges Two Redhead ionization gauges
STATUS:	Funded
DISCIPLINES:	Ionospheres & Radio Physics Planetary Atmospheres (prime)

EGO (S-49); Atlas-Agena B; 1963/AMR; 270 km, 110,000 km, 31°; L. Cahill, Program Scientist:

EXPERIMENTER:	H. Taylor, GSFC N. W. Spencer, GSFC
PARAMETER:	Density of positive ions in mass range from 1 to 50 AMU and from 10 to 10^5 ions per cc
EXPERIMENT:	Direct measurement of the distribution of exospheric ionic composition
TECHNIQUE:	On board spectrometer to give direct readings. By varying the retarding potential of tube and by adjusting the gain of amplifier, entire range is covered

Interest In
Satellites (Contd.)

EGO (S-49) (Contd.)

INSTRUMENT: Ruggedized RF ion mass spectrometer

STATUS: Funded

DISCIPLINES: Ionospheres & Radio Physics
Planetary Atmospheres (prime)

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EXPERIMENTER: H. Bridge, MIT A. Bonetti, MIT
A. J. Lazarus, MIT B. Rossi, MIT
F. Scherb, MIT

PARAMETER: Interplanetary plasma

EXPERIMENT: To study the properties of plasma from the Sun by measuring proton and electron flux, the energy spectrum, the direction of flux, and temporal and spatial variations of these quantities in the energy range from 10 ev to 10 kev

TECHNIQUE: Measurement of plasma flux and energy by collection in Faraday cup and modulation by electric fields

INSTRUMENT: Faraday cup plasma probe

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Ionospheres & Radio Physics

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Interest In
Satellites (Contd.)

EGO (S-49) (Contd.)

EXPERIMENTER: Michael Bader, Ames Res. Center

PARAMETER: Interplanetary plasma

EXPERIMENT: To study plasma from the Sun by measuring proton concentrations ranging from 10^{-2} to 10^{-4} particles per cm^3 as a function of proton energy in the range 0.2 to 20 kev

TECHNIQUE: Measurement of plasma energy by analysis with curved plate spectrometer

INSTRUMENT: Curved plate plasma probe

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Ionospheres & Radio Physics

POGO (S-50); Thor-Agena D; 1964/PMR; 260 km, 920 km, polar orbit; R. F. Fellows, Program Scientist:

EXPERIMENTER: J. R. Winckler, Univ. of Minn.
R. Gallet, NBS

PARAMETER: VLF signals and particle measurements

EXPERIMENT: VLF emissions and high energy electron bunches in the magnetosphere.

TECHNIQUE: Correlation, preferably in the spacecraft, of VLF signals with particle measurements.

Interest In
Satellites (Contd.)

POGO (S-50) (Contd.)

INSTRUMENT:	Measurements obtained from other, more general-purpose experiments
STATUS:	POGO experiments being funded in CY 62 and 63 for flight
DISCIPLINES:	Particles & Fields (prime) Ionospheres & Radio Physics

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EXPERIMENTER:	L. Jones, Univ. of Mich. E. Schaefer, Univ. of Mich.
PARAMETER:	Neutral species and positive ions in range 0 to 40 AMU
EXPERIMENT:	To obtain neutral and ionic composition of atmosphere as a function of altitude, geographic location, time of day, season, and geophysical phenomena
TECHNIQUE:	Using one sensor, program to measure neutral, then to look at ions. Utilize two mass ranges 0 - 6 AMU and 0 - 40 AMU
INSTRUMENT:	Paul Massenfilter spectrometer tube
STATUS:	Funded for FY 1963
DISCIPLINES:	Planetary Atmospheres (prime) Ionospheres & Radio Physics

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Interest in Satellites (Contd.)

POGO (S-50) (Contd.)

EXPERIMENTER: G. P. Newton, GSFC

PARAMETER: Variations in detector pressure in range from about 10^{-5} to 10^{-10} mmhg

EXPERIMENT: To measure directly atmospheric density as a function of altitude, latitude, time of day, season, and geophysical phenomena

TECHNIQUE: Direct measurement of RAM pressure using sensor coupled to the atmosphere by an orifice

INSTRUMENT: Bayard-Alpert type ionization gauge

STATUS: Funded for FY 1963

DISCIPLINES: Ionospheres & Radio Physics
Planetary Atmospheres (prime)

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EXPERIMENTER: H. Taylor, GSFC; H. C. Brinton, GSFC

PARAMETER: Measurement of atmospheric positive ion composition and density in range 1-45 AMU. Total ion current also measured.

EXPERIMENT: Direct measurement of ion composition and density as function of altitude, geographic location, time of day, season, and geophysical phenomena

TECHNIQUE: Appropriate voltage programming of grids of RF ion mass spectrometer

Interest in
Satellites (Contd.)

POGO (S-50) (Contd.)

INSTRUMENT: Ruggedized RF ion mass spectrometer

STATUS: Funded for FY 1963

DISCIPLINES: Ionospheres & Radio Physics
Planetary Atmospheres (prime)

Interest In Space Probes

PROJECT DESIGNATION:	Mariner II
VEHICLE:	Atlas-Agena B
DATE/SITE:	Launched 27 Aug. 1962 from AMR
TRAJECTORY:	Venus fly-by
EXPECTED LIFETIME:	Closest approach to Venus on 14 Dec. 1962
HEADQUARTERS CONTACT :	F. Kochendorfer
Alternate :	G. A. Reiff
EXPERIMENTER:	L. D. Kaplan, JPL G. Neugebauer, JPL C. Sagan, UCBerkeley
PARAMETER:	Atmospheric and surface temperature
EXPERIMENT:	Measure Venus atmospheric temperatures and map cloud coverage
TECHNIQUE:	Infrared energy received by scanning Venus may be interpreted to give temperature
STATUS:	Funded by Lunar & Planetary Programs through flight instrument
DISCIPLINES:	Planetary Atmospheres (prime) Planetology Ionospheres & Radio Physics

Geoprobes and Sounding Rockets

NASA No.: 4.44, 4.45

VEHICLE: Aerobee 150A

DATE/SITE: 1st. Qtr 1963/ Wallops

TRAJECTORY: 230 km peak altitude

HEADQUARTERS CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: S. J. Bauer, GSFC
H. A. Whale, GSFC

PARAMETER: Electron density

EXPERIMENT: Comparison of different techniques for measuring electron density, and investigation of electroacoustic mode

TECHNIQUE and INSTRUMENT: C. W. propagation, RF probe, electroacoustic probe, swept frequency probe, Langmuir probe.

STATUS: Funded by Goddard

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 4.58, 4.59

VEHICLE: Aerobee 150A

DATE/SITE: 1963 (1st Qtr)/Wallops

TRAJECTORY: 230 km peak altitude

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.58, 4.59 (Contd.)

HEADQUARTERS
CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: L. H. Rorden, Stanford Research Inst.

PARAMETER: VLF signals 0.5-30 kc/s

EXPERIMENT: Investigation of entry and exit of whistler mode signals by measuring signals on 6 frequencies as a function of altitude.

TECHNIQUE and INSTRUMENT: Swept receiver

STATUS: Funded through GSFC

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 4.64, 4.65

VEHICLE: Aerobee 150A

DATE/SITE: 1963 (1st Qtr)/Wallops

TRAJECTORY: 225 km peak altitude

HEADQUARTERS
CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: G. P. Serbu, GSFC
Radio Research Laboratories, Japan

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.64, 4.65 (Contd.)

PARAMETER: Charged-particle concentration and temperature distribution as a function of altitude.

EXPERIMENT: Joint U. S.-Japanese experiment in the lower ionosphere to investigate the processes occurring in the lower ionosphere and to cross-check different measuring techniques

TECHNIQUE: Use of two independent experimental techniques for simultaneous comparison of the above mentioned parameters

INSTRUMENT: Composite electron and ion trap and resonance probe.

STATUS: Awaiting formal agreement

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 4.80

VEHICLE: Aerobee 150A

DATE/SITE: December 1962/Wallops

TRAJECTORY: 200 km peak altitude

HEADQUARTERS CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: D. G. Cartwright, CSIRO (Australia)

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 4.80 (Contd.)

PARAMETER: Intensity and spectrum of VLF signals in range 0.7 - 12 kc/s

EXPERIMENT: To investigate the mechanism whereby VLF signals enter into the whistler mode in the lower ionosphere

TECHNIQUE and INSTRUMENT: 2 VLF receivers with orthogonal loops.

STATUS: Funded through GSFC

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 8.14

VEHICLE: Argo D-4

DATE/SITE: 1963 (3rd or 4th Qtr)/Wallops

TRAJECTORY: 800 km peak altitude

HEADQUARTERS CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: A. R. Molozzi, Defence Research Telecommunications Establishment (Canada)

PARAMETER: Electron density, radio noise

EXPERIMENT: Elucidation of problems connected with interpretation of topside sounder data; development tests for next generation topside sounder.

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 8.14 (Contd.)

TECHNIQUE: Pulse delay soundings, noise and "splash" measurement.

INSTRUMENT: Radio swept frequency transmitter and receiver.

STATUS: Funded through GSFC

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 8.18

VEHICLE: Argo D-4

DATE/SITE: 1963 (3rd Qtr)/Ft. Churchill

TRAJECTORY: 1000 km

HEADQUARTERS CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: R. W. Knecht, National Bureau of Standards
S. Russell, Airborne Instruments Lab.

PARAMETER: Electron density, radio noise

EXPERIMENT: To elucidate problems connected with the interpretation of topside sounder data. Tests of next generation topside sounder techniques.

TECHNIQUE and INSTRUMENT: Swept frequency radio transmitter and receiver

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 8.18 (Contd.)

STATUS: Funded through GSFC

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 8.19, 8.20

VEHICLE: Argo D-4 (2 Veh.)

DATE/SITE: 1963 (1st Qtr) (depending on launcher readiness)/Ft. Churchill

TRAJECTORY: 980 km peak altitude

HEADQUARTERS CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: A. Nagy, Univ. of Michigan in collaboration with Ballistics Research Laboratory

PARAMETER: Electron density, ion density, electron temperature, magnetic field

EXPERIMENT: To measure above parameters in auroral conditions

TECHNIQUE and INSTRUMENT: Cylindrical Langmuir probe, precession magnetometer, CW propagation on 2 frequencies

STATUS: Partially funded by Geophysics and Astronomy Programs

DISCIPLINES: Ionospheres & Radio Physics

Geoprobes and Sounding Rockets (Contd.)

NASA No.:	8.25, 8.26, 8.27
VEHICLE:	Argo D-4
DATE/SITE:	1963/Wallops
TRAJECTORY:	800 km peak altitude
HEADQUARTERS CONTACT :	E. R. Schmerling, SGP
Alternate :	J. R. Holtz, SGF
EXPERIMENTER:	R. E. Bourdeau, GSFC N. W. Spencer, GSFC S. J. Bauer, GSFC H. A. Taylor, GSFC
PARAMETER:	Densities of ions and electrons, neutral densities, electron and ion temperatures
EXPERIMENT:	In conjunction with a separate, simultaneous measurement of solar flux, to measure the individual quantities which enter into the continuity equation. Some cross-checking with Topside Sounder data is also planned.
TECHNIQUE and INSTRUMENT:	CW propagation measurement Planar and spherical ion probes Retarding potential analyzer Ionization gauge
STATUS:	Funded by Geophysics & Astronomy in FY 1963
DISCIPLINES:	Ionospheres & Radio Physics (prime) Planetary Atmospheres

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 8.28, 8.30

VEHICLE: Argo D-4

DATE/SITE: 1963 (2nd Qtr)/Wallops

TRAJECTORY: 1100 km peak altitude

HEADQUARTERS
CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: J. S. Nisbet, Pennsylvania State Univ.

PARAMETER: Electron density

EXPERIMENT: Accurate determination of electron density profile by radio wave propagation between rocket and separating capsule.

TECHNIQUE: Propagation of signals between rocket and capsule

INSTRUMENT: Receivers, transmitters, phase comparators

STATUS: 3 year step funded to March 1965

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 14.33, 14.34

VEHICLE: Nike-Apache

DATE/SITE: 1963 (2nd Qtr, 3rd Qtr)/Wallops

TRAJECTORY: 160 km peak altitude

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.33, 14.34 (Contd.)

HEADQUARTERS
CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: S. J. Bauer, GSFC

PARAMETER: Electron density, solar flux

EXPERIMENT: E region study to correlate flux measurements with measurements of electron density

TECHNIQUE: CW propagation, ion probe
INSTRUMENT: Simple radiation detector

STATUS: Goddard FY 1963 budget

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 14.86, 14.87

VEHICLE: Nike Apache

DATE/SITE: February 1963/Wallops

TRAJECTORY: 160 km peak altitude

HEADQUARTERS
CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: L. G. Smith, Geophysics Corp. of America

PARAMETER: Electron density, X-ray and UV flux

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.86, 14.87 (Contd.)

EXPERIMENT: Development test for eclipse experiment

TECHNIQUE and INSTRUMENT: Langmuir probe
Lyman - ion chamber
X-ray photon counters

STATUS: Funded to January 1964

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 14.88 - 14.94

VEHICLE: Nike Apache (7 Veh.)

DATE/SITE: July 1963/Ft. Churchill

TRAJECTORY: 160 km peak altitude

HEADQUARTERS CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: L. G. Smith, Geophysics Corp. of America

PARAMETER: Electron density, X-ray and UV flux

EXPERIMENT: To measure changes in the ionosphere during an eclipse by correlating the above parameters

TECHNIQUE and INSTRUMENT: Langmuir probe
Lyman - ion chamber
X-ray photon counters

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 14.88 - 14.94 (Contd.)

STATUS: Funded to January 1964

DISCIPLINES: Ionospheres & Radio Physics

NASA No.: 14.107, 14.108, 14.109

VEHICLE: Nike Apache

DATE/SITE: January 1963/Wallops

TRAJECTORY: 120 km peak altitude

HEADQUARTERS CONTACT : E. R. Schmerling, SGP
Alternate : J. R. Holtz, SGF

EXPERIMENTER: E. C. Whipple, GSFC

PARAMETER: Ion and electron densities; also electrical conductivity; monitor solar UV and X-ray emissions

EXPERIMENT: D region investigation - simultaneous measurement of a number of parameters in an effort to investigate the processes which produce the D region

TECHNIQUE and INSTRUMENT: Gerdien condenser, Faraday rotation propagation experiment, ionization chambers

STATUS: Funded through GSFC

DISCIPLINES: Ionospheres & Radio Physics

Interest in Geoprobes and Sounding Rockets

The following experiments are of interest to the Ionospheres and Radio Physics discipline.

Arcas; 3 Q 1963, New Zealand; 80 Km; R. Fellows, Program Scientist :

EXPERIMENTER: P. Gregory, Univ. of New Zealand

PARAMETER: Winds, wind shears, D region radio scattering characteristics

EXPERIMENT: Determine correlation with R.F. radar information of shears and turbulence in the 60 to 90 Km region.

TECHNIQUE: Release particles from rocket and photograph time dependent dispersion to determine winds and shears

INSTRUMENT: Particle disperser and photographic equipment

STATUS: Funded by Geophysics & Astronomy Programs

DISCIPLINES: Planetary Atmospheres (prime) Ionospheres & Radio Physics

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NASA No. 14.08, 14.09
Nike-Apache; Wallops Island, Va. and Ft. Churchill, Canada
4 Q 1963; to 200 Km; M. Dubin, Program Scientist :

EXPERIMENTER: E. Schaefer, Univ. of Michigan
L. M. Jones, Univ. of Michigan

PARAMETER: Atmospheric composition-relative and absolute concentrations of neutral and ionic constituents for each AMU

Interest in
Geoprobes and Sounding Rockets (Contd.)

EXPERIMENT: Determination of the chemical and ionic composition of the atmosphere and the generation and loss mechanisms of atmospheric constituents. Measurement of atmospheric structure variations as affected by solar radiation and particle bombardment.

TECHNIQUE: Measurements of the altitude profile of composition and determination of diurnal and latitude variations

INSTRUMENT: Paul Massenfilter mass spectrometer

STATUS: Funded NASw-138; contract extension under review

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

NASA No. 14.26 through 14.29
Nike-Apache; 4 Q 1963, Wallops Island, Va., Ft. Churchill, Canada, and Eglin AFB, Florida; to 200 Km; M. Dubin, Program Scientist:

EXPERIMENTER: E. R. Manring, Geophysics Corp. of America
J. E. Blamont, Univ. of Paris

PARAMETER: Wind velocity, shears, diffusion coefficient and temperature of the atmosphere, chemiluminescent and energetic particle excitation efficiencies

EXPERIMENT: Investigation of the tidal and dynamo motions and current systems between 80 and 200 Km altitude. Determination of latitude, seasonal and diurnal variation of atmospheric temperature and density

Interest in
Geoprobes and Sounding Rockets (Contd.)

TECHNIQUE: Release of fluorescent (alkali) vapors in the atmosphere at twilight. Coordinated series of launchings from a global net of launching sites

INSTRUMENT: Photographic camera net, Fabry-Perot interferometers, absorption cells, and photometers

STATUS: Funded - to be continued 1963 - 1964

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

NASA No. 14.110 and 8.03;
Nike-Apache and Javelin; 3 Q 1963, 4 Q 1963, Wallops Island, Va.; to 200 Km to 1000 Km; M. Dubin, Program Scientist:

EXPERIMENTER: G. Sharp, Lockheed Aircraft Corp.
D. McKibben, Lockheed Aircraft Corp.

PARAMETER: Composition of ions, ion density, ion temperature

EXPERIMENT: Determination of composition, density, and energy distribution of the atmosphere to 1000 Km

TECHNIQUE: Direct measurements with ion probes and mass spectrometers

INSTRUMENT: Paul Massenfilter, magnetic mass spectrometer, ion probe

STATUS: Funded. Additional funds for one (1) Nike-Apache required

DISCIPLINES: Planetary Atmospheres (prime)
Ionospheres & Radio Physics

Interest in
Geoprobes and Sounding Rockets (Contd.)

NASA No. 14.06, 14.07, 14.79 through 14.85; Nike-Apache (9); 2nd and 3rd qtr 1963/India, Equatorial Launch Site; 160 to 180 km; L. J. Cahill, Jr., Program Scientist:

EXPERIMENTER:	L. J. Cahill, Univ. New Hampshire A. White, Univ. New Hampshire
PARAMETER:	Magnetic field
EXPERIMENT:	The structure and intensity of the equatorial electrojet current in the ionosphere will be determined.
TECHNIQUE:	Determination of electric current density through magnetic field produced by current.
INSTRUMENT:	Proton precession magnetometer
STATUS:	Funded
DISCIPLINES:	Particles and Fields (prime) Ionospheres & Radio Physics

Supporting Research

AREA OF INVESTIGATION:	Ionospheres and Radio Physics
TITLE:	Theoretical research in planetary ionospheres
PRINCIPAL INVESTIGATOR:	R. W. Knecht
ORGANIZATION:	CRPL, National Bureau of Standards
ADDRESS:	Boulder, Colorado
CONTRACT NUMBER:	R-65
TIME PERIOD:	12 June 1962 - 11 June 1963
FUNDED BY:	Lunar and Planetary Programs
AMOUNT:	$10,000
TECHNICAL MONITOR:	James M. Weldon
ALTERNATE CONTACT:	Roger C. Moore
DESCRIPTION:	The work will consist of study and development of reasonable models of the Mars and Venus ionospheres in support of "topside sounding" experiment to be flown on later Mariner spacecraft. This grant also supports some experiment design studies in connection with future planetary ionosphere sounding.

AREA OF INVESTIGATION:	Ionospheres and Radio Physics
TITLE:	Ionospheric Sounding Instrumentation

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	A. O. Sperber
ORGANIZATION:	Airborne Instruments Laboratory
ADDRESS:	Long Island, New York
CONTRACT NUMBER:	NASw 513
TIME PERIOD:	5 Sept. 1962 - 4 Sept. 1963
FUNDED BY:	Lunar and Planetary Programs (SL)
AMOUNT:	$78,089
TECHNICAL MONITOR:	James M. Weldon (SL)
ALTERNATE CONTACT:	Roger C. Moore (SL)
DESCRIPTION:	The work will be done in cooperation with CRPL, National Bureau of Standards, and will consist of design studies for instrumenting an experiment to sound the Venus ionosphere from the "topside."

AREA OF INVESTIGATION:	Ionospheric Physics
TITLE:	Ionospheric Electron Density Studies and Computations
PRINCIPAL INVESTIGATOR:	J. W. Wright
ORGANIZATION:	National Bureau of Standards
ADDRESS:	Boulder, Colorado
CONTRACT NUMBER:	NTF-84 (Amd 2)

Supporting Research (Contd.)

TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1962
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$125,000
TECHNICAL MONITOR:	J. C. Seddon, GSFC
DESCRIPTION:	Continue to improve high-speed computer techniques for obtaining electron density profiles from ionograms, furnish such profiles for the NASA Ionosphere Program upon request, and make closely related ionospheric investigations.

AREA OF INVESTIGATION:	Ionospheric Physics
TITLE:	Ionospheric Studies Using Satellite Beacon Transmissions
PRINCIPAL INVESTIGATOR:	C. G. Little H. J. A. Chivers
ORGANIZATION:	National Bureau of Standards
ADDRESS:	Boulder, Colorado
CONTRACT NUMBER:	R-30 (Amd. 1)
TIME PERIOD:	1 July 1962 - 1 July 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$147,000
TECHNICAL MONITOR:	E. R. Schmerling, SGP

Supporting Research (Contd.)

ALTERNATE CONTACT:	R. E. Bourdeau, GSFC
DESCRIPTION:	This is a continuation of IGY Project 32.41. Faraday and Doppler observations are being made on the Russian satellites and planned for S-66. Electron content, scintillations and propagation path effects are to be studied.

AREA OF INVESTIGATION:	Ionospheric Physics
TITLE:	Ionospheric Studies Using Satellite Beacon Transmissions
PRINCIPAL INVESTIGATOR:	G. W. Swenson, Jr. K. C. Yeh
ORGANIZATION:	University of Illinois
CONTRACT NUMBER:	NsG-24 (Suppl 3)
TIME PERIOD:	1 July 1962 - 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$109,991
TECHNICAL MONITOR:	J. C. Seddon, GSFC
DESCRIPTION:	Continuation of work on studying the total electron content of the ionosphere and small-scale irregularities in the F-region by Faraday rotation and differential Doppler measurements. Monitoring stations have been established, personnel trained, and techniques and equipment developed which are expected to be important in conducting the S-66 Ionosphere Beacon Satellite program.

Supporting Research (Contd.)

AREA OF INVESTIGATION: Ionospheric Physics

TITLE: Physics of Low Density Plasmas

PRINCIPAL INVESTIGATOR: I. Harris

ORGANIZATION: University of Maryland

CONTRACT NUMBER: NsG 220

TIME PERIOD: 1 Feb. 1962 - 31 Jan. 1963

FUNDED BY: Geophysics & Astronomy Programs

AMOUNT: $48,376

TECHNICAL MONITOR: E. R. Schmerling, SGP

ALTERNATE CONTACT: F. R. Gracely, SGP

DESCRIPTION: Perform theoretical studies in the following areas of low density plasma physics:

1. Waves in a plasma and instabilities
2. Structure of shock waves
3. Radiation processes in plasmas
4. Applications to space physics

AREA OF INVESTIGATION: Ionospheric Physics

TITLE: Study of Electron Densities in the Upper Ionosphere Based on a Separating Capsule Rocket Experiment

PRINCIPAL INVESTIGATOR: J. S. Nisbet

Supporting Research (Contd.)

ORGANIZATION:	Penn State University
ADDRESS:	University Park, Pa.
CONTRACT NUMBER:	NsG-134 (Suppl. 1)
TIME PERIOD:	1 March 1962 - 28 Feb. 1965
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$150,000
TECHNICAL MONITOR:	E. R. Schmerling, SGP
ALTERNATE CONTACT:	R. E. Bourdeau, GSFC
DESCRIPTION:	Scientific portion of the program for the development of the separating capsule experiment. This is designed to give accurate, high-resolution electron densities by sending signals between the rocket and the separated capsule.

AREA OF INVESTIGATION:	Ionospheric Physics
TITLE:	Ionospheric Research Utilizing Satellite Transmissions
PRINCIPAL INVESTIGATOR:	R. A. Helliwell O. K. Garriott
ORGANIZATION:	Stanford University
ADDRESS:	Stanford, California
CONTRACT NUMBER:	NsG-30 (Suppl. 2)

Supporting Research (Contd.)

TIME PERIOD:	1 July 1961 - 30 June 1962 plus no-cost extension to 31 Dec. 1962
FUNDED BY:	GSFC (HQ)
AMOUNT:	$132,600
TECHNICAL MONITOR:	J. C. Seddon, GSFC
DESCRIPTION:	Continuation of present program of data collection and analysis in support of the S-66 Ionosphere Beacon Satellite and for other satellites with suitable transmissions. Faraday rotation and differential doppler measurements are used for electron content determinations and observations on irregularities.

AREA OF INVESTIGATION:	Ionospheric Physics
TITLE:	Ionospheric Studies Using Satellite Beacon Transmissions
PRINCIPAL INVESTIGATOR:	W. J. Ross
ORGANIZATION:	Penn State University
ADDRESS:	University Park, Pa.
CONTRACT NUMBER:	NsG-114
TIME PERIOD:	1 Nov. 1960 - 31 Oct. 1962 (no cost extension to May 1963)
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$127,612

Supporting Research (Contd.)

TECHNICAL MONITOR:	J. C. Seddon
DESCRIPTION:	Continue research to determine the electron content of the ionosphere by Faraday rotation and differential Doppler measurements on satellite signals and studies of the seasonal, diurnal, and other variations of the electron content and equivalent slab thickness.

AREA OF INVESTIGATION:	Ionospheric Physics
TITLE:	Ionospheric Studies Using Satellite Beacon Transmissions
PRINCIPAL INVESTIGATOR:	J. E. Titheridge
ORGANIZATION:	Univ. of Auckland
ADDRESS:	New Zealand
CONTRACT NUMBER:	NsG-54 (Suppl 2)
TIME PERIOD:	1 Dec. 1961 - 1 Dec. 1962
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$20,000
TECHNICAL MONITOR:	J. C. Seddon, GSFC
DESCRIPTION:	Continue the study of antipodal propagation by rotating interferometer to determine bearing and elevation of signals. Determination of electron density profiles by measuring bearing, elevation and Doppler shift.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Ionospheres and Radio Physics
TITLE:	Radiation processes of charged particles moving in the upper atmosphere and composition and properties of the magnetosphere
PRINCIPAL INVESTIGATOR:	Manlio Abele
ORGANIZATION:	Polytechnic Institute of Brooklyn
ADDRESS:	Brooklyn, New York,
CONTRACT NUMBER:	NsG-165 (Suppl. 1)
TIME PERIOD:	1 May 1962 - 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$22,300
TECHNICAL MONITOR:	A. Levine, GSFC
DESCRIPTION:	Conduct theoretical study of the forces acting on bodies in rarefied ionized environments.

AREA OF INVESTIGATION:	Ionospheres and Radio Physics
TITLE:	Radio propagation techniques for the study of planetary ionospheres and interplanetary medium
PRINCIPAL INVESTIGATOR:	O. K. Garriott
ORGANIZATION:	Stanford University
ADDRESS:	Stanford, Calif.

Supporting Research (Contd.)

CONTRACT NUMBER:	NsG-329
TIME PERIOD:	1 Oct. 1962 - 30 Sept. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$81,000
TECHNICAL MONITOR:	J. Weldon
DESCRIPTION:	Includes development, through prototype, of spacecraft instrument required to receive and process signals; one at 50 Mc and one at higher harmonic of 50 Mc.

Interest In
Supporting Research

AREA OF INVESTIGATION:	Radio astronomy
TITLE:	Radio experiments in space
PRINCIPAL INVESTIGATOR:	F. T. Haddock
ORGANIZATION:	University of Michigan
ADDRESS:	Ann Arbor, Mich.
CONTRACT NUMBER:	NsG-181 (Suppl. 1)
TIME PERIOD:	1 Aug. 1962 - 31 July 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$133,770
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Conduct research on space probe techniques for possible measurements of electromagnetic phenomena
DISCIPLINES:	Astronomy (prime) Ionospheres & Radio Physics

AREA OF INVESTIGATION:	Energetic Particles & Ionospheric Physics
TITLE:	Initiate studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during the IQSY.
PRINCIPAL INVESTIGATOR:	D. K. Bailey

Interest In
Supporting Research (Contd.)

ORGANIZATION:	National Bureau of Standards
ADDRESS:	Boulder, Colo.
CONTRACT NUMBER:	R-74
TIME PERIOD:	15 Nov. 1962 - 15 May 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$25,000
TECHNICAL MONITOR:	L. J. Cahill
DESCRIPTION:	Support of studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during IQSY. This initial funding will be used primarily for the design, construction and purchase of long-lead-time experimental apparatus.
DISCIPLINES:	Particles & Fields (prime) Ionospheres & Radio Physics

Supporting Research

AGENCY	AREA	LEVEL OF EFFORT (FY 63)	PRINCIPAL INVESTIGATOR
Goddard Space Flight Center	Ionospheres & Radio Physics	$353,100	J. A. Kane A. L. Levine K. W. Ogilvie R. G. Stone H. A. Whale E. C. Whipple, Jr.

PARTICLES AND FIELDS PROGRAM

OBJECTIVES:

The Energetic Particles Program:

The energetic particles program is concerned with the study of the particles of energy greater than a few electron-volts which are found in the trapped and auroral radiation, solar and galactic cosmic radiation and the interplanetary plasmas. Eventually, the trapped and auroral radiation associated with the other planets will be studied. The interaction between the charged particles and the magnetic fields is such that they must be studied simultaneously on the same vehicles in order to understand the phenomena. It is also necessary to make simultaneous measurements at widely-separated points, such as on the ground, above the Earth, at the heights of satellites in polar and highly eccentric orbits, and in interplanetary space. Certain of the phenomena are related to the 11-year solar cycle, and it is necessary to monitor certain phenomena over an 11-year period. The present time begins a transition period from high solar activity towards the next minimum which will occur in 1964-1965.

Galactic cosmic radiation consists of a low flux of electrons, protons, alpha particles and nuclei of heavier atoms. These particles range in energy from an as yet undetermined lower limit below 10 Mev to an as yet undetermined upper limit in excess of 10^{19} electron volts. The flux varies by a factor of two over the 11-year solar cycle and occasionally decreases sharply for a few days after a solar flare--the so-called Forbush decrease.

The origin of the particles, the mechanism by which they are accelerated to high energies, the nature of the mechanism (or mechanisms) which produces the 11-year solar

cycle and the Forbush modulation of the flux--these are some of the questions which have shaped the galactic cosmic radiation experimental program.

After some, but not all, major solar flares, the intensity of the positively-charged component of cosmic rays has been observed to increase by an amount which varies from barely detectable increases up to increases four orders of magnitude above the cosmic ray background for particles in the energy range from one to several hundred Mev. These particles are given the name solar cosmic rays. The intensity reaches a maximum about one to ten hours after the flare and then begins to decrease, returning to the normal background cosmic ray value about one week after the flare. There is considerable variation in the intensity, duration and energy spectrum from event to event. Solar activity prior to the solar flare and the resulting changes in the interplanetary magnetic fields influence the time required for the particles to reach the Earth, the energy spectrum, and the duration and intensity of the event. Therefore, it is important to monitor continuously the intensity of the radiation in interplanetary space, together with measurements of the interplanetary magnetic field. Information is needed on as many of the events as possible to improve statistical interpretations.

The fundamental questions which shape the solar cosmic radiation experimental program are:

(1) The unidirectional spectral intensity of the particles and the variation of this quantity with time and space during as many events as possible.

(2) The nature of the accelerating mechanism on the Sun.

(3) The effects of the conditions in interplanetary space on the duration, intensity, and the spatial and angular distribution of the particles.

(4) Variation of the frequency and intensity of these events with time over several solar cycles.

The trapped radiation exists in the region around the Earth known as the magnetosphere. Trapped radiation is observed from about 400 miles above the surface of the Earth out to the boundary of the geomagnetic field which occurs at about 40,000 miles on the sunlit side of the Earth. The geomagnetic field and the trapped radiation appear to terminate at the same place. The characteristics of the radiation varies with position in the trapping region. There is an inner region which is stable with time and characterized by a high intensity of protons with energies in the range from a few kev to several hundred Mev. The energy spectrum has been observed to vary with position and there is a variation in intensity with solar activity. Although this region is characterized by the protons, particularly, high energy proton, there is also a high flux of electrons. Farther out, at about 10,000 miles, there is a region characterized by an extremely high flux of low energy protons. This may be the region associated with the geomagnetic ring current. Beyond this region the trapped radiation is characterized by electrons with energies extending up to several Mev. Recent evidence has shown that the observed fluctuations in intensity in the outer region cannot be entirely accounted for on the basis of solar particles injected into the Earth's magnetic field. Therefore, there must be a mechanism in the vicinity of the Earth which accelerates the trapped particles. Recent evidence has shown that "bunches" of particles oscillating back and forth along the magnetic field lines produce VLF emissions.

Measurements during IGY have shown that both low energy protons and electrons are associated with aurora, with the major part of the incident energy carried by the electrons. These particles may come from the trapped injection belts or they may come directly from the Sun.

Some of the major questions associated with the areas of trapped and auroral radiation are:

(1) Origin of the radiation in the various regions of the belt.

(2) Lifetime and trajectories of the particles.

(3) Nature of the local accelerating mechanisms.

(4) Relation between the trapped and auroral radiation.

(5) Effects of the trapped radiation on the atmosphere and ionosphere.

(6) Existence and nature of the trapped radiation belts around the other planets and the moon.

Recent measurements have shown that there is a plasma in interplanetary space. Measurements have shown that there is a density of about 10 particles/cm^3 with energy of about 500 ev traveling radially outward from the Sun.

The fundamental questions in this area are:

(1) Determination of the unidirectional spectral intensity of the particles and the variations of this with time, position and solar activity.

(2) Relation of the spectral intensity to the magnetic field at the same point and at the same time.

(3) Studies of the time variations from short periods (the effects of hydromagnetic waves) to periods of 11 years (solar cycle).

The Magnetic Field Program:

The Magnetic Field Program encompasses measurement of the magnetic fields of the Sun, planets, and natural satellites of the solar system, and of interplanetary and galactic space.

Experiments are to be carried out in conjunction with the scientific investigation of the physical processes causing the fields and their time changes. Simultaneous measurements of particle fluxes and plasma densities are required to understand the interaction between these phenomena and the magnetic field.

The major problems and objectives of the program are as follows:

(1) To survey the geomagnetic field in as great detail as possible over the whole Earth, to be repeated at no less than five-year intervals. Present plans for IQSY (International Year of the Quiet Sun) call for a World Magnetic Survey in 1964-1965. As a part of this Survey, magnetometers will be flown on polar orbiting satellites and it will be possible to make measurements of the fields to an accuracy of better than $\pm$ 5 gamma. These measurements will be made at an altitude of approximately 500 km at points spaced 10 km along a trajectory with the minimum spacing between trajectories of about 400 km at the equator.

(2) To investigate the sources, presumably ionospheric, of electric current systems that give rise to such ground-observed phenomena as the diurnal magnetic variations; more pronounced variations caused by the equatorial electrojet; and the magnetic storm changes, particularly the polar disturbances. Studies recently carried out near the equator indicate that the equatorial electrojet does exist. Further sounding rocket investigation of the equatorial electrojet is planned. This work is to be done in conjunction with electron density measurements.

(3) To study the character of the outer geomagnetic field including the rapid fluctuations that may be related to hydromagnetic waves in the exospheric plasma. Vehicles for such studies need to be eccentric orbiting satellites with apogees in excess of 15 Earth radii. These satellites must be launched in various directions into the magnetosphere; toward the rear of the geomagnetic cavity, toward the interesting polar regions, as well as toward the compressed sunlit

side of the magnetosphere. An interesting possibility for continuously monitoring field changes with a minimum of ground equipment would be a "geostationary" satellite at about six Earth radii so as to have a 24-hour period and remain stationary for long periods of time over one geographic area.

(4) To study the boundary region of the Earth's magnetic field and the turbulent region immediately beyond this boundary. Eccentric orbiting satellites with apogees near 20 Earth radii will suffice for boundary investigations on the sunlit side of the magnetosphere and in the polar regions. For boundary investigations toward the dark side of the Earth, satellites with highly eccentric orbits and deep space probes will be needed. Magnetic measurements of low fields (of the order of 10 gamma) with high frequency response are needed in the investigation of the turbulent layer. The measurements must give the direction as well as the magnitude of the fluctuating fields.

(5) To study the interplanetary magnetic field presumably due to "frozen" fields in plasma clouds ejected from the Sun and the hydromagnetic disturbances traveling through these clouds. For this purpose, two types of missions are needed: (a) the deep space probe with primary emphasis on approaching the Sun as closely as possible; and (b) a far satellite in order to be free from direct effects of the Earth's field and monitor the interplanetary field near the Earth's orbit.

(6) To study the magnetic fields of the Earth's moon and of the other planets beginning with Mars and Venus. Basically, this would be a study of the permanent magnetic fields of these bodies by planned near misses with space probes. The initial information desired about the magnetic fields of the Moon, Mars and Venus is the existence or absence of such fields. The approximate magnitude of the field and the orientation of the poles should be determined also. From such measurements, together with the theory of the origin of planetary magnetic fields, it may be possible to understand

something of the internal structure of the Moon and the planets.

(7) In order to realize the scientific objectives of the experiments in which emphasis is placed on the time variations of the magnetic field, it is very desirable to combine measurements with those of the particle environment of the probe. It is also essential that Earth-based observations be made simultaneously with observations from spacecraft. Theoretical studies in support of the satellite and rocket measurements are essential.

TECHNIQUES AND INSTRUMENTS:

Available:

The basic instruments used in measurements of energetic particles are the ionization chamber, the Geiger counter, the scintillation counter, the Cerenkov detector and nuclear emulsions. Solid state detectors have been developed and are now in use. The ionization chamber measures the total amount of ionization produced both by charged particles and electromagnetic radiation. The Geiger counter detects any charged particle with sufficient energy to penetrate its walls. The scintillation counter and the solid state detectors can be used to identify particles and to measure their charge and energy. The Cerenkov detector can be used to determine the direction of travel of a particle. Nuclear emulsions are similar to ordinary photographic emulsions except that they are much thicker and their grains blacken when struck by a charged particle. Emulsions can be used to measure the velocity, mass, charge and direction of travel of a charged particle. However, in order to obtain these data, the emulsions must be recovered.

Scintillation counters, Cerenkov counters and solid state detectors give out pulses which are related to the energy lost by a particle in the counter. Pulse height analyzers have been built which can determine the size of

such a pulse and store it in the appropriate channel for later transmission to the ground. Such information can be used to measure the energy spectrum of the charged particles. The shape of the pulse from a scintillation counter can be used to distinguish between protons and electrons.

There are four major types of magnetometers in use at the present time--the search coil, the fluxgate, the proton precession, and rubidium vapor magnetometer.

The search coil magnetometer consists either of a coil of wire mounted in a spinning vehicle to measure the dc field or of a triaxial search coil mounted in a stabilized vehicle to measure the changes in the vector field. In the first case, the voltage output from the coil is a measure of the scalar field at right angles to spin axis of the rocket. In the second case the voltage output from one axis of the search coil is a measure of the rate of change of the magnetic field through the coil.

The fluxgate magnetometer gives a voltage output proportional to the component of the magnetic field parallel to the core of magnetometer.

The output of a proton precession magnetometer is a signal with frequency proportional to the proton magnetic moment and the strength of the local field. The proton magnetic moment is known very accurately; therefore, the field can be determined to the accuracy with which the frequency is measured. This instrument is used for measuring very accurately the total field in the region from the surface of the Earth to an altitude of about 2000 km.

The rubidium vapor magnetometer is similar to the proton instrument, but the atomic magnetic moments are utilized. Optical pumping into certain Zeeman sublevels is employed to attain phase coherence of atoms in the Rb vapor sample. Using the vapor cell in a feedback loop self oscillation is attained with a continuous precessive signal. This instrument may be used in fields as low as a few gammas.

Under Development:

Detectors are under development to measure the flux, composition and energy spectra of particles with a charge greater than three fundamental charge units. Solid state detectors to replace the heavier scintillation counters, and photodiodes to replace photomultiplier tubes, are under

development. Spark chambers, bubble chambers, and luminescent chambers are under development for possible space use. The path of a charged particle is made visible and preserved photographically or electronically for study.

These tracks, similar to nuclear emulsion tracks, yield information about the charge, mass, and energy of the particles. It may be feasible to telemeter this information so that vehicle recovery is not necessary.

A helium magnetometer is also under development. The helium magnetometer is similar to the rubidium vapor magnetometer except that helium gas is used rather than rubidium vapor.

PROJECTS AND TASKS:

Satellites

PROJECT DESIGNATION:	A-15, A-16, Relay, Communication Satellite and A-19
VEHICLE:	Thor-Delta
DATE/SITE:	4Q62, 2 & 3Q63
ORBIT:	Apogee 4800 km, Perigee 500 km, Inclination 45°
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	L. Jaffe, FC

EXPERIMENTER:	W. Brown, Bell Telephone Laboratories
PARAMETER:	Flux and energy spectrum of protons
EXPERIMENT:	Determine proton energy spectrum ($1.5 \leq E \leq 25$ Mev)
TECHNIQUE:	Measurement of energy by energy loss in detector and pulse height discrimination
INSTRUMENT:	Solid state detectors
STATUS:	Funded by GSFC
DISCIPLINES:	Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION: A-15, 16, 19 Relay (Contd.)

EXPERIMENTER: W. Brown, Bell Telephone Laboratories

PARAMETER: Flux and energy spectrum of electrons

EXPERIMENT: Determine electron energy spectrum ($0.2 \leq E \leq 2$ Mev)

TECHNIQUE: Measurement of energy by energy loss in solid state detector and by pulse height discrimination

INSTRUMENT: Solid state detectors

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-flight hardware; Univ. of California-data reduction

PARAMETER: Omindirectional proton flux

EXPERIMENT: Determine integral omindirectional flux of protons ($E \geq 35$ Mev)

TECHNIQUE: Measurement of energy by electronic discrimination of light pulses in plastic scintillator

INSTRUMENT: Shielded scintillation counter

Satellites (Contd.)

PROJECT DESIGNATION: A-15, 16, 19 Relay (Contd.)

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-flight hardware; Univ. of California-data reduction

PARAMETER: Flux and energy spectrum of electrons

EXPERIMENT: Determine directional intensity and energy distribution of electrons ($0.5 \leq E \leq 1$ Mev)

TECHNIQUE: Measurement of energy by electronic discrimination of light pulses in plastic scintillator

INSTRUMENT: Scintillation counter

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-flight hardware; Univ. of California-data reduction

PARAMETER: Trapped proton flux and energy spectrum

EXPERIMENT: Determine directional intensity and energy distribution of protons ($1 \leq E \leq 3$ Mev)

Satellites (Contd.)

PROJECT DESIGNATION: A-15, 16, 19 Relay (Contd.)

TECHNIQUE: Measurement of energy by electronic discrimination of energy loss pulses in solid state detector

INSTRUMENT: Silicon PN junction detector

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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EXPERIMENTER: Carl McIlwain, State Univ. of Iowa-flight hardware; Univ. of California-data reduction

PARAMETER: Proton flux and energy spectrum

EXPERIMENT: Determine directional intensity and energy distribution of protons ($18 \leq E \leq 60$ Mev)

TECHNIQUE: Detection of higher energy protons through coincidence counting and shielding with two solid state detectors

INSTRUMENT: Silicon PN junction telescope

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

Satellites (Contd.)

PROJECT DESIGNATION:	Eccentric Orbiting Geophysical Observatory (S-49)
VEHICLE:	Atlas-Agena
DATE/SITE:	4Q1963/AMR
ORBIT:	Apogee 110,000 km, Perigee 275 km, inclination 31°
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	C. D. Ashworth
EXPERIMENTER:	F. B. McDonald, GSFC Duncan A. Bryant, GSFC
PARAMETER:	Primary cosmic radiation
EXPERIMENT:	Determine the charge and energy spectra of the primary cosmic radiation to assist in determining the interstellar material and to study cosmic ray modulation mechanisms.
TECHNIQUE:	Scintillation detection, energy measurement by pulse height discrimination and analysis
INSTRUMENT:	Cosmic ray telescope
STATUS:	Funded by GSFC through flight hardware
DISCIPLINES:	Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION: S-49 (EGO) (Contd.)

EXPERIMENTER: T. L. Cline, GSFC
E. W. Hones, Jr., Inst. for Defense Analysis

PARAMETER: Low-energy positrons and gamma rays

EXPERIMENT: To detect and measure positrons (0 to 3 Mev) in the trapped particle belts and in interplanetary space and to monitor solar proton bursts (30 kev to 1.2 Mev)

TECHNIQUE: Detection of gamma ray pair from positron annihilation

INSTRUMENT: Double gamma ray spectrometer

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Solar Physics

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EXPERIMENTER: Leo R. Davis, GSFC

PARAMETER: Trapped particles

EXPERIMENT: To study spacial and temporal fluctuations of the trapped particle belts by observing trapped electrons with directional energy flux, 10 kev $\leq E \leq$ 100 kev and the directional intensity of protons (120 kev $\leq E \leq$ 4.5 Mev)

Satillites (Contd.)

PROJECT DESIGNATION: S-49 (EGO) (Contd.)

TECHNIQUE: Detection of charged particles by scintillation in phosphor layer. Energy measurement by range of particles in various absorbers

INSTRUMENT: Ion-electron scintillation detector

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

****

EXPERIMENTER: E. J. Smith, JPL
Robert E. Holzer, UCLA

PARAMETER: Magnetic field

EXPERIMENT: Investigate magnetic field fluctuations in the range 0.01 to 1,000 cps and to investigate their relation to surface fluctuations

TECHNIQUE: Detection of magnetic fluctuations by signals induced in search coils

INSTRUMENT: Triaxial search coil magnetometer

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION: S-49 (EGO) (Contd.)

EXPERIMENTER: John A. Simpson, Univ. of Chicago
C. Y. Fan, Univ. of Chicago
Peter Meyer, Univ. of Chicago

PARAMETER: Low energy galactic cosmic radiation flux

EXPERIMENT: Investigate low energy galactic cosmic radiation, study energetic particle fluxes of protons above 0.2 Mev and other nuclei at higher energies, and examine possibility of measuring isotopic abundances using solid state detector technique

TECHNIQUE: Detection of charged particles by energy loss in solid state detectors. Energy measurement by shielding and pulse height discrimination

INSTRUMENT: Solid state detectors and telescopes

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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EXPERIMENTER: James P. Heppner, GSFC

PARAMETER: Magnetic field

Satellites (Contd.)

PROJECT DESIGNATION: S-49 (EGO) (Contd.)

EXPERIMENT: To measure magnitude and direction of the magnetic field vector over range 1 to 50,000 gammas to accuracy ≤ 1 gamma in order to study propagation of magnetic disturbances within the magnetosphere and the interaction between the solar wind and the Earth's magnetic field.

TECHNIQUE: Measurement of scalar field magnitude by Rb vapor instrument. Measurement of direction with fluxgate sensors.

INSTRUMENT: Fluxgate and rubidium-vapor magnetometers

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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EXPERIMENTER: John R. Winckler, Univ. of Minnesota
Roger L. Arnoldy, Univ. of Minnesota

PARAMETER: Trapped radiation and cosmic radiation

EXPERIMENT: To study injection, trapping, and loss mechanisms in the trapped radiation belts.

TECHNIQUE: An electron spectrometer will measure electron energy up to 4 Mev, ionization and Geiger counters will monitor galactic cosmic radiation and continually monitor the Earth's trapped radiation (electron energy from 20 kev to 20 Mev).

Satellites (Contd.)

PROJECT DESIGNATION: S-49 (EGO) (Contd.)

INSTRUMENT: Magnetic electron spectrometer, ionization chamber, Geiger counters

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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EXPERIMENTER: Kinsey A. Anderson, Univ. of California

PARAMETER: Solar cosmic rays

EXPERIMENT: Measure solar cosmic ray protons and solar X-rays to assist in studying emissions from solar fluxes and propagation to the Earth (protons 3-30 Mev)

TECHNIQUE: Detection of protons and X-rays in scintillation detectors. Energy measurement by shielding and pulse height analysis.

INSTRUMENT: Scintillation type detector

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Solar Physics

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Satellites (Contd.)

PROJECT DESIGNATION: S-49 (EGO) (Contd.)

EXPERIMENTER: James A. Van Allen, State Univ. of Iowa
L. A. Frank, State Univ. of Iowa

PARAMETER: Trapped electrons

EXPERIMENT: Measure the omnidirectional intensities of electrons in the outer trapped particle region in order to understand the origin of the trapped radiation belts and fluctuations in the belts

TECHNIQUE: Detection of charged particles by Geiger counters. Energy determination by shielding and detector response

INSTRUMENT: Geiger-Mueller tubes

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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EXPERIMENTER: Herbert Bridge, MIT; A. Bonetti, MIT
B. Rossi, MIT; A. J. Lazarus, MIT
F. Scherb, MIT

PARAMETER: Interplanetary plasma

EXPERIMENT: To study the properties of plasma from the Sun by measuring proton and electron flux, the energy spectrum, the direction of flux, and temporal and spatial variations of these quantities in the energy range from 10 ev to 10 kev

Satellites (Contd.)

PROJECT DESIGNATION: S-49 (EGO) (Contd.)

TECHNIQUE: Measurement of plasma flux and energy by collection in Faraday cup and modulation by electric fields

INSTRUMENT: Faraday cup plasma probe

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Ionospheres & Radio Physics

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EXPERIMENTER: Michael Bader, Ames Res. Center

PARAMETER: Interplanetary plasma

EXPERIMENT: To study plasma from the Sun by measuring proton concentrations ranging from 10^{-2} to 10^{-4} particles per cm^3 as a function of proton energy in the range 0.2 to 20 kev

TECHNIQUE: Measurement of plasma energy by analysis with curved plate spectrometer

INSTRUMENT: Curved plate plasma probe

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Ionospheres & Radio Physics

Satellites (Contd.)

PROJECT DESIGNATION:	S-50 POGO
VEHICLE:	Thor-Agena
DATE/SITE:	1964/PMR
ORBIT:	500-1000 km near circular, polar orbit, inclination 87°
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	R. F. Fellows
Alternate :	C. D. Ashworth
EXPERIMENTER:	W. R. Webber, Univ. of Minnesota
PARAMETER:	Cosmic rays
EXPERIMENT:	Measure rigidity and charge spectrum of galactic and solar cosmic rays in order to study origin and modulation mechanisms of cosmic radiation
TECHNIQUE:	Charged particle detection and energy measurement by energy loss in Cerenkov-scintillation telescope
INSTRUMENT:	Scintillation-Cerenkov detector
STATUS:	Funded by GSFC through flight hardware
DISCIPLINES:	Particles & Fields (prime) Solar Physics

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Satellites (Contd.)

PROJECT DESIGNATION: S-50 (POGO) (Contd.)

EXPERIMENTER: J. A. Van Allen, State Univ. of Iowa

PARAMETER: Trapped electrons

EXPERIMENT: Measure trapped and dumped electrons in order to study the origin and fluctuation mechanisms for the trapped particle belts

TECHNIQUE: Vertical and horizontal detectors in order to distinguish between trapped electrons and electrons in the loss cone

INSTRUMENT: Thin-window Geiger tubes

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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EXPERIMENTER: H. V. Neher, CIT/JPL
H. R. Anderson, CIT/JPL

PARAMETER: Cosmic radiation

EXPERIMENT: Monitor cosmic radiation and trapped radiation with an instrument of well known response and with a long history of use in balloon measurements at high latitudes

TECHNIQUE: Charged particle detection by ionization chamber

Satellites (Contd.)

PROJECT DESIGNATION: S-50 (POGO) (Contd.)

INSTRUMENT: Integrating ionization detector

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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EXPERIMENTER: J. A. Simpson, Univ. of Chicago

PARAMETER: Trapped radiation and low energy cosmic rays

EXPERIMENT: To study low energy protons and nucleons by measuring energetic particle flux from 0.3 Mev/nucleon to 30 Mev/nucleon

TECHNIQUE: Charged particle detection with scintillation telescope and electronic energy analysis

INSTRUMENT: Scintillation telescope

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION: S-50 (POGO) (Contd.)

EXPERIMENTER: L. R. Davis, GSFC; R. A. Hoffman, GSFC
A. Konradi, GSFC; J. M. Williamson, GSFC

PARAMETER: Trapped radiation

EXPERIMENT: To study fluctuations in the trapped radiation by measuring low energy trapped particles, 10-100 kev electrons and 100 kev-4.5 Mev protons

TECHNIQUE: Absorber wheel, energy discrimination, phospor-photomultiplier scintillation detection

INSTRUMENT: Ion-electron detector

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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EXPERIMENTER: J. Winckler, Univ. of Minnesota
R. Gallet, NBS

PARAMETER: VLF emissions and trapped electrons

EXPERIMENT: To study correlations between VLF emissions and trapped electron bunches in order to assist in understanding trapped particle acceleration and loss mechanisms

Satellites (Contd.)

PROJECT DESIGNATION: S-50 (POGO) (Contd.)

TECHNIQUE: Logic box correlation of VLF and electron data from Helliwell-Stanford VLF experiment and Davis-GSFC electron experiment

INSTRUMENT: Uses Davis' and Helliwell's instruments
Logic box built at Univ. of Minnesota

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields (prime)
Ionospheres & Radio Physics

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EXPERIMENTER: H. R. Boroson, GSFC
J. Cain, GSFC
J. P. Heppner, GSFC

PARAMETER: Magnetic field

EXPERIMENT: Scalar magnetic field measurements for World Magnetic Survey

TECHNIQUE: Scalar field measurement of high absolute accuracy. Signal counting and storage on board spacecraft

INSTRUMENT: Rb vapor magnetometer

STATUS: Funded by GSFC through flight hardware

DISCIPLINES: Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION:	S-50 (POGO) (Contd.)
EXPERIMENTER:	R. E. Holzer, UCLA E. J. Smith, JPL
PARAMETER:	Magnetic field fluctuations
EXPERIMENT:	To measure magnetic field fluctuations in low audio and sub audio range of frequencies and to correlate these measurements with surface fluctuations
TECHNIQUE:	Detection of fluctuations in search coils
INSTRUMENT:	Triaxial search coil magnetometer
STATUS:	Funded by GSFC through flight hardware
DISCIPLINES:	Particles & Fields

Satellites (Contd.)

PROJECT DESIGNATION:	S-57 (OSO)
VEHICLE:	Delta
DATE/SITE:	4Q63/AMR
ORBIT:	Circular 300 km
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	J. L. Mitchell
EXPERIMENTER:	E. M. Hafner, Univ. of Rochester M. F. Kaplon, Univ. of Rochester
PARAMETER:	Solar and galactic cosmic rays
EXPERIMENT:	To measure charge and energy spectra of charged particles of energies $>$ 3.3 Mev/nucleon
TECHNIQUE:	Detector unidirectionally sensitive to relativistic particles ($\beta \geq 0.72$) which would discriminate between protons ($Z = 1$), alpha particles ($Z = 2$), and the L group of nuclei ($3 \leq Z \leq 5$), the M group of nuclei ($6 \leq Z \leq 9$) and the H group ($Z \geq 10$). The detector will also be sensitive to all charged particles received corresponding to $\beta \geq 0.35$ for protons and correspondingly higher β for higher charged particles.

Satellites (Contd.)

PROJECT DESIGNATION: S-57 (OSO) (Contd.)

INSTRUMENT: Counter telescope with scintillators and Cerenkov radiators

STATUS: Funded through flight hardware

DISCIPLINES: Particles & Fields (prime)
Solar Physics

****

EXPERIMENTER: S. Bloom J. Waggoner) Univ. of Calif.
C. Schrader R. Kaifer) Lawrence Radiation Laboratory

PARAMETER: Trapped particles

EXPERIMENT: To study the lower region of the radiation belts by discriminating between electron ionization events and proton ionization events

TECHNIQUE: Solid state detection of particles and discrimination by energy loss

INSTRUMENT: Proton-electron discriminator

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

Satellites (Contd.)

PROJECT DESIGNATION:	Interplanetary Monitoring Probe (IMP) (S-74a, S-74b, S-74c)
VEHICLE:	Thor-Delta
DATE/SITE:	1963, 1964/AMR
ORBIT:	Apogee 300,000 km, Perigee 200 km, inclination 31°
EXPECTED LIFETIME:	1 year
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	E. Ehrlich
EXPERIMENTER:	J. A. Simpson, Univ. of Chicago
PARAMETER:	Cosmic rays
EXPERIMENT:	Measure solar and galactic protons and alpha particles, 5-200 Mev
TECHNIQUE:	Range vs. energy loss
INSTRUMENT:	Solid state detectors
STATUS:	Funded by GSFC
DISCIPLINES:	Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION: S-74 (IMP) (Contd.)

EXPERIMENTER: F. B. McDonald, GSFC

PARAMETER: Cosmic rays

EXPERIMENT: Measure solar and galactic protons, 10-100 Mev

TECHNIQUE: E by $\frac{de}{dx}$ counter telescope

INSTRUMENT: Crystal and scintillation detectors, GM counters

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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EXPERIMENTER: K. A. Anderson, Univ. of California

PARAMETER: Trapped particles

EXPERIMENT: Identify and measure energies and pitch angle distributions of trapped particles

TECHNIQUE: Ionization detector plus particle detector

INSTRUMENT: Ionization chamber; thin-wall Geiger tubes

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION: S-74 (IMP) (Contd.)

EXPERIMENTER: N. F. Ness, GSFC

PARAMETER: Magnetic field

EXPERIMENT: Measurement of the geomagnetic field, interplanetary magnetic field and fluctuations

TECHNIQUE: Scalar and vector measurements of magnetic field

INSTRUMENT: Rb vapor and fluxgate magnetometers

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

****

EXPERIMENTER: H. Bridge, MIT
B. Rossi, MIT

PARAMETER: Plasma

EXPERIMENT: Measure flux and energy of interplanetary plasma; protons and electrons 0 to 8 kev

TECHNIQUE: Plasma energy measurement with retarding electric fields

INSTRUMENT: Faraday cup plasma probe

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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Satellites (Contd.)

PROJECT DESIGNATION:	S-74 (IMP) (Contd.)
EXPERIMENTER:	M. Bader, Ames Res. Center
PARAMETER:	Plasma
EXPERIMENT:	Measure interplanetary plasma flux and velocity protons 0.2 to 2 kev
TECHNIQUE:	Energy separation with electric fields
INSTRUMENT:	Curved plate electrostatic analyzer
STATUS:	Funded by GSFC
DISCIPLINES:	Particles & Fields

Interest In Satellites

The following experiments are of interest to the Particles and Fields discipline.

S-49 (EGO); Atlas-Agena; 4Q63/AMR; 110,000 km, 275 km, 31°; L. J. Cahill, Jr., Program Scientist:

EXPERIMENTER: Eldon C. Whipple, GSFC

PARAMETER: Plasma

EXPERIMENT: To study plasma in magnetosphere and interplanetary space by obtaining the densities of ions and electrons and their energy distribution in the thermal energy range.

TECHNIQUE: Measurement of plasma energy by modulation with electric fields

INSTRUMENT: Planar ion and electron trap

STATUS: Funded

DISCIPLINES: Ionospheres & Radio Physics (prime)
Particles & Fields

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EXPERIMENTER: Rita C. Sagalyn, AFCRL
M. Smiddy, AFCRL

PARAMETER: Plasma

Interest In
Satellites (Contd.)

S-49 (EGO) (Contd.)

EXPERIMENT: To study plasma in the magnetosphere and interplanetary by measuring the concentration and energy distribution of charged particles in range 0 to 1.0 kev for densities of positively and negatively charged particles with concentration in the range 10 to 5 X 10^6 per cc

TECHNIQUE: Measurement of plasma energy by analysis with curved plate electrostatic spectrometer.

INSTRUMENT: Spherical electrostatic analyzer

STATUS: Funded by GSFC

DISCIPLINES: Ionospheres & Radio Physics (prime)
Particles & Fields

S-74 (IMP); Thor-Delta; 1963, 1964/AMR; 300,000 km, 200 km, 31°; L. J. Cahill, Jr., Program Scientist:

EXPERIMENTER: G. P. Serbu, GSFC

PARAMETER: Plasma

EXPERIMENT: Measure thermal ions and electrons 0 to 10 ev

TECHNIQUE: Planar trap collection of thermal particles

INSTRUMENT: Planar trap ion-electron detector

STATUS: Funded by GSFC

DISCIPLINES: Ionospheres & Radio Physics (prime)
Particles & Fields
Solar Physics

Space Probes

PROJECT DESIGNATION:	Ranger (P-53, P-54, P-55, P-56) (Rangers 6-9)
VEHICLE:	Atlas-Agena B
DATE/SITE:	First flight 3Q63; later flight schedules not firm/AMR
TRAJECTORY:	Lunar impact
EXPECTED LIFETIME:	66 hour trajectory to impact
HEADQUARTERS CONTACT :	N. W. Cunningham
Alternate :	W. Jakobowski
EXPERIMENTER:	M. Bader, Ames Research Center T. B. Fryer, Ames Research Center
PARAMETER:	Proton flux in solar plasma
EXPERIMENT:	To detect the magnitude and direction of the proton flux in the solar plasma
TECHNIQUE:	The proton flux will be measured and telemetered throughout the flight
INSTRUMENT:	Low energy solar proton detector
STATUS:	First flight models delivered, funded by Lunar & Planetary Programs
DISCIPLINES:	Particles & Fields

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Space Probes (Contd.)

PROJECT DESIGNATION: Ranger (P-53 through P-56) (Contd.)

EXPERIMENTER: H. Anderson, JPL; H. V. Neher, CIT
W. McDonald, JPL; J. A. Van Allen, SUI

PARAMETER: Particle flux in energy ranges of $E > 0.5$ Mev for electrons and $E > 10$ Mev for protons with the 10311 tubes and $E > 35$ kev for electrons and $E > 0.5$ Mev for protons with the 213 tube.

EXPERIMENT: To measure particle flux in energy ranges of $E > 0.5$ Mev for electrons and $E > 10$ Mev for protons with the 10311 tubes and $E > 35$ kev for electrons and $E > 0.5$ Mev for protons with the 213 tube.

TECHNIQUE: The particle flux will be measured and telemetered throughout the flight

INSTRUMENT: Three Geiger-Mueller counters consisting of two RCL 10311 tubes to be operated in coincidence and one 213 tube; integrating ionization chamber

STATUS: First flight models delivered, funded by Lunar & Planetary Programs

DISCIPLINES: Particles & Fields

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EXPERIMENTER: E. Smith, JPL

PARAMETER: Fluctuating magnetic fields

Space Probes (Contd.)

PROJECT DESIGNATION: Ranger (P-53 through P-56) (Contd.)

EXPERIMENT: To provide a survey of lunar electrodynamics in the frequency range of 1 to 1000 cps.

TECHNIQUE: Measurements will be made and telemetered throughout the flight

INSTRUMENT: Search coil magnetometer

STATUS: First flight models delivered, funded by Lunar & Planetary Programs

DISCIPLINES: Particles & Fields

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EXPERIMENTER: R. Bourdeau, GSFC
G. Serbu, GSFC

PARAMETER: Low energy charged particles with energies from 0.1 to 30 ev.

EXPERIMENT: To determine the number, density, and energy of charged particles with energies from 0.1 to 30 ev.

TECHNIQUE: The particle flux will be measured and telemetered throughout the flight

INSTRUMENT: Low energy ion detector

STATUS: First flight models delivered, funded by Lunar & Planetary Programs

DISCIPLINES: Particles & Fields

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Space Probes (Contd.)

PROJECT DESIGNATION: Ranger (P-53 through P-56) (Contd.)

EXPERIMENTER: T. A. Farley, UCLA
N. Sanders, STL

PARAMETER: Energetic Particles

EXPERIMENT: Measurement of fluxes of low energy protons and electrons: protons, 500 kev $< E < 1500$ kev; electrons, 50 kev $< E < 800$ kev

TECHNIQUE: Detection of pulses in plastic scintillator and cesium iodide crystal. Separation of protons and electrons by pulse shape discrimination

INSTRUMENT: Proton-electron spectrometer

STATUS: First flight models delivered. Funded by Lunar & Planetary Programs

DISCIPLINES: Particles & Fields

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EXPERIMENTER: G. F. Pieper, Applied Physics Laboratory

PARAMETER: Energetic Particles

EXPERIMENT: Measurement of the absolute electron flux in the energy range 250 kev to a few Mev

TECHNIQUE: Detection of particles with shielded solid state detectors. Energy is determined by pulse height analysis.

INSTRUMENT: Solid state detectors

STATUS: Flight models delivered. Funded by Lunar & Planetary Programs

DISCIPLINES: Particles & Fields

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Space Probes (Contd.)

PROJECT DESIGNATION:	Mariner II
VEHICLE:	Atlas-Agena B
DATE/SITE:	Launched 27 Aug. 1962 from AMR
TRAJECTORY:	Venus fly-by
EXPECTED LIFETIME:	Closest approach to Venus on 14 Dec. 1962
HEADQUARTERS CONTACT :	F. Kochendorfer
Alternate :	G. Reiff
EXPERIMENTER:	P. J. Coleman, Jr., UCLA L. Davis, CIT E. J. Smith, JPL C. P. Sonett, Ames
PARAMETER:	Magnetic fields
EXPERIMENT:	Study of planetary and interplanetary magnetic fields
TECHNIQUE:	Vector measurement of field with tri-axial magnetometer
INSTRUMENT:	Fluxgate magnetometer
STATUS:	Funded by Lunar & Planetary Programs through flight instrument
DISCIPLINES:	Particles & Fields

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Space Probes (Contd.)

PROJECT DESIGNATION: Mariner II (Contd.)

EXPERIMENTER: M. Neugebauer, JPL
C. W. Snyder, JPL

PARAMETER: Plasma

EXPERIMENT: Study of flux and energy spectrum of interplanetary plasma

TECHNIQUE: Measurement of plasma energy by electrostatic spectrometer

INSTRUMENT: Curved plate electrostatic analyzer

STATUS: Funded by Lunar & Planetary Programs through flight instrument

DISCIPLINES: Particles & Fields

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EXPERIMENTER: H. R. Anderson, JPL
H. V. Neher, CIT
J. Van Allen, SUI

PARAMETER: Cosmic rays

EXPERIMENT: Study of solar and galactic cosmic rays

TECHNIQUE: Comparison of responses of two detectors for particle identification and energy response

INSTRUMENT: Ionization chamber and GM tubes

STATUS: Funded by Lunar & Planetary Programs through flight instrument

DISCIPLINES: Particles & Fields

Geoprobes and Sounding Rockets

NASA No.: 11.06

VEHICLE: Argo D-8

DATE/SITE: 1Q63/PMR

TRAJECTORY: 2000 km altitude

HEADQUARTERS
CONTACT : L. J. Cahill, Jr.
Alternate : J. Holtz

EXPERIMENTER: T. Cline, GSFC

PARAMETER: Positron flux

EXPERIMENT: Identification and measurement of positrons (0.5 Mev) in the inner belt.

TECHNIQUE: Gamma ray pair detection

INSTRUMENT: Scintillation pair detector

STATUS: Funded by GSFC

DISCIPLINES: Particles & Fields

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EXPERIMENTER: J. R. Winckler, Univ. of Minnesota

PARAMETER: Trapped electrons

EXPERIMENT: Measurement of electron flux and energy spectrum (0.05 - 3 Mev). Development and testing of similar systems for satellite use.

Geoprobes and Sounding Rockets (Contd.)

NASA No.: 11.06 (Contd.)

TECHNIQUE: Energy separation by magnetic field and counting with charged particle detectors

INSTRUMENT: Magnetic electron spectrometer and ionization chamber

STATUS: Funded by GSFC through FY 65 (3 year step grant)

DISCIPLINES: Particles & Fields

NASA No.: 14.06, 14.07, 14.79 through 14.85

VEHICLE: Nike-Apache (9)

DATE/SITE: 2,3Q63/India, Equatorial Launch Site

TRAJECTORY: 160-180 km

HEADQUARTERS CONTACT : L. J. Cahill, Jr.
Alternate : J. Holtz

EXPERIMENTER: L. J. Cahill, Univ. of New Hampshire
A. White, Univ. of New Hampshire

PARAMETER: Magnetic field

EXPERIMENT: The structure and intensity of the equatorial electrojet current in the ionosphere will be measured.

TECHNIQUE: Determination of electric current density through measurement of magnetic field produced by current.

Geoprobes and Sounding Rockets (Contd.)

NASA No.:	14.06, 14.07, 14.79 through 14.85 (Contd.)
INSTRUMENT:	Proton precession magnetometer
STATUS:	Funded by GSFC through FY 64
DISCIPLINES:	Particles & Fields (prime) Ionospheres & Radio Physics

Other Flight Experiments

PROJECT DESIGNATION:	Determination of characteristics of high altitude primary cosmic radiation at low latitudes
VEHICLE:	Balloons
DATE/SITE:	1962-1964/South Africa, Southern U.S.
TRAJECTORY:	Top of atmosphere (approximately 100,000 ft.)
DURATION:	Several hours
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	F. R. Gracely
EXPERIMENTER:	M.W. Friedlander, Washington University
PARAMETER:	Galactic and solar cosmic rays
EXPERIMENT:	The experiment is designed to investigate the properties of the primary cosmic radiation at low latitudes near the South African magnetic anomaly
TECHNIQUE:	Magnetically oriented stacks of nuclear emulsions exposed at the top of the atmosphere
INSTRUMENT:	Nuclear emulsions
STATUS:	Funded by Particles & Fields through FY 64
DISCIPLINES:	Particles & Fields

Other Flight Experiments (Contd.)

PROJECT DESIGNATION:	Monitoring of galactic and solar cosmic rays
VEHICLE:	Balloon
DATE/SITE:	1963/Minneapolis and locations in Canada
TRAJECTORY:	40 km at wind velocity
DURATION:	Several hours
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	F. R. Gracely
EXPERIMENTER:	W. R. Webber, Univ. of Minnesota J. R. Winckler, Univ. of Minnesota R. Arnoldy, Univ. of Minnesota
PARAMETER:	Galactic and solar cosmic rays
EXPERIMENT:	This experiment is designed to measure the charge and energy spectra of cosmic rays at several geomagnetic latitudes during the solar minimum period. This experiment is closely correlated with rocket and satellite experiments conducted at the Univ. of Minnesota under the same grant.
TECHNIQUE:	Balloon-borne particle detectors at the top of the atmosphere
INSTRUMENT:	A newly developed Cerenkov-scintillation telescope is to be employed
STATUS:	Funded by Geophysics & Astronomy Programs through FY 65 for flight hardware
DISCIPLINES:	Particles & Fields (prime) Solar Physics

Other Flight Experiments

PROJECT DESIGNATION:	Determination of characteristics of high altitude primary cosmic radiation at low latitudes
VEHICLE:	Balloons
DATE/SITE:	1962-1964/South Africa, Southern U.S.
TRAJECTORY:	Top of atmosphere (approximately 100,000 ft.)
DURATION:	Several hours
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	F. R. Gracely
EXPERIMENTER:	M.W. Friedlander, Washington University
PARAMETER:	Galactic and solar cosmic rays
EXPERIMENT:	The experiment is designed to investigate the properties of the primary cosmic radiation at low latitudes near the South African magnetic anomaly
TECHNIQUE:	Magnetically oriented stacks of nuclear emulsions exposed at the top of the atmosphere
INSTRUMENT:	Nuclear emulsions
STATUS:	Funded by Particles & Fields through FY 64
DISCIPLINES:	Particles & Fields

Other Flight Experiments (Contd.)

PROJECT DESIGNATION:	Monitoring of galactic and solar cosmic rays
VEHICLE:	Balloon
DATE/SITE:	1963/Minneapolis and locations in Canada
TRAJECTORY:	40 km at wind velocity
DURATION:	Several hours
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	F. R. Gracely
EXPERIMENTER:	W. R. Webber, Univ. of Minnesota J. R. Winckler, Univ. of Minnesota R. Arnoldy, Univ. of Minnesota
PARAMETER:	Galactic and solar cosmic rays
EXPERIMENT:	This experiment is designed to measure the charge and energy spectra of cosmic rays at several geomagnetic latitudes during the solar minimum period. This experiment is closely correlated with rocket and satellite experiments conducted at the Univ. of Minnesota under the same grant.
TECHNIQUE:	Balloon-borne particle detectors at the top of the atmosphere
INSTRUMENT:	A newly developed Cerenkov-scintillation telescope is to be employed
STATUS:	Funded by Geophysics & Astronomy Programs through FY 65 for flight hardware
DISCIPLINES:	Particles & Fields (prime) Solar Physics

Other Flight Experiments (Contd.)

PROJECT DESIGNATION:	Isotopic abundance of helium
VEHICLE:	Balloon
DATE/SITE:	1962/Ft. Churchill
TRAJECTORY:	40 km wind velocity
DURATION:	Several hours
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	R. F. Gracely
EXPERIMENTER:	M. F. Kaplon, Univ. of Rochester
PARAMETER:	Measurement of abundance of helium isotopes
EXPERIMENT:	The abundance of the various isotopes of helium in the cosmic radiation is to be measured in order to assist in determining the origin of the cosmic radiation
TECHNIQUE:	Measurement of tracks on nuclear emulsion exposed at balloon altitude
INSTRUMENT:	Nuclear emulsions
STATUS:	Present grant expires 31 Dec. 1962 Funded by Geophysics & Astronomy Programs
DISCIPLINES:	Particles & Fields

Other Flight Experiments (Contd.)

PROJECT DESIGNATION:	Low energy solar and galactic cosmic rays
VEHICLE:	Balloon
DATE/SITE:	1963/Ft. Churchill
TRAJECTORY:	40 km wind velocity
DURATION:	Several hours
HEADQUARTERS CONTACT :	L. J. Cahill, Jr.
Alternate :	F. R. Gracely
EXPERIMENTER:	K. A. Anderson, Univ. of California
PARAMETER:	Low energy cosmic rays
EXPERIMENT:	Low energy protons will be measured in order to understand the production and propagation of solar protons
TECHNIQUE:	Charged particle detectors above the atmosphere
INSTRUMENT:	Cerenkov, scintillation and solid state detectors will be used
STATUS:	Funded by Geophysics & Astronomy Programs through March 1963
DISCIPLINES:	Particles & Fields (prime) Solar Physics

Supporting Research

AREA OF INVESTIGATION:	Magnetodynamics
TITLE:	Research on charged particles and fields in space
PRINCIPAL INVESTIGATOR:	R. H. Vestine
ORGANIZATION:	Rand Corporation
ADDRESS:	Santa Monica, California
CONTRACT NUMBER:	NASr-21(05)
TIME PERIOD:	1 Nov. 1961 - 30 April 1963
FUNDED BY:	Particles & Fields through FY 1963
AMOUNT:	$149,630
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	J. E. Naugle
DESCRIPTION:	Study energetic particles of the Van Allen radiation belts in connection with the polar regions and with aurora and magnetic disturbances. Improve the calculations of the earth's magnetic field out to about 20 earth radii. Extend previous studies of the interaction of solar streams and magnetic fields with the geomagnetic field. Improve the theoretical and experimental description of the radiation belts.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Magnetodynamics
TITLE:	A theoretical study of the ring current and geomagnetic field phenomena
PRINCIPAL INVESTIGATOR:	Syun-ichi Akasofu Sydney Chapman
ORGANIZATION:	Geophysical Institute
Address:	College, Alaska
CONTRACT NUMBER:	NsG 201-62 (Suppl 1)
TIME PERIOD:	15 Jan. 1962 - 31 Dec. 1962
FUNDED BY:	NASA Hq., Particles & Fields through FY 1963
AMOUNT:	$35,000
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	J. E. Naugle
DESCRIPTION:	This is an interpretive and theoretical study of ring current effects. Surface magnetic measurements, satellite particle and magnetic measurements, and calculated ring current fields are to be correlated.

AREA OF INVESTIGATION:	Magnetodynamics
TITLE:	Development, construction and testing of magnetometers suitable for use on satellites.

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	L. J. Cahill, Jr.
ORGANIZATION:	Univ. of New Hampshire
ADDRESS:	Durham, New Hampshire
CONTRACT NUMBER:	NASw-155 (Amd. 2)
TIME PERIOD:	19 June 1961 - 30 June 1963
FUNDED BY:	NASA Hq., Particles & Fields through FY 1963
AMOUNT:	$86,900
TECHNICAL MONITOR:	L. J. Cahill, Jr.
ALTERNATE CONTACT:	John E. Naugle
DESCRIPTION:	Fluxgate magnetometers are being developed and flown on eccentric orbiting satellites. Investigation is in progress of the outer geomagnetic field and its boundary with the interplanetary medium.

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Data reduction and analysis for heavy primary cosmic ray experiment in Explorer VII satellite.
PRINCIPAL INVESTIGATOR:	M. Pomerantz
ORGANIZATION:	Bartol Research Foundation, The Franklin Institute
ADDRESS:	Philadelphia, Pa.

Supporting Research (Contd.)

CONTRACT NUMBER:	NASr-79 and Amd 1 and 2
TIME PERIOD:	1 Nov. 1961 - 31 Jan. 1963
FUNDED BY:	NASA Hq., Particles & Fields through FY 1963
AMOUNT:	$45,100
TECHNICAL MONITOR:	L. J. Cahill
DESCRIPTION:	Complete reduction and analysis of the ionization chamber data from the Explorer VII satellite.

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Theoretical and experimental studies related to the particles and fields associated with the major bodies of the solar system and with interplanetary space.
PRINCIPAL INVESTIGATOR:	J. A. Van Allen
ORGANIZATION:	State Univ. of Iowa
ADDRESS:	Iowa City, Iowa
CONTRACT NUMBER:	NsG-233-62
TIME PERIOD:	1 Nov. 1961 - 31 Oct. 1964
FUNDED BY:	NASA Hq., Particles & Fields through FY 1964
AMOUNT:	$600,000

Supporting Research (Contd.)

TECHNICAL MONITOR:	L. J. Cahill
DESCRIPTION:	Continuing program of Space Science research including experimental and theoretical studies of trapped radiation and related phenomena.

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Cosmic ray instrumentation in satellite and planetary probe experiments
PRINCIPAL INVESTIGATOR:	J. R. Winckler E. P. Ney
ORGANIZATION:	Univ. of Minnesota
ADDRESS:	Minneapolis, Minnesota
CONTRACT NUMBER:	NASw-56 (Amd. 4)
TIME PERIOD:	1 March 1961 - 31 Dec. 1962
FUNDED BY:	NASA Hq., Particles & Fields through Dec. 1962
AMOUNT:	$260,000
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	J. Lindsay, GSFC
DESCRIPTION:	This is a three year step grant for research in galactic and solar cosmic radiation trapped radiation, and zodiacal light. Satellite experiments are planned as well as supporting balloon and rocket flights.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Experimental and theoretical studies of energetic particles and electro-dynamical processes in interplanetary space and in the vicinity of planets
PRINCIPAL INVESTIGATOR:	John Simpson
ORGANIZATION:	Univ. of Chicago
ADDRESS:	Chicago, Ill.
CONTRACT NUMBER:	NsG-179-61
TIME PERIOD:	1 Aug. 1961 - 31 July 1964
FUNDED BY:	NASA Hq., Particles & Fields through FY 1964
AMOUNT:	$420,000
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	F. B. McDonald, GSFC G. Ludwig, GSFC
DESCRIPTION:	This is a three-year step grant for research in galactic and solar cosmic radiation and trapped radiation. Satellite experiments are planned as well as supporting balloon flights.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Coincidence telescope for study of primary cosmic radiation
PRINCIPAL INVESTIGATOR:	P. E. Shearin
ORGANIZATION:	Univ. of North Carolina
CONTRACT NUMBER:	NASw-59 (Amd. 4)
TIME PERIOD:	6 June, 1962 - 31 Dec. 1962
FUNDED BY:	NASA Hq., Geophysics & Astronomy Programs
AMOUNT:	$22,620
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	J. E. Naugle
DESCRIPTION:	A Geiger tube telescope combined with a gas Cerenkov detector is being developed for measurement of energy spectra of high energy cosmic ray particles.

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Investigations of the interaction of solar flare particles with the coronal plasma
PRINCIPAL INVESTIGATOR:	Ludwig Oster

Supporting Research (Contd.)

ORGANIZATION:	Yale University
CONTRACT NUMBER:	NsG 176-61
TIME PERIOD:	1 Nov. 1961 - 31 Oct. 1963
FUNDED BY:	NASA Hq.
AMOUNT:	$11,955
TECHNICAL MONITOR:	E. R. Schmerling
DESCRIPTION:	This research is a theoretical investigation of the interaction of solar flare particles with coronal plasma. The investigation is aimed at determining whether excitation of plasma oscillation by the fast particles may be responsible for observed non-thermal radio emission.

AREA OF INVESTIGATION:	Energetic particles
TITLE:	A determination of some characteristics of high altitude primary cosmic radiation at low and/or southern latitudes
PRINCIPAL INVESTIGATOR:	M. W. Friedlander
ORGANIZATION:	Washington University
ADDRESS:	St. Louis, Mo.
CONTRACT NUMBER:	NsG 185-61 and Suppl 1 and 2
TIME PERIOD:	1 Sept. 1961 - 31 Aug. 1964

Supporting Research (Contd.)

FUNDED BY:	NASA Hq., Particles & Fields through FY 1964
AMOUNT:	$143,431
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	Carl E. Fichtel, GSFC
DESCRIPTION:	Nuclear emulsions are employed in an investigation of primary cosmic radiation at the top of the atmosphere.

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Research on low-energy cosmic radiation from the Sun
PRINCIPAL INVESTIGATOR:	K. A. Anderson
ORGANIZATION:	Univ. of California
ADDRESS:	Berkeley, California
CONTRACT NUMBER:	NASr-26
TIME PERIOD:	15 March 1961 - 14 March 1963
FUNDED BY:	NASA Hq., Particles & Fields through FY 1963
AMOUNT:	$99,498
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	F. R. Gracely

Supporting Research (Contd.)

DESCRIPTION:	Instruments are being developed for satellite experiments to investigate low energy solar particle radiation. Balloon flights are conducted as part of the research effort and in testing the satellite instruments.

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Study of geomagnetically trapped particles
PRINCIPAL INVESTIGATOR:	Carl E. McIlwain
ORGANIZATION:	Univ. of California
ADDRESS:	San Diego, California
CONTRACT NUMBER:	NASr-116
TIME PERIOD:	27 July 1962 - 30 June 1963
FUNDED BY:	NASA Hq., Particles & Fields through FY 1963
AMOUNT:	$277,997
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	Daniel M. Brown, GSFC
DESCRIPTION:	This research is a program of experimental and theoretical investigation of trapped radiation.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Energetic particles
TITLE:	Analytical and experimental research in space physics, including balloon and rocket flight experiments
PRINCIPAL INVESTIGATOR:	J. R. Winckler E. P. Ney
ORGANIZATION:	Univ. of Minnesota
ADDRESS:	Minneapolis, Minn.
CONTRACT NUMBER:	NsG 281-62
TIME PERIOD:	1 July 1962 - 30 June 1965
FUNDED BY:	NASA Hq., Particles & Fields through FY 1965
AMOUNT:	$800,000
TECHNICAL MONITOR:	L. J. Cahill
ALTERNATE CONTACT:	F. R. Gracely
DESCRIPTION:	This is a three year step grant for research in galactic and solar cosmic radiation trapped radiation, and zodiacal light. Satellite experiments are planned as well as supporting balloon and rocket flights.

AREA OF INVESTIGATION:	Particles & Fields
TITLE:	Low energy proton detector system

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	Thomas A. Farley
ORGANIZATION:	Univ. of California
ADDRESS:	Los Angeles, Calif.
CONTRACT NUMBER:	NsG 249-62
TIME PERIOD:	1 March 1962 - 28 Feb. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$92,040
TECHNICAL MONITOR:	U. Liddel
DESCRIPTION:	The objective is to design, develop, and construct a single flight prototype of a low energy proton detector. This instrument, when developed, will measure the spectral intensity of protons in the energy range between 0.2 and 5.0 Mev. It should provide ample discrimination against electrons of all but the greatest intensities observed in the outer zone. This instrument is being developed for the Ranger program.

AREA OF INVESTIGATION:	Particles & Fields
TITLE:	Plasma investigations in interplanetary space
PRINCIPAL INVESTIGATOR:	H. S. Bridge B. Rossi
ORGANIZATION:	Massachusetts Inst. of Technology

Supporting Research (Contd.)

ADDRESS:	Cambridge, Massachusetts
CONTRACT NUMBER:	NASw 75 (Amd. 5)
TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1962
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$149,400
TECHNICAL MONITOR:	U. Liddel
DESCRIPTION:	To design, construct, and test a prototype apparatus to measure plasma density and motion within the solar system as a function of time and position. The basic detector to accomplish this is a Faraday cup constructed so that it responds only to protons. The contract covers the building of flight units for our space probes and continued research and development in this field.

AREA OF INVESTIGATION:	Particles & Fields
TITLE:	Theoretical investigation of solar wind
PRINCIPAL INVESTIGATOR:	E. N. Parker
ORGANIZATION:	Univ. of Chicago
ADDRESS:	Chicago, Illinois

Supporting Research (Contd.)

CONTRACT NUMBER:	NsG 96-60 (Suppl 2)
TIME PERIOD:	1 Aug. 1962 - 31 July 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$39,496
TECHNICAL MONITOR:	U. Liddel
DESCRIPTION:	Investigate the theoretical aspects of magneto-hydrodynamic phenomena in space. Studies of the solar wind will be needed in order to interpret flight data and to plan future experiments. This research also includes theoretical studies of geomagnetic storm phenomena and of the kinetic properties of interplanetary gas.

AREA OF INVESTIGATION:	Particles & Fields
TITLE:	Laboratory studies of outer space phenomena
PRINCIPAL INVESTIGATOR:	Ralph W. Waniek
ORGANIZATION:	Advanced Kinetics
ADDRESS:	Costa Mesta, California
CONTRACT NUMBER:	NASw-427
TIME PERIOD:	9 April 1962 - 9 April 1963
FUNDED BY:	Lunar & Planetary Programs

Supporting Research (Contd.)

AMOUNT:	$76,328
TECHNICAL MONITOR:	U. Liddel
DESCRIPTION:	An attempt will be made to simulate, in the laboratory, the interaction of solar plasma with the geomagnetic field. These experiments will consist mainly of the injection of plasma from a gun into a cavity containing a small magnetic dipole. Measurements will be made of the variations and/or oscillations in the field's particle fluxes, and in the electromagnetic radiation produced by the interaction of the plasma and the field.

AREA OF INVESTIGATION:	Particles & Fields
TITLE:	Investigate magnetic fields and charged particles
PRINCIPAL INVESTIGATOR:	L. Davis
ORGANIZATION:	California Inst. of Technology
ADDRESS:	Pasadena, California
CONTRACT NUMBER:	NsG 151-61 (Suppl. 1)
TIME PERIOD:	1 May 1962 - 30 April 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$16,000

Supporting Research (Contd.)

TECHNICAL MONITOR: U. Liddel

DESCRIPTION: Conduct a theoretical investigation of magnetic fields and energetic charged particles in planetary exospheres and interplanetary space. Among the particular studies contemplated are:

(1) The development of a model for the boundary between the geomagnetic field and interplanetary space.

(2) The development of a model of the interplanetary magnetic fields as deduced from magnetometer measurements and solar and galactic cosmic ray data.

(3) A study of the relation of the galactic magnetic field to the interplanetary region.

(4) A study of the diffusion of trapped particles due to variations in the geomagnetic field.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Energetic Particles
TITLE:	Balloon flying expedition for cosmic ray studies at Ft. Churchill, Canada
PRINCIPAL INVESTIGATOR:	M. F. Kaplon
ORGANIZATION:	University of Rochester
ADDRESS:	Rochester, New York
CONTRACT NUMBER:	NsG-162 (Suppl. 1)
TIME PERIOD:	1 June 1962 - 31 Dec. 1962
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$15,000
TECHNICAL MONITOR:	J. E. Naugle
DESCRIPTION:	Conduct investigation of the abundance of helium isotopes and other selected nuclei in low-energy primary cosmic radiation

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AREA OF INVESTIGATION:	Plasma Physics
TITLE:	Techniques for extraterrestrial measurement of low energy charged particle fluxes in the interplanetary plasma
PRINCIPAL INVESTIGATOR:	T. D. Wilkerson
ORGANIZATION:	University of Maryland
ADDRESS:	College Park, Md.

Supporting Research (Contd.)

CONTRACT NUMBER:	NsG-283
TIME PERIOD:	1 July 1962 - 30 June 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$18,179
TECHNICAL MONITOR:	F. B. McDonald, GSFC
DESCRIPTION:	Techniques for extraterrestrial measurement of low energy charged particle fluxes in the interplanetary plasma

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AREA OF INVESTIGATION:	Energetic Particles
TITLE:	High altitude balloon monitoring for cosmic rays and solar terrestrial phenomena
PRINCIPAL INVESTIGATOR:	J. R. Winckler and E. P. Ney
ORGANIZATION:	University of Minnesota
ADDRESS:	Minneapolis, Minn.
CONTRACT NUMBER:	NsG-109
TIME PERIOD:	1 Oct. 1960 - 30 Sept. 1961 plus no-cost extension to 31 Dec. 1962
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$105,000
TECHNICAL MONITOR:	J. E. Naugle

Supporting Research (Contd.)

DESCRIPTION:	Investigation of primary cosmic radiation and of trapped particle precipitation at balloon altitudes with nuclear emulsions and charged particle detectors.

AREA OF INVESTIGATION:	Energetic Particles and Ionospheric Physics
TITLE:	Initiate studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during the IQSY
PRINCIPAL INVESTIGATOR:	D. K. Bailey
ORGANIZATION:	NBS
ADDRESS:	Boulder, Colo.
CONTRACT NUMBER:	R-74
TIME PERIOD:	15 Nov. 1962 - 15 May 1963
FUNDED BY:	Geophysics & Astronomy Programs
AMOUNT:	$25,000
TECHNICAL MONITOR:	L. J. Cahill
DESCRIPTION:	Support of studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during IQSY. This initial funding will be used primarily for the design, construction and purchase of long-lead-time experimental apparatus.
DISCIPLINES:	Particles and Fields (prime Ionospheres and Radio Physics

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Supporting Research

AGENCY	AREA	LEVEL OF EFFORT (FY 63)	PRINCIPAL INVESTIGATOR
Goddard Space Flight Center	Theoretical Studies on Cosmic Rays	$14,000	A. L. Levine
	Theoretical Studies in Particle Motion	$30,000	J. Gilbert
	Development of Particle Detectors	$671,000	F. B. McDonald
	World Magnetic Survey Theoretical Studies	$56,000	J. C. Cain
	Theoretical Studies in Magnetic Fields	$38,000	I. Harris
	Theoretical Studies in Magnetohydro-dynamics and Magnetic Fields in Space	$92,000	A. L. Levine
	Advanced Magnetometer Development	$101,400	N. F. Ness

PLANETOLOGY

OBJECTIVES:

The planetology program is concerned with the condensed material of the solar system: Planets (including Earth), moons, asteroids, comets, meteorites, and related objects.

These solid objects can be studied with respect to their elemental composition, their phase composition, the combination, arrangement, and evolution, of these phases, and the rock units that they constitute, the solid objects as entities, and their history.

Ancient life and large scale climatic features of the planets are of interest to this discipline.

Knowledge obtained through the planetology program provides the basis for recommendations for scientific research required to permit effective accomplishment of manned lunar landings, and for the scientific programs to be carried out by man in space.

The short-range program for Planetology has as its objectives furthering our knowledge about the moon by means of spacecraft and ground-based activities; the study of meteorite craters and impact sites on Earth; investigations of meteorites and tektites; planetary exploration; and the continuation of ground-based supporting research programs.

The primary questions we hope to answer about the moon are concerned with the nature and chemical composition of its surface and interior. A few of the more crucial questions concerning the lunar surface are as follows:

1. Is the lunar surface fairly uniform, or does it vary considerably with location?

2. Does the surface material on the moon represent true lunar composition, or is this material a superficial cover of meteoritic debris?

3. What is the particle size of the surface materials?

4. What is the elemental composition of the lunar materials?

5. What is the molecular structure of the lunar materials?

6. What is the crystalline structure of the lunar materials?

7. How are surface materials affected by solar particle bombardment?

8. What are the physical parameters (heat conductivity, electrical conductivity, density, etc.) of the lunar materials?

9. Is there water on or near the moon's surface?

Concerning the interior of the moon, we hope to learn such things as the following:

1. Does the moon have a core?

2. Has mineral differentiation occurred on the moon?

3. What is the thermal history of the moon?

4. Is the moon layered with depth?

5. Does the moon have "moonquakes"?

6. What is the density distribution within the moon?

7. Does the moon have a magnetic field?

Through 1966 the exploration of Venus and Mars will be by means of spacecraft that will fly by the two planets and make measurements of atmospheres, magnetic fields, and radiation belts. The balloon-borne Strato II flights will make infra-red measurements of the temperatures of Venus and Mars. Thus, for the next five years the exploration of these two planets is only indirectly associated with the Planetology Program; however, the programs for the exploration of Venus and Mars will, in time, parallel the lunar exploration program.

This short-range Planetology Program does not envision any large effort related to comets. However, a study is underway on the possibility of probing the coma of a comet, and this effort would be of interest to the Planetology Program.

TECHNIQUES FOR LUNAR INVESTIGATIONS:

The basic data concerning the surface of the moon will be gathered by ground-based observations and by unmanned spacecraft within the next five-year period. These investigations will be concentrated on the leading side of the moon in the vicinity of the equator, in the same area where the manned lunar landings will be made. Work will be done in the following areas: geodesy; topographic mapping; photogeology; ground-based radar; microwave and telescopic analysis of the lunar surface; and unmanned flight-supported geology and geophysics.

Geodesy, in its broadest context, will be studied mainly through Earth-based activity. First and second order triangulation points that have horizontal as well as vertical control are being measured on photographic plates and these control points are being used in the preparation of topographic maps. It is possible that a spacecraft will be placed in orbit around the moon before 1966, and the resulting data will be used to determine the figure of the moon, as well as provide the higher resolution photography needed for scientific studies of the surface.

Topographic mapping of the moon on a scale of 1:1,000,000 is being done by the Air Force Chart and Information Center, using data supplied in large part by NASA grantees. These base maps are fundamental to scientific work and direct NASA support of the present low level ACIC program will be needed in order to complete the topographic maps required for the photogeologic mapping. Extension of the topographic mapping, either in areal coverage or to larger scales, will require new photography by means of orbiting spacecraft. Eventually, maps of a scale of approximately 1:100,000 will be needed for the photogeologic work and the manned lunar landings. Ideally, such photography should be available before mid-1965.

Photogeologic mapping of the moon began two years ago under a NASA agreement with the U. S. Geological Survey. The area 32° north and south of the equator, to the limbs, will be covered with photogeologic maps in a scale of 1:1,000,000 by mid-1965. Extension of the mapping to 48° north and south should be completed by the end of 1965. Further photogeologic mapping, either on 1:1,000,000 or 1:100,000 scales, will depend upon photography acquired by means of orbiting spacecraft.

Investigations of the lunar surface by means of ground-based radar and microwave began two years ago. The interpretations of these data lack resolution and are subject to some doubt, but they seem to indicate variations in surface properties between some craters and the lunar surface in general. Future work should be concentrated on perfecting the interpretational method and improving resolutions.

Photometric studies of the lunar surface tend to verify the small surface relief indicated by radar. It has been found in the laboratory that small scale, intricately-structured surfaces give photometric results comparable to those obtained from the moon.

Unmanned flight-supported geology and geophysics will be accomplished by means of the Ranger and Surveyor spacecraft. Beginning in 1963, flights will be made by Rangers 6, 7, 8, and 9. The primary objective of these flights is to take close-up photographs of the lunar surface. The secondary objective is to make measurements, in the discipline of particles and fields, enroute to the moon. Rangers 10, 11, 12, 13, and 14 have been authorized for 1964 and 1965. The spacecraft will carry a TV system and other experiments, not yet selected.

Two Surveyor, soft-landing, spacecraft are scheduled to be flown in 1964, followed by three in 1965. The purposes of these flight will be to:

1. Determine the mineral and chemical composition of the lunar surface materials at particular points.

2. Determine the bearing strength, topography, texture, and nature of the lunar surface at particular points.

3. Determine the number and severity of secondary rock particles created by meteorite bombardment.

These unmanned-flight results will contribute greatly to the manned lunar expeditions which will start after 1966. Preliminary to a manned lunar flight, we must know the physical condition of the lunar surface, particularly with regard to the thickness of any dust layer, and the clinging effect of this dust caused by the lack of surface oxides; the activity of this surface induced by solar particles; and the flux of the secondary meteorite particles.

Ground-based research related to lunar exploration is being done in five areas: geology, geophysics and nuclear physics, geochemistry, astronomy, and radar and radio astronomy.

Instruments for Unmanned Lunar Exploration

Available:

With the exception of the Ranger gamma-ray detector, single-component seismometer and TV equipment, spacecraft instrumentation in use and available at the present time has been developed for the exploration of the Earth's high atmosphere and interplanetary space. There are no other instruments available which have been completely developed for lunar surface exploration, although some of the following instruments are in advanced stages of flight-approved testing.

Under Development:

Vidicon camera systems for lunar approach.

Gamma-ray spectrometer for identification of natural and induced radioactive elements.

Single axis short-period seismometer.

Television systems for medium--and high--resolution reconnaissance of the lunar surface.

Lunar surface sampler.

Sample handling and processing equipment.

Radiometers for determination of radiation temperatures on the surface and subsurface.

Magnetic susceptibility technique for surface and subsurface measurements.

Radiation heating and cooling technique for determining surface and subsurface thermal conductivities.

Configurations of detectors and explosive charges to determine subsurface acoustic velocities of the moon.

Techniques to determine the mechanical bearing and shearing strength of the lunar soil.

X-ray diffractometer for mineralogical analyses.

X-ray spectrometer for elemental analyses.

Facsimile equipment for high resolution pictures.

Gas chromatograph for the analysis of volatile gases.

Petrographic microscope.

An instrument to use the Rutherford scattering technique for light-element analysis.

Three-axis long-period seismometer.

Three-axis fluxgate magnetometer.

Modified "Redhead" pressure gauge.

Electrostatic deflection plasma probe.

Neutron activation and inelastic scattering technique for elemental analysis.

Absorption spectrophotometer for elemental analysis.

Mass spectrometer for elemental analysis.

TECHNIQUES FOR EARTH INVESTIGATIONS:

The Earth investigations in the field of Planetology are limited to the study of meteorite impact sites. Work will be concerned with establishing geologic and mineralogic criteria by means of which impact sites can be identified; identifying impact sites; detailed geologic investigations of impact sites; and laboratory investigations of the physics and chemistry of hypervelocity impact.

The impact site and meteorite crater investigations are being done primarily to learn about the physics of natural impact events and to determine the flux of large meteorites in geological time. It is apparent that identification of impact sites will continue at a growing rate.

TECHNIQUES FOR METEORITE AND TEKTITE STUDIES:

For the next five years, meteorites are likely to be the only extraterrestrial materials available for study on Earth. A comprehensive program is in progress that includes studies in geochemistry, mineralogy, petrography, petrology, age dating, and cosmic radiation history of meteorites. The results of these studies will be of great help in formulating and extending theories on the origin of the solar system, the original chemical composition of the solar system, and nucleogenesis within the solar system. In addition, various studies are underway that will lead to a better knowledge of meteorite flux. We are also studying the Earth trajectories of meteorites in order to determine their position of origin within the solar system.

A comprehensive study of the major and minor elements of tektites is being done by the U. S. Geological Survey. If, as some scientists believe, tektites originate on the moon, a detailed understanding of their chemical and mineralogical characteristics will be of great value.

TECHNIQUES FOR GENERAL EARTH-BASED SUPPORTING RESEARCH:

Most of the Earth-based research is for direct support of lunar, Earth impact site, or meteorite studies. However, some grants, of a more general nature, include basic research on the general problem of planetary interiors as well as research in geochemical instrumentation.

PROJECTS AND TASKS: Space Probes

PROJECT DESIGNATION:	Ranger Rangers 6 through 9
VEHICLE:	Atlas-Agena B
DATE/SITE:	First flight in third quarter CY 63, later flight schedules not firm
TRAJECTORY:	Lunar impact
EXPECTED LIFETIME:	66 hour trajectory to impact
HEADQUARTERS CONTACT :	N. W. Cunningham, Program Chief
Alternate:	W. Jakobowski, Program Engineer
EXPERIMENTER:	G. Kuiper, Univ. of Arizona H. C. Urey, Univ. of California at San Diego E. Shoemaker, U. S. Geological Survey, Wash. D. C. A. Hibbs, JPL R. Heacock, JPL E. Dobies, JPL
PARAMETER:	Television picture of lunar surface
EXPERIMENT:	To determine lunar topography from a series of TV pictures. Resolution of pictures will range from approximately one km for the first down to one meter for the last picture.
TECHNIQUE:	Beginning at a lunar altitude of 5000 miles a series of TV pictures will be taken down to an altitude of about 50,000 feet. The resulting pictures will be examined and interpreted.

Space Probes (Contd.)

PROJECT DESIGNATION: Rangers 6 through 9 (Contd.)

INSTRUMENT: An RCA TV system consisting of six one-inch vidicon cameras

STATUS: Funded by JPL through FY 63. Program is scheduled to continue through FY 67

DISCIPLINES: Planetology

PROJECT DESIGNATION: Surveyor
P-42 through P-48, soft-landing spacecraft

VEHICLE: Atlas-Centaur

DATE/SITE: Two in 1964, four in 1965, one in 1966/AMR

TRAJECTORY: Lunar direct

EXPECTED LIFETIME: 30 days after landing

HEADQUARTERS CONTACT : B. Milwitzky, Program Chief
Alternate: M. J. Swetnick, Program Scientist

EXPERIMENTER: Not selected; to be designated in Jan. 1963

PARAMETER: The flux of secondary rock particles on the lunar surface

EXPERIMENT: This experiment is to measure the flux of secondary particles generated by meteorite impacts.

TECHNIQUE: The instrument has not been selected

Space Probes (Contd.)

PROJECT DESIGNATION: Surveyor
P-42 through P-48 (Contd.)

STATUS: Funds have been transferred to Goddard for preliminary work.

DISCIPLINES: Planetology

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EXPERIMENTER: Not selected

PARAMETER: Major component composition of lunar surface

EXPERIMENT: Elemental analysis of lunar surface material

TECHNIQUE: The instrument can be placed directly on the surface or it can be placed on samples prepared for the X-ray, diffraction experiment.

INSTRUMENT: Gold-silicon surface barrier diodes will be used to detect the Rutherford Scattering of 6.1 Mev alpha-particles from a strong curium source.

STATUS: A prototype, funded by Lunar & Planetary Programs has been built

DISCIPLINES: Planetology

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EXPERIMENTER: S. P. Clark, Yale Univ.
F. Press, Calif. Inst. of Tech.
F. E. Ingerson, Univ. of Texas
G. C. Kennedy, Univ. of Calif., Los Angeles

Space Probes (Contd.)

PROJECT DESIGNATION: Surveyor P-42 through P-48 (Contd.)

PARAMETER: Magnetic properties

EXPERIMENT: Determine magnetic properties of lunar surface material.

TECHNIQUE: After calibrating, at least 12 inches above the surface, the instrument will be placed on the surface. Mutual inductance will be measured with the coils adjacent to the surface

INSTRUMENT: An air-core transformer consisting of a primary and a secondary winding and a reverse wound bucking coil in the primary circuit.

STATUS: Prototype built, funded by Lunar & Planetary Programs

DISCIPLINES: Planetology

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EXPERIMENTER: S. P. Clark, Yale Univ.
F. E. Ingerson, Univ. of Texas
G. C. Kennedy, Univ. of Calif., Los Angeles
E. M. Shoemaker, US Geological Survey
F. Press, Calif. Inst of Tech.

PARAMETER: Thermal diffusivity

EXPERIMENT: Determine thermal diffusivity of lunar surface material

TECHNIQUE: The instrument will be used to detect changes in temperature when used in conjunction with a sunshade of known surface emissivity.

Space Probes (Contd.)

PROJECT DESIGNATION: Surveyor
P-42 through P-48 (Contd.)

INSTRUMENT: Infrared interferometer spectrometer

STATUS: A prototype has been built with Lunar & Planetary funds

DISCIPLINES: Planetology

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EXPERIMENTER: M. Ewing, Columbia Univ.
F. Press, CIT

PARAMETER: Lunar vibrations

EXPERIMENT: Determine body properties of the moon

TECHNIQUE: The instrument will be placed on the surface.

INSTRUMENT: Single axis seismometer

STATUS: A prototype was built for the Ranger program with Lunar & Planetary funds

DISCIPLINES: Planetology

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EXPERIMENTER: S.P. Clark, Yale Univ.
F. Press, Calif. Inst. of Tech.
F. E. Ingerson, Univ. of Texas
G. C. Kennedy, Univ. of Calif., Los Angeles
E. M. Shoemaker, US Geological Survey

PARAMETER: Hardness, bearing, and shear strength of lunar surface

EXPERIMENT: To determine surface hardness, bearing strength, and shear strength.

Space Probes (Contd.)

PROJECT DESIGNATION: Surveyor P-42 through P-48 (Contd.)

TECHNIQUE: The instrument consists of two vertically loaded flat circular plates, one 2 inches in diameter, one 4 inches in diameter and a spudded annular ring. Thrust is applied first to the 2 inch plate, then to the 4 inch plate; indentation can be to a maximum of 9 inches; thrust to a maximum of 50 pounds. Shear strength from 0.4 to 2.4 lb./inch^2 can be measured by applying a torque to the annular ring.

INSTRUMENT: Bevameter

STATUS: Prototype under construction. Funded by JPL.

DISCIPLINES: Planetology

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EXPERIMENTER: G. P. Kuiper, Univ. of Arizona
E. M. Shoemaker, US Geological Survey

PARAMETER: Topography and texture of lunar surface

EXPERIMENT: Obtain series of overlapping pictures of landing site and surrounding area during final descent phase. Obtain panoramic pictures from spacecraft after landing.

TECHNIQUE: The two horizontal cameras will be able to give 360° coverage around the spacecraft, and view from 15° above to 45° below the horizon. The horizontal cameras will have lenses with focal lengths variable from 25 to 100 mm. A series of pictures will be taken during the first descent phase.

Space Probes (Contd.)

PROJECT DESIGNATION: Surveyor P-42 through P-48 (Contd.)

INSTRUMENT: Two horizontal and one downward-looking television cameras

STATUS: Funded by JPL

DISCIPLINES: Planetology

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EXPERIMENTER: H. Hess, Princeton Univ.
E. Goldberg, U. of Calif., San Diego

PARAMETER: Mineralogy of the lunar surface

EXPERIMENT: Obtain diffraction patterns that will permit a determination of the mineral composition

TECHNIQUE: Surface material will be scooped up by an extendable arm, dumped into a processor that will crush the material. The powdered rock will be dropped into a sample holder, irradiated and scanned by a detector. Twenty values will be telemetered to Earth.

INSTRUMENT: X-ray diffractometer

STATUS: Funded by JPL, prototype being tested.

DISCIPLINES: Planetology

Interest in Space Probes

PROJECT DESIGNATION:	Mariner II
VEHICLE:	Atlas-Agena B
DATE/SITE:	Launched 27 August 1962 from AMR
TRAJECTORY:	Venus fly-by
EXPECTED LIFETIME:	Closest approach to Venus on 14 Dec 1962
HEADQUARTERS CONTACT :	F. D. Kochendorfer
Alternate:	G. A. Reiff
EXPERIMENTER:	L. D. Kaplan, JPL G. Neugebauer, JPL C. Sagan, Univ. of Calif.,Berkeley
PARAMETER:	Atmospheric and surface temperature
EXPERIMENT:	Measure Venus atmospheric temperatures and map cloud coverage
TECHNIQUE:	Infrared energy received by scanning Venus may be interpreted to give temperature
INSTRUMENT:	Infra-red radiometer
STATUS:	Funded by Lunar and Planetary Programs through flight instrument
DISCIPLINES:	Planetary Atmospheres (prime) Planetology Ionospheres and Radio Physics

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Interest in Space Probes (Contd.)

PROJECT DESIGNATION: Mariner II (Contd.)

EXPERIMENTER: W. M. Alexander, GSFC

PARAMETER: Intensity and frequency of micrometeorite impacts near Venus

EXPERIMENT: Measure mass and number distributions of cosmic dust in ecliptic; also structural and velocity information

TECHNIQUE: Particles hit acoustical plate and are recorded by microphone and counted.

INSTRUMENT: Crystal microphone

STATUS: Funded by Geophysics and Astronomy through flight instrument

DISCIPLINES: Planetology
Planetary Atmospheres (prime)

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EXPERIMENTER: A. Barrett, Mass. Inst. of Tech.
A. E. Lilley, Harvard Univ.
J. Copeland, Ewen Knight Corp
D. E. Jones, JPL

PARAMETER: Atmospheric and surface temperature

EXPERIMENT: Measure Venus surface brightness temperature and temperature at intermediate level in Venus atmosphere

TECHNIQUE: Microwave energy at 19 mm & 13.5 mm received by scanning Venus may be interpreted to give temperature

INSTRUMENT: Microwave radiometer

Interest in Space Probes (Contd.)

STATUS: Funded by Lunar and Planetary Programs through flight instrument

DISCIPLINES: Planetary Atmospheres (prime)
Planetology

PROJECT DESIGNATION: Rangers 6 through 9

VEHICLE: Atlas-Agena B

DATE/SITE: First flight in third quarter CY 63
later flight schedules not firm

TRAJECTORY: Lunar impact

EXPECTED LIFETIME: 66 hour trajectory to impact

HEADQUARTERS CONTACT : N. W. Cunningham, Program Chief
Alternate: W. Jakobowski, Program Engineer

EXPERIMENTER: W. M. Alexander, GSFC

PARAMETER: Dust particle flux in cislunar space

EXPERIMENT: Dust particle experiment for Ranger impactors

TECHNIQUE: Particles hit acoustical plate and are recorded by microphone and counted.

INSTRUMENT: Micrometeorite detector

Interest in Space Probes (Contd.)

STATUS: Flight instrument built with Lunar & Planetary Program funds

DISCIPLINES: Planetary Atmospheres (prime)
Planetology

Other Flight Experiments

PROJECT DESIGNATION:	Stratoscope II
VEHICLE:	High altitude, free balloon
DATE/SITE:	1963/Palastine, Texas
TRAJECTORY:	25 km maximum altitude
EXPECTED LIFETIME:	About 12 hours
HEADQUARTERS CONTACT :	N. G. Roman
Alternate :	R. C. Moore
EXPERIMENTER:	M. Schwarzschild, Princeton Univ.
PARAMETER:	Planets and star fields; IR spectrometry of Mars.
EXPERIMENT:	Take high resolution photographs of planets and star fields. Make IR spectrometric observations of Mars.
TECHNIQUE:	Photography; spectrophotometry
STATUS:	Funded by Bioscience Program (NASr-113) jointly with NSF and ONR for development and three flights
DISCIPLINES:	Planetology (prime) Planetary Atmospheres Biosciences

Supporting Research

AREA OF INVESTIGATION:	Geology - related to lunar work
TITLE:	Photogeological lunar mapping
PRINCIPAL INVESTIGATOR:	Eugene M. Shoemaker
ORGANIZATION:	Department of Interior, U. S. Geological Survey
ADDRESS:	Menlo Park, California
CONTRACT NUMBER:	Order R-66
TIME PERIOD:	22 June 1962 - 30 June 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	Approx. $372,000 of a total $556,200
TECHNICAL MONITOR:	R. Bryson
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The U.S. Geological Survey is conducting studies designed to increase our geological understanding of the moon, research on Ranger and Surveyor TV experiments, research on tektites, and research on meteorite craters on Earth. The specific program is concerned with work in the following areas: a. Photogeologic mapping of the moon. b. Investigation of meteorite impact sites and craters on Earth. c. Chemical, petrographic, and physical investigations of materials of possible lunar origin (tektites and meteoritic dust). d. Research on Ranger and Surveyor TV experiments.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geology - related to lunar work
TITLE:	A study of lunar craters
PRINCIPAL INVESTIGATOR:	G. S. Hawkins
ORGANIZATION:	Boston University
ADDRESS:	Boston, Massachusetts
CONTRACT NUMBER:	NsG - 246
TIME PERIOD:	1 April 1962 - 31 March 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$12,608
TECHNICAL MONITOR:	R. Bryson
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This work is an attempt to support the hypothesis that lunar craters have been caused by a bombardment of meteorites over the last 5 billion years. The number and size of the lunar craters will be investigated to see if they are consistent with the number of meteorites which must have collided with the surface during its history.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geology - related to lunar work
TITLE:	X-ray diffraction studies of lunar-like material
PRINCIPAL INVESTIGATOR:	H. H. Hess
ORGANIZATION:	Princeton University
ADDRESS:	Princeton, New Jersey
CONTRACT NUMBER:	NsG - 196
TIME PERIOD:	1 May 1961 - 31 Sept. 1962 plus no-cost extension to 1 March 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$46,110
TECHNICAL MONITOR:	V. C. Fryklund, Jr.
ALTERNATE CONTACT:	R. J. Allenby
DESCRIPTION:	The investigator is preparing X-ray diffraction patterns for various minerals, and mixtures of minerals, that might be found on the lunar surface. This work is in support of the X-ray diffraction experiment for the Surveyor lander.

AREA OF INVESTIGATION:	Geology - Earth impact site work
TITLE:	Photogeological lunar mapping
PRINCIPAL INVESTIGATOR:	E. M. Shoemaker

Supporting Research (Contd.)

ORGANIZATION:	Department of Interior, U.S. Geological Survey
ADDRESS:	Menlo Park, California
CONTRACT NUMBER:	Order R-66
TIME PERIOD:	22 June 1962 - 30 June 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$184,000 of a total $556,200
TECHNICAL MONITOR:	R. Bryson
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	Recognition and investigation of terrestrial impact structures is important for exploring the lunar surface. A better knowledge of the characteristics of large Earth-impact structures is essential for intelligent interpretation of possible lunar impact features. Many terrestrial impact sites have been so altered by erosion that recognition is all but impossible. Shatter cones have been found at known impact craters, and it is believed that this geological marker will aid in identification of possible sites. The U.S.G.S will undertake a search for shatter cones at locations suspected of being sites of meteor or asteroid impacts, and will also attempt to correlate the presence of shatter cones with other evidence of meteoritic impact. Identified craters will be studied for structural and geological features inherent in impact structures.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics - related to lunar work
TITLE:	Develop a lunar seismometer
PRINCIPAL INVESTIGATOR:	F. Press
ORGANIZATION:	Calif. Inst. of Tech.
ADDRESS:	Pasadena, Calif.
CONTRACT NUMBER:	NASw - 81 (Amd. 7)
TIME PERIOD:	1 July 1962 - 30 June 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$140,429
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The seismometer prototype for the Ranger Program was developed under the original contract. The extension of the program will include reducing the Ranger data; work on a three-component low frequency seismometer, development of controlled explosive seismic systems, and theoretical studies of lunar models.

AREA OF INVESTIGATION:	Geophysics - related to lunar work
TITLE:	Planetary seismic research & instrument development

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	M. Ewing, J. Oliver, and G. H. Sutton
ORGANIZATION:	Columbia University
ADDRESS:	New York, New York
CONTRACT NUMBER:	NASw - 82 (Amd. 1 & 2)
TIME PERIOD:	1 July 1959 - 30 June 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$370,000
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The seismometer prototype for the Surveyor program was developed under the original contract. The extension of this program will include testing of the flight instrument and consultation with JPL concerning the design and possible modifications of the second flight prototype. Further studies will include lunar heat flow studies (initiated in connection with Surveyor instrument design), calculations of theoretical lunar tides, and investigations of the possible use of active (generated energy source) seismology on the moon and planets.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics - related to lunar work
TITLE:	Magnetic measurements of lunar rocks
PRINCIPAL INVESTIGATOR:	V. Vacquier
ORGANIZATION:	Univ. of Calif. at San Diego
ADDRESS:	San Diego, California
CONTRACT NUMBER:	NsG - 303
TIME PERIOD:	1 Oct. 1962 - 30 June 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$27,200
TECHNICAL MONITOR:	V. C. Fryklund
ALTERNATE CONTACT:	R. J. Allenby
DESCRIPTION:	One of the primary properties of the moon is its magnetic field. To properly understand this field, we must know the magnetic characteristics of the lunar rocks. The grant is for the purpose of developing reliable and ultra-sensitive magnetometers to accomplish this objective.

AREA OF INVESTIGATION:	Geophysics - related to lunar work
TITLE:	Research on meteorites and lunar problems
PRINCIPAL INVESTIGATOR:	H. Brown

Supporting Research (Contd.)

ORGANIZATION:	Calif. Inst. of Tech.
ADDRESS:	Pasadena, California
CONTRACT NUMBER:	NsG 56-60
TIME PERIOD:	1 Dec. 1961 - 1 Dec. 1962
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$142,500
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The technical objective of this grant is to improve our knowledge of the geology, geochemistry, and geophysics of the moon. This involves the following research areas: (1) Theoretical analysis of the behavior of volatile lunar substances. (2) Photoelectric investigations of lunar color variations. (3) Geochemical study of meteorite thin sections. (4) X-ray fluorescence studies. (5) Shadow variation studies of lunar photographs. (6) Development of an Earth-based lunar infrared telescope. (7) Compilation and translation of lunar literature.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics - related to lunar work
TITLE:	Laboratory experiments relating to the lunar surface
PRINCIPAL INVESTIGATOR:	T. Gold
ORGANIZATION:	Cornell University
ADDRESS:	Ithaca, New York
CONTRACT NUMBER:	NsG 119-61
TIME PERIOD:	1 Dec. 1960 - 1 Dec. 1962
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$117,170
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This grant is for the study of possible lunar materials under bombardment by energetic protons and soft x-rays in a vacuum system. The surface characteristics of the moon may have been profoundly influenced by intense solar radiation which arrives unreduced by atmospheric absorption. This radiation may contribute to dust formation and transportation, it may have a solidifying effect on the existing dust, and it may result in a layer of free electrons floating just above a positively charged surface. Laboratory investigations of these possible effects are necessary for our lunar studies.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics - related to lunar work
TITLE:	Study of rock dust in a vacuum
PRINCIPAL INVESTIGATOR:	J. Green
ORGANIZATION:	North American Aviation, Inc.
ADDRESS:	Downey, California
CONTRACT NUMBER:	NASw - 457
TIME PERIOD:	19 July 1962 - 18 July 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	Funded in FY 63 - $48,931
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	R. Bryson
DESCRIPTION:	Two key measurements on rock dust under vacuum, sonic velocity and penetrability, may be performed conveniently in the laboratory under simulated lunar conditions. Both measurements are germane to the interpretation of the results of early lunar probe and geophone measurements. Under this project, these studies will be made on rock dust under a temperature range of 134 to -153° C and at pressures of 760, 10^{-2}, and 10^{-8}mms. of Hg.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics - related to lunar work
TITLE:	Sputtering effects on moon's surface
PRINCIPAL INVESTIGATOR:	G. K. Wehner
ORGANIZATION:	General Mills, Inc.
ADDRESS:	Minneapolis 13, Minn.
CONTRACT NUMBER:	NASw 424
TIME PERIOD:	24 April 1962 - 23 April 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$46,606
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The objective is to investigate the sputtering effects of solar radiation on the moon's surface. The condition of the lunar surface is of great interest and importance to NASA's space effort. One of the most important modifying influences on this surface is the solar energy continually bombarding the lunar rocks. This project should help us understand this process.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics - basic research
TITLE:	Theoretical investigation of the constitution of the moon and planets
PRINCIPAL INVESTIGATOR:	G. J. F. MacDonald
ORGANIZATION:	Univ. of Calif. at Los Angeles
ADDRESS:	Los Angeles, Calif.
CONTRACT NUMBER:	NsG 216-62
TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$113,964
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This project is for theoretical calculations on the internal structure of the planets and the structure of their atmospheres. It is proposed to investigate the effect of convected heat on the thermal balance of the planet. In addition, a study will be made of the mass distribution within the planet compatible with astronomical observations and with thermal calculations.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics - basic research
TITLE:	Internal constitution of the planets
PRINCIPAL INVESTIGATOR:	R. Wildt
ORGANIZATION:	Yale University
ADDRESS:	New Haven, Connecticut
CONTRACT NUMBER:	NsG 312-63
TIME PERIOD:	1 Oct. 1962 - 30 Sept. 1965
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$117,760
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	Dr. Wildt will make theoretical studies of the internal constitution of the planets with emphasis on the Jovian planets. Until recently, progress on constructing better planetary models has been blocked by lack of information about the equation of state of solids under high pressure and the thermodynamic properties of such matter. Many of the requisite data can now be obtained by novel experimental techniques only a few years old. Using these new techniques, new models of the Jovian planets will be constructed. This project will also lead to the acquisition of up-to-date astronomical constants relating to the mechanical properties of planetary bodies, i.e., moments of inertia, ellipticities, etc.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geophysics
TITLE:	Fundamental research in Earth and planetary sciences, including development of advanced scientific experiments in lunar, planetary, and space exploration
PRINCIPAL INVESTIGATOR:	L. V. Berkner
ORGANIZATION:	Graduate Research Center of the Southwest
ADDRESS:	Dallas, Texas
CONTRACT NUMBER:	NsG 269
TIME PERIOD:	1 April 1962 - 31 March 1965
FUNDED BY:	Grants & Research Contracts
AMOUNT:	$923,000
TECHNICAL MONITOR:	J. T. Holloway
ALTERNATE CONTACT:	D. C. Holmes
DESCRIPTION:	This grant is for the support of a broad program of fundamental research in Earth and planetary sciences, including development of advanced scientific experiments in lunar, planetary, and space exploration.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geochemistry - related to lunar work
TITLE:	Feasibility of neutron analysis of lunar surface
PRINCIPAL INVESTIGATOR:	R. E. Wainerdi
ORGANIZATION:	Texas A & M
ADDRESS:	College Station, Texas
CONTRACT NUMBER:	NsG 256-62
TIME PERIOD:	1 May 1962 - 30 April 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$84,800
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This grant is to investigate the feasibility of, and design equipment capable of, performing neutron activation analysis of the lunar surface. This work would include a study of the most feasible method of neutron activation, a study of possible neutron sources, and the development of appropriate computer programs for the processing of information from the neutron activation instrumentation.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geochemistry - research in methods and instrumentation
TITLE:	Research in gas chromatography
PRINCIPAL INVESTIGATOR:	S. R. Lipsky
ORGANIZATION:	Yale University
ADDRESS:	New Haven, Connecticut
CONTRACT NUMBER:	NsG - 192
TIME PERIOD:	1 Aug. 1961 - 31 July 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$97,640
TECHNICAL MONITOR:	D. P. Easter
ALTERNATE CONTACT:	R. J. Allenby
DESCRIPTION:	The purpose of this grant is to conduct research on methods of improving the sensitivity and reliability of gas chromatographs and to design for the Surveyor missions a flight instrument capable of performing extraterrestrial gas and vapor analysis. The instrument's primary purpose will be to help detect organic materials on the lunar surface.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Geochemistry - research in methods of instrumentation
TITLE:	A research program for the study of infrared instrumentation for thermal photography of the moon.
PRINCIPAL INVESTIGATOR:	D. H. Menzel
ORGANIZATION:	Harvard University
ADDRESS:	Cambridge, Mass.
CONTRACT NUMBER:	NsG 64-60 (Suppl 1)
TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$153,253
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	The research consists of three parts: (1) Continued development of IR equipment for ground-based observations. (2) Continued development of IR spacecraft instrumentation. (3) Observations of the moon with IR equipment.

AREA OF INVESTIGATION:	Geochemistry - research in methods and instrumentation
TITLE	Chemical analysis by Rutherford scattering

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	A. Turkevich
ORGANIZATION:	University of Chicago
ADDRESS:	Chicago 37, Illinois
CONTRACT NUMBER:	NsG 127-61
TIME PERIOD:	1 May 1961 - 1 Nov. 1962 plus no-cost extension through 30 April 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$200,969
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	D. P. Easter
DESCRIPTION:	Basic studies are being conducted on elemental chemical analysis by the technique of alpha particle scattering, which is a new method of chemical analysis in its early stages of development. This project also includes the design and construction of a prototype instrument suitable for the Surveyor program.

AREA OF INVESTIGATION:	Geochemistry - basic research
TITLE:	Study solid inert gases at high pressures
PRINCIPAL INVESTIGATOR:	G. C. Kennedy
ORGANIZATION:	University of Calif. at Los Angeles

Supporting Research (Contd.)

ADDRESS:	Los Angeles, Calif.
CONTRACT NUMBER:	NsG 314-63
TIME PERIOD:	1 Oct. 1962 - 30 Sept. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$85,000
TECHNICAL MONITOR:	V. C. Fryklund
ALTERNATE CONTRACT:	R. J. Allenby
DESCRIPTION:	Study the solid phases of noble gases and hydrogen, methane, ammonia, and CO_2 at high pressures. Most materials, including inert gases, are drastically affected by very high pressures. Possibly we will never know the real nature of a planetary interior, (even if the asteroid belt did form from a planet, we must assume that retrograde metamorphism has altered the fragments); but, on the other hand, we can subject likely materials to pressures known to exist in a planetary interior and determine phase equilibria for various temperatures and pressures. These results will enable us to construct a much more likely model of planetary interiors.

AREA OF INVESTIGATION: Meteorite and tektite studies

Supporting Research (Contd.)

TITLE:	Composition and structure of meteorites and the lunar surface
PRINCIPAL INVESTIGATOR:	G. O. S. Arrhenius
ORGANIZATION:	Univ. of Calif. at San Diego
ADDRESS:	San Diego, California
CONTRACT NUMBER:	NsG 317-63
TIME PERIOD:	1 July 1962 - 30 Sept. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$83,018
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This is a grant for a detailed study of the petrography and composition of meteorites, and of the effects of shock waves on rock. Knowledge of the petrography of meteorites is extremely important in helping us work out the history of the meteorites. For example, crystal size and shape is indicative of the heat and pressure of the forming body. Recrystalization indicates remelting at some time in the meteorite's life. Knowledge of chemical composition will help us determine not only the original chemical composition of the solar system, but also the amount of differentiation that has taken place since that time. Shock waves probably have lead to the formation of some minerals found in meteorites; if such minerals can be recognized they will assist in the interpretation of the history of the particular meteorite.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Study trace elements in meteorites
PRINCIPAL INVESTIGATOR:	G. G. Goles
ORGANIZATION:	Univ. of Calif. at San Diego
ADDRESS:	San Diego, Calif.
CONTRACT NUMBER:	NsG 319-63
TIME PERIOD:	15 Sept. 1962 - 14 Sept. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$55,158
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This is a project to determine the relative abundances of eleven trace elements in various meteorites. Studies of the abundances of these elements in meteorites, especially chondrites, have proven most useful in outlining the "cosmic abundance curve." However, fractionation processes have modified these abundances, and the nature and extent of the fractionation must be investigated. The results of this work will lead to a better understanding of the original chemical composition of the solar system and a better model of the chemical and physical history of the meteorites.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Determine cosmic abundance of elements
PRINCIPAL INVESTIGATOR:	H. E. Suess
ORGANIZATION:	Univ. of Calif. at San Diego
ADDRESS:	San Diego, Calif.
CONTRACT NUMBER:	NsG 322-63
TIME PERIOD:	15 Sept. 1962 - 14 Sept. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$66,242
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The basic scientific objective of this project is to derive accurate data for the chemical composition of the primeval medium from which the terrestrial planets formed. Work at present involves studies on the degree of oxidation of meteorites, the primordial rare gas content of meteorites, and the study of how much mass separation in the gas phase had taken place at the time of formation of the solar system. The work involves measurements utilizing the electron microprobe and X-ray fluorescence methods.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Study the inert gases of meteorites
PRINCIPAL INVESTIGATOR:	H. C. Urey
ORGANIZATION:	Univ. of Calif. at San Diego
ADDRESS:	San Diego, Calif.
CONTRACT NUMBER:	NsG 323-63
TIME PERIOD:	15 Sept. 1962 - 14 Sept. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$73,054
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This grant is to study the relative isotopic abundances of various elements in meteorites, extract and study the inert gases in meteorites, and determine meteorite ages. Preliminary measurements on a few meteorites have shown that isotopic variations exist between meteorites and between meteorites and terrestrial rocks. These isotopic variations are caused by differences in the chemical and physical histories of the materials, and should be investigated. An ancillary benefit of this work is the building up at this University of a group of people capable of performing detailed and skilled investigations on lunar material when this is available.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorites and tektites
TITLE:	Studies of inert gases in meteorites; X-ray diffraction studies of meteorites
PRINCIPAL INVESTIGATOR:	J. R. Arnold, H. E. Suess, and G. O. S. Arrhenius
ORGANIZATION:	Univ. of Calif.
ADDRESS:	San Diego, Calif.
CONTRACT NUMBER:	NsG - 97 (Suppl. 1)
TIME PERIOD:	15 Sept. 1960 - 14 Sept. 1962 plus no cost extension to 31 Jan. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$31,174
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund, Jr.
DESCRIPTION:	The investigators are determining the abundance of the inert gases in meteorites. The investigators are also developing techniques for the application of X-ray diffraction analysis to minute amounts of minerals in meteorites.

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	The interaction of meteorites and cosmic rays

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	J. R. Arnold
ORGANIZATION:	Univ. of Calif. at San Diego
ADDRESS:	San Diego, Calif.
CONTRACT NUMBER:	NsG 321-63
TIME PERIOD:	2 years; 15 Sept. 1962 - 14 Sept. 1965
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	Funded in FY 63 - $102,331
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The technical objectives of this grant are to continue studies on the interaction of meteorites and cosmic rays, and to consider the origin and history of meteorites. Work in this field has progressed to the point where it is felt that cosmic ray intensity has been relatively consistent in past time. In this case, the study of the cosmic ray history of the meteorites will determine the exposure times, the amount of shielding, and perhaps, the relative position of a meteorite in its parent body. Work will also be conducted on the geochemistry of the early solar nebula, including condensation of liquid and solid materials from it.

Supporting Research (Cont d.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Proposal for study of interplanetary material
PRINCIPAL INVESTIGATOR:	M. Ewing and W. A. Cassidy
ORGANIZATION:	Columbia University (Lamont Geological Observatory)
ADDRESS:	New York, New York
CONTRACT NUMBER:	NsG 232-62
TIME PERIOD:	1 March 1962 - 28 Feb. 1963 plus no-cost extension through 1 July 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	Funded in FY 62 - $32,635 (Lunar & Planetary Programs - $16,635, GSFC - $16,000)
TECHNICAL MONITOR:	R. J. Allenby
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	This grant is for continued work on the study of the abundance and composition of cosmic dust and cosmic spherules found in ocean sediments. Meteorite material separated from deep sea cores will be chemically analyzed and isotopic studies will be made. An attempt will be made to separate the siliceous spherules or chondrules from these cores. Changes in frequency of occurrence (flux) of cosmic material with depth (which is a function of time) in cores will be studied.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Investigate the isotopic chemistry of meteorites
PRINCIPAL INVESTIGATOR:	G. Wetherill
ORGANIZATION:	Univ. of Calif. at Los Angeles
ADDRESS:	Los Angeles, Calif.
CONTRACT NUMBER:	NsG 313-63
TIME PERIOD:	1 Sept. 1962 - 31 Aug. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	Funded in FY 63 - $72,430
TECHNICAL MONITOR:	V. C. Fryklund
ALTERNATE CONTACT:	R. J. Allenby
DESCRIPTION:	Recent results indicate that large isotopic variations may exist between different meteorites. These variations can arise only if the meteorite came from different parent bodies or if the fragments have had greatly different histories since the breakup of the parent body. Many of our assumptions about meteorites will be changed if these isotopic variations are confirmed. By means of spectrometic and radiochemical techniques, this project will investigate these reported isotopic variations.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Mineralogy of stony meteorites
PRINCIPAL INVESTIGATOR:	C. Frondel
ORGANIZATION:	Harvard University
ADDRESS:	Cambridge, Mass.
CONTRACT NUMBER:	NsG 282-63
TIME PERIOD:	1 July 1962 - 30 June 1965
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$65,865
TECHNICAL MONITOR:	V. C. Fryklund
ALTERNATE CONTACT:	R. J. Allenby
DESCRIPTION:	Professor Frondel plans to make a comprehensive study of the minor and accessory constituents of stony meteorites in the Harvard meteorite collection. In addition, there is the possibility of some work being done on the major constituents of stony meteorites. This work will be done largely by standard mineralogic methods; however, microfocus x-ray analysis will be used to analyze small mineral particles in thin sections and polished surfaces.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Research on tektites
PRINCIPAL INVESTIGATOR:	W. H. Pinson
ORGANIZATION:	Mass. Inst. of Tech.
ADDRESS:	Cambridge, Mass.
CONTRACT NUMBER:	NsG 222-61
TIME PERIOD:	15 Oct. 1961 - 14 Oct. 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$67,808
TECHNICAL MONITOR:	R. Bryson
ALTERNATE CONTACT:	V. C. Fryklund
DESCRIPTION:	The formation of tektites apparently cannot be attributed to strictly terrestrial processes, because tektites differ in physical and chemical properties from ordinary terrestrial glass. In an attempt to solve these problems, rubidium-strontium data will be obtained from tektites by mass-spectrometric and neutron activation techniques. Further work will involve the determination of the amounts of other trace elements in tektites of the MIT meteorite collection.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite and tektite studies
TITLE:	Research on tektites and meteorites, and radiation damage in related silicate materials
PRINCIPAL INVESTIGATOR:	A. J. Cohen and T. B. Massalski
ORGANIZATION:	Mellon Institute
ADDRESS:	Pittsburgh 13, Pa.
CONTRACT NUMBER:	NsG 57-60 (Suppl. 1)
TIME PERIOD:	1 Jan. 1962 - 31 Dec. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	Funded in FY 62 - $202,902
TECHNICAL MONITOR:	R. Bryson
ALTERNATE CONTACT:	R. J. Allenby
DESCRIPTION:	Dr. A. J. Cohen is studying selected tektite fields in an attempt to solve the problem of tektite origins. He is also studying the radiation damage in silicate minerals caused by heating of meteorite impact. His approach to this problem involves both field work and geochemical laboratory analysis of crater-associated materials. Dr. Massalski is engaged in studies of the nature, distribution, composition, and properties of various metallic and non-metallic phases in the meteorites.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Meteorite recovery
TITLE:	Systematic in-flight photography and subsequent recovery of meteorites
PRINCIPAL INVESTIGATOR:	F. Whipple
ORGANIZATION:	Smithsonian Astrophysical Observatory
ADDRESS:	Boston, Massachusetts
CONTRACT NUMBER:	NsG-291
TIME PERIOD	1 July 1962 - 31 Dec. 1963
FUNDED BY:	Bioscience Program $120,000 Lunar and Planetary Programs $60,000 Geophysics and Astronomy Programs $59,500
TECHNICAL MONITOR:	M. Dubin
ALTERNATE CONTACT:	R. Moore
DESCRIPTION:	SAO will install and operate a network of stations in the lower Midwest U. S. covering an area of 10^6 squarekm with 13 or more stations. Meteors and fireballs of visual magnitude greater than -5 may be photographed by this network. From the photographic data, accurate trajectory and impact point of the meteorite-in-flight may be measured. The photographic measurements will improve the knowledge of luminous efficiency and the meteoritic ablation process as a function of velocity in the atmosphere. From trajectory data, field collection teams will investigate and attempt to recover the fall. The recovered meteorites will subsequently be analyzed in various scientific laboratories for composition, radioactive spallation products, and biochemical content.

Supporting Research (Contd.)

AREA OF INVESTIGATION:	Radar astronomy for lunar investigations
TITLE:	Research concerning electromagnetic-scatter theory.
PRINCIPAL INVESTIGATOR:	W. W. Koepsel
ORGANIZATION:	Univ. of New Mexico
ADDRESS:	Albuquerque, New Mexico
CONTRACT NUMBER:	NsG 129
TIME PERIOD:	1 Feb. 1962 - 31 Jan. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$30,923
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	W. Brown, JPL
DESCRIPTION:	The work consists of determining an improved acoustical model, and hence an actual surface model of the moon. The model will be used to interpret and determine an improved estimate of the lunar surface with regard to its surface roughness and dielectric properties.

AREA OF INVESTIGATION:	Radar astronomy for lunar investigations
TITLE:	Radar data analysis

Supporting Research (Contd.)

PRINCIPAL INVESTIGATOR:	K. M. Siegel
ORGANIZATION:	Conductron Corporation
ADDRESS:	Ann Arbor, Michigan
CONTRACT NUMBER:	NASw 490
TIME PERIOD:	7 Aug. 1962 - 6 Aug. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$48,550
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	W. Brown, JPL
DESCRIPTION:	The work to be done consists of a program of radar data analysis work with the aim of extending previously developed theoretical models of the lunar surface. Work on a physical model to explain the Venus surface temperatures will also continue.

AREA OF INVESTIGATION:	Radar and radio astronomy for lunar investigations.
TITLE:	Radio astronomy research on millimeter wavelengths.
PRINCIPAL INVESTIGATOR:	A. W. Straiton
ORGANIZATION:	University of Texas
ADDRESS:	Austin, Texas

Supporting Research (Contd.)

CONTRACT NUMBER:	NASr 87
TIME PERIOD	13 Nov. 1961 - 12 May 1963
FUNDED BY:	Lunar & Planetary Programs Tracking & Data Acquisition
AMOUNT:	$370,000
TECHNICAL MONITOR:	J. M. Weldon
ALTERNATE CONTACT:	R. C. Moore
DESCRIPTION:	Design, fabrication and installation of a 16 foot parabolic reflector antenna. It will be used for making observations of the moon and planets at wavelengths down to 2 mm which should yield information concerning their surface structure.

AREA OF INVESTIGATION:	Radio astronomy for lunar investigations
TITLE:	Radiometric measurements of Venus and the moon in the millimeter range.
PRINCIPAL INVESTIGATOR:	J. Copeland
ORGANIZATION:	Ewen Knight Corporation
ADDRESS:	East Natick, Mass.
CONTRACT NUMBER:	NASw 593
TIME PERIOD:	1 May 1962 - 1 May 1963

Supporting Research (Contd.)

FUNDED BY: Lunar & Planetary Programs

AMOUNT: $202,055

TECHNICAL MONITOR: J. M. Weldon

ALTERNATE CONTACT: R. C. Moore

DESCRIPTION: Using a 28-foot radio telescope, the radiometric characteristics of Venus and the moon will be investigated to assist in determining their brightness temperatures. Three radiometers at 3.3 cm., 8.5 mm, and 4 mm will be developed for this task. The Venus observations will support the Mariner R radiometer experiment during the 1962 approach and will aid in determining the temperature of the surface and atmosphere of the planet. The lunar observations, also at these frequencies, may ascertain the degree of limb darkening.

AREA OF INVESTIGATION: Astronomy for lunar investigations

TITLE: Continual photographic patrol and study of the physical conditions of the moon and planets.

PRINCIPAL INVESTIGATOR: C. W. Tombaugh

ORGANIZATION: New Mexico State University

ADDRESS: University Park, New Mexico

CONTRACT NUMBER: NsG 142 (Suppl.2)

Supporting Research (Contd.)

TIME PERIOD:	15 April 1962 - 14 April 1964
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$188,435
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	J. M. Weldon
DESCRIPTION:	This grant covers photographic, photoelectric, and spectrographic observations and studies of the moon and the planets. The work involves a daily patrol of Venus and Mars. During these patrols sudden and unexpected changes occur in the atmospheres and surfaces of the planets.

AREA OF INVESTIGATION:	Astronomy for lunar and planetary investigations
TITLE:	Selenodetic and physical studies of the lunar surface.
PRINCIPAL INVESTIGATOR:	G. P. Kuiper
ORGANIZATION:	Univ. of Arizona
ADDRESS:	Tucson, Arizona
CONTRACT NUMBER:	NsG 161
TIME PERIOD:	1 June 1962 - 31 May 1963
FUNDED BY:	Lunar & Planetary Programs

Supporting Research (Contd.)

AMOUNT:	$248,400
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	J. M. Weldon
DESCRIPTION:	This grant supports broad telescopic studies of the moon and the planets. It includes continual photography, visual observations, selenodesy, standard coordinates, crater diameters, atlases, and polarization studies of the moon.

AREA OF INVESTIGATION:	Astronomy for lunar investigations
TITLE:	A far eastern lunar observing station
PRINCIPAL INVESTIGATOR:	Z. Kopal
ORGANIZATION:	University of Manchester
ADDRESS:	Manchester, England
CONTRACT NUMBER:	NsG 297
TIME PERIOD:	15 Aug. 1962 - 14 Aug. 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$25,374
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	J. M. Weldon

Supporting Research (Contd.)

DESCRIPTION:	To determine the unevenness of the lunar surface, the shadows cast by irregularities are photographed during the time the moon is observable. Obviously, several well-spaced observatories would be able to provide an uninterrupted record of shadow changes. This grant supports work at the Kyoto Observatory in Japan which will collaborate with the Pic-du-Midi and Flagstaff Observatories.

AREA OF INVESTIGATION:	Astronomy for lunar and planetary investigations.
TITLE:	The use of television techniques with telescopes above the atmosphere.
PRINCIPAL INVESTIGATOR:	M. Schwarzschild
ORGANIZATION:	Princeton University
ADDRESS:	Princeton, New Jersey
CONTRACT NUMBER:	NsG 69 (Suppl. 4)
TIME PERIOD:	1 July 1962 - 30 June 1963
FUNDED BY:	Lunar & Planetary Programs Geophysics & Astronomy Programs Bioscience Programs
AMOUNT:	Lunar & Planetary - $200,000 Geophysics & Astronomy - $200,000 Bioscience - $100,000
TECHNICAL MONITOR:	R. C. Moore

Supporting Research (Contd.)

ALTERNATE CONTACT:	J. M. Weldon
DESCRIPTION:	For some years to come astronomical instruments above the atmosphere, which promises to revolutionize the entire study of astronomy, will probably be unmanned. To send full information to the ground, television promises to be a most useful tool; both for pointing the instruments at stars, the moon, or planets, and for transmitting the research data to the ground. The purpose of this grant is to design and construct the needed instruments.

AREA OF INVESTIGATION:	Planetary Astronomy
TITLE:	Lunar & Planetary 60 inch telescope
PRINCIPAL INVESTIGATOR:	G. P. Kuiper
ORGANIZATION:	Univ. of Arizona
ADDRESS:	Tucson, Arizona
CONTRACT NUMBER:	NASr-82
TIME PERIOD:	21 Aug. 1962 - 20 Aug. 1964
FUNDED BY:	Lunar & Planetary Programs $375,000
TECHNICAL MONITOR:	R. C. Moore
DESCRIPTION:	Construction of a 60-inch lunar and planetary telescope
DISCIPLINES:	Planetology (prime) Astronomy Planetary Atmospheres

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Supporting Research (Contd.)

AREA OF INVESTIGATION:	Astronomy for lunar investigations
TITLE:	Multicolor photoelectric photometry of the moon and planets
PRINCIPAL INVESTIGATOR:	D. H. Menzel G. de Vaucouleurs
ORGANIZATION: ADDRESS:	Harvard College Cambridge, Mass.
CONTRACT NUMBER:	NsG-89
TIME PERIOD:	15 June 1960 - 30 June 1963
FUNDED BY:	Lunar & Planetary Programs
AMOUNT:	$175,000
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	R. J. Allenby
DESCRIPTION:	Multicolor photoelectric photometry of the moon and planets utilizing ground-based telescopes in South Africa and Southern France. The photometer will obtain data in thirteen spectral regions from 3200 A to 1 micron.

Supporting Research

Agency	Area	Level of Effort (FY 63)	Principal Investigators
Ames Research Center	Tektite studies	$14,000	D. R. Chapman
	Micrometeorite detector	$15,000	V. Rogallo
	Hypervelocity impact studies	$10,000	D. E. Gault
Goddard Space Flight Center	Meteorite and micrometeorite studies	$383,500	M. Alexander M. Lipschutz O. Berg
	Tektite studies	$70,000	J. O'Keefe P. Lowman B. Shute L. Walter
	Space chemistry	$89,000	B. Donn
	Lunar studies	$15,000	P. Lowman L. Walter W. Cameron J. O'Keefe
Langley Research Center	Geophysics-related to lunar work	$125,000	J. E. Stitt G. W. Brooks C. H. Nelson
	Planetary astronomy	$70,000	C. H. Nelson

Supporting Research (Contd.)

Agency	Area	Level of Effort (FY 63)	Principal Investigators
Marshall Space Flight Center	Tektite studies	$5,000	E. Adams R. Huffaker
Jet Propulsion Laboratory	Geology-lunar studies	$100,000	R. Speed
	Geology-other planets	$100,000	H. W. Washburn
	Geophysics-lunar studies	$82,000	H. W. Washburn
	Geochemistry-lunar studies	$67,000	H. W. Washburn

BIOSCIENCE

NASA's requirement for knowledge of the life sciences comes at a time when the developments in experimental biology are reaching a high level - especially those dealing with our knowledge of the role of nucleic acid-protein interactions in storage and transmission of information, both within living cells and between generations of cells. The recent, very suggestive, observations that Ribonucleic acid may play a role in nerve information storage, and the development of new concepts of the coding mechanism in Desoxyribonucleic acid give us a hitherto unavailable opportunity for development of universal biological theory, embracing evolutionary as well as homeostatic adaption to environment, and inherited as well as learned behavioral systems.

Of direct relevance to space exploration is biological orientation in space and time. All living organisms so far studied on Earth exhibit rhythmic patterns of metabolism and behavior of remarkable temporal precision, independent of known external cues and uninfluenced by temperature change over a wide temperature range. This finding indicates a non-chemically regulated system of time estimation as an inherent component of living matter. In view of the extreme importance of the time parameter in space travel, this matter should receive the closest and most immediate attention. Solution of such problems as the "genetic drift" of microbial cultures which interferes with the development of algal life support systems, the prediction of evolutionary patterns in extraterrestrial environments, the communication with non-human species and the development of unorthodox methods of transferring knowledge to the human brain will be essential in long term space exploration of the future.

NASA's bioscience problems are all of the type which could perhaps be solved by truly significant advances in biological theory, and probably not by any other avenue.

Behavioral Biology

OBJECTIVES:

To seek fundamental knowledge concerning the behavior of organisms, their behavioral mechanisms of adaptation to artificial and extraterrestrial environments, and to determine the biological bases of such behavior, thus providing a broader understanding of the functioning of the total organism and its environmental interactions.

Research activities encompass studies on the most primitive behavioral patterns of lower organisms as well as more complex forms of behavior displayed by primates, and includes investigations which transcend species differences and provide general principles which apply at all phylogenetic levels.

Emphasis is placed on intensive study in the following areas, which appear to hold promise of the greatest return in terms of basic scientific information and future applicability to space research.

1. Conduct research leading to the development of appropriate conceptual models, and devise techniques for more accurate description, more refined analysis and more effective control of behavior. Application of these to the study of various forms of behavior, including those amenable to manipulation by reinforcement as well as less modifiable patterns such as tropistic, instinctive or species-specific behavior.

2. Study the principles involved in the acquisition, processing, storage, and retrieval of information in living systems. Investigate new concepts of behavior pattern formation and localization at the molecular level and integrate these with electrophysiological data and observed behavior.

3. Conduct investigations on the mechanisms of

inter- and intraspecies communication of intelligent information, emotional status and basic drives, in an attempt to discover the mechanisms of communication which nature has evolved and to supplement these mechanisms by technological devices.

4. Conduct studies concerned with the orientation of biological organisms in time and space in the absence of terrestrial cues, including the mechanisms of internal clocks, their synchronization with environmental stimuli, and their modifiability through conditioning.

5. Conduct correlated ground-based and in-flight studies designed to investigate the effects of weightlessness and other conditions peculiar to the space environment on processes such as discrimination, perception, motivation and learning. Explore special responses or behavioral capacities for adjustment to altered gravity found in biological organisms.

PROJECTS AND TASKS:

Supporting Research:

Area of Investigation:	Interspecies Communication
Title:	Basic research on interspecies communication
Principal Investigator:	John C. Lilly
Organization:	Communication Research Institute
Address:	St. Thomas, Virgin Islands and Miami, Florida
Agreement Number:	NsG 278

Time Period:	July, 1962 - June, 1963
Status:	Funded by Biosciences through FY 63
Amount:	$80,700 (FY 63)
Technical Monitor:	Richard Belleville
Description:	This effort involves the translation of high frequency sound emitted by Dolphin into human, audible range and the translation of low frequency human speech into high frequency audible range of the Dolphin, as well as the development of a real time frequency converter for matching vocal emissions. The high sonic frequencies (4 kc and above) are of prime concern.

Exobiology

OBJECTIVES:

The clearcut identification of life on other planets is a matter of major importance to our understanding of the universe, or at least the solar system, from a biological point of view. For hundreds of years man has awaited confirmation of theories regarding the separate origins of life on different planets and how this may relate to the origin of life on earth. The search for and study of extraterrestrial life remains as one of the greater challenges of the space age.

TECHNIQUES AND INSTRUMENTATION:

Ground-based studies on the origin of life and in-flight experiments will be conducted to identify and study extraterrestrial life. It is planned to determine the types of analyses essential for the identification of extraterrestrial life and related substances. Prototype instrumentation will be developed, including vidicon microscope, gas chromatograph, infrared spectrophotometer, radioactive CO_2 analyzer, mass spectrometer, optical rotation, and other organic compound and life detection apparatus. Exotic environment simulation chambers are needed as well as methods equipment and components for decontamination of vehicles and payloads. This includes the development of heat resistant componentry that is, resistant to time-temperature cycles essential to kill all bacterial spores.

PROJECTS AND TASKS: Supporting Research:

Space Biology or Exobiology Institutes

The purpose is to fund and develop centers chiefly in academic environments, where broad and interdisciplinary research can be conducted in the exploration of space from the exobiological and cosmobiological point of view. The establishment of such centers would hinge largely on available laboratory space and on-board staff members with

recognized competence and interest in specialized relevant disciplines as well as the overall subject of this specific program.

Title:	Space Bioscience Institute
Principal Investigator:	S. Fox
Organization:	Florida State University
Address:	Tallahassee, Florida
Agreement Number:	NsG-173
Time Period:	Oct., 1961 - Sept., 1964
Status:	Funded by Biosciences through FY 62
Amount:	$784,000
Technical Monitor:	F. H. Quimby
Description:	To conduct experiments on the origin of life, to analyze biochemically samples from terrestrial areas where life or its precursors may have originated, to study lunar samples for evidence of past or terminated prebiochemical development, to study the planetary environments and atmospheres including models and simulation devices, and to prepare experiments for flight in probes and satellites to determine effects of space environments on biological processes, Fox, Hess, and Metz, senior authorities in biochemistry, planetary

"meteorology", and biology, respectively, are leading a group of other scientists and technicians in the above and other related work.

Microbial Analysis of the Upper Atmosphere

This effort was launched primarily because of the great interest of the biological community in the quantity, distribution and nature of organisms in the stratosphere and because existing data are limited and unreliable. Although most scientists do not take the theory of panspermia seriously, for those who do, this program would obviously throw some light on the question, particularly if a means of sampling in space itself could be perfected.

Title:	Sampling Program for Microbes in the Stratosphere
Principal Investigator:	V. Greene
Organization:	General Mills
Address:	Minneapolis, Minnesota
Agreement Number:	NASr-81
Time Period:	Jan., 1962 - Jan., 1963
Status:	Funded by Biosciences through FY 62
Amount:	$73,820
Technical Monitor:	F. H. Quimby
Description:	To determine the distribution and nature of microorganisms in the upper terrestrial atmosphere at various altitudes up

to 26 kilometers. Unique features are control of contamination by means of sampling during balloon descent, and processing of large volumes of ambient air in order to obtain specimens of microbes present in low numbers, particularly in view of the fact that the undisturbed atmosphere at sea level contains only ten organisms per cubic foot.

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Title:	Detection, Collection and Study of Microorganisms Existing in the Upper Atmosphere
Principal Investigator:	W. Oswald and S. Elberg
Organization:	University of California
Address:	Berkeley, California
Agreement Number:	NsG-104-61 (Suppl 1)
Time Period:	July, 1962 - July, 1963
Status:	Funded by Biosciences through FY 62
Amount:	$33,000
Technical Monitor:	F. H. Quimby
Description:	To develop a means of collecting and identifying microorganisms from the upper atmosphere and possibly space. Objectives are similar to those of General Mills but intensive study will

be made of non-filter methods of collection, sealing mechanism, and even in-flight culture media.

Meteorite Collection and Analysis

Application of various methods of increasing available meteorite material of the carbonaceous chondrite type for chemical and biological analysis. At the present time there are only 19 meteorites in this class in existence. Most of these are either very small, contaminated, in Russia, or tied up by curators in museums. Analysis of the now limited material is being conducted under NASA support by Meinschein, Calvin, and the Ames Research Center. New "finds" would go to these and other experienced groups.

Title:	In-Flight Photography and Recovery of Meteorites
Principal Investigator:	F. L. Whipple
Organization:	Smithsonian Astrophysical Observatory
Address:	Cambridge, Massachusetts
Agreement Number:	NsG-291-62
Time Period:	July, 1962 - Dec., 1963
Status:	FY 62 funds
Amount:	$120,000 - Bioscience $60,000 - Lunar & Planetary $59,500 - Geophysics & Astronomy
Technical Monitor:	Maurice Dubin
Description:	To track and recover meteorites by means of 13 camera triangulation stations scattered

over 1,000,000 square kilometers in Texas, South Dakota, Nebraska, Kansas, Oklahoma, and Missouri.

Sterilization of Spacecraft

The aim is to develop methods and procedures for reducing the number of bacteria to the best minimum on lunar and Venus probes and for actually sterilizing capsules destined for Martian landing. The techniques developed must permit optimum performance of the instrument payload and must produce no decrement in the overall reliability of the mission.

Title:	Sterilization of Spacecraft
Principal Investigator:	C. Phillips
Organization:	Ft. Detrick (U.S. Army)
Agreement Number:	R-35 (Amd 1)
Time Period:	Aug., 1962 - July, 1963
Status:	Funded by Biosciences through FY 63
Amount:	$30,000
Technical Monitor:	F. H. Quimby
Description:	Studies and development of methods for the decontamination of spacecraft with emphasis on levels of natural contamination in spacecraft components and the utilization of ethylene oxide for surface sterilization.

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Title:	Study of Heat Sterilization
Principal Investigator:	E. Fritzsching
Organization:	Wilmot Castle Corp.
Agreement Number:	NASw-550
Time Period:	Oct., 1962 - July, 1963
Status:	Funded by Biosciences through FY 63
Amount:	$91,681
Technical Monitor:	F. H. Quimby
Description:	To develop and define conditions necessary to achieve sterility of various components of space probes by means of heat.

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Title:	Viability of Organisms in Simulated Space
Principal Investigator:	W. H. Keller and G. Silverman
Organization:	National Research Corporation
Agreement Number:	NASr-41
Time Period:	April, 1962 - April, 1963
Status:	Funded by Biosciences through FY 63
Amount:	$82,440
Technical Monitor:	F. H. Quimby

Description:	To determine the ability of microorganisms to survive combinations of freezing, ionizing radiations, dessication, and ultraviolet energy. Of particular interest is the combination of high vacuum and high temperature with respect to spacecraft sterilization.

Infrared Spectroscopy of the Planets

This covers infrared spectrum studies of the planets to obtain information of biological significance such as the presence of CO_2, CH_4, and C=O, C=N, NH_2, CO, oxides of nitrogen, water vapor, and, of course, a confirmation or lack thereof of the classical observations of Sinton interpreted as an accumulation of hydrocarbonous materials in the dark areas of Mars. Instrumentation may be ground-based, balloon-launched, carried on a planetary fly-by, etc., with certain advantages and limitations in each case.

Title:	Infrared Planetary Observatory in the Stratosphere
Principal Investigator:	H. Weaver and C. Sagan
Organization:	University of California
Address:	Berkeley, California
Agreement Number:	NsG-255-62
Time Period:	April, 1962 - April, 1963
Status:	Funded by Biosciences through FY 62
Amount:	$336,318

Technical Monitor: Dale Smith (Ames)

Description: The purpose of this research is to obtain infrared spectra of Mars and perhaps Venus with that of the Moon as control and to obtain such spectra on an instrument and telescope (Stratoscope II) carrying balloon at 24 kilometers. At this altitude moisture and CO_2 will not block the spectral range of interest; namely, 1 to 7 microns. The data will provide information for a study of organic molecules on the surface of Mars as well as watervapor content and chemical composition of the Martain atmosphere. Flights will be made during Martian opposition.

Note: See "Interest in Other Flights" for description of Stratoscope II

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Design, Development, and Testing of Life Detectors

Consideration will be given to numerous remote instrument approaches for demonstrating the presence of life or life related substances on extraterrestrial bodies. The devices are designed to provide one or more sensors with metabolic, physical, chemical, or morphological facts which are presented to receiving stations on the Earth by telemetry as interpretable data for study of extraterrestrial life.

Title:	The Detection of Extraterrestrial Life by Means of 'J' Bands
Principal Investigator:	R. Kay and E. Walwick
Organization:	Aeronutronic
Address	Newport Beach, California
Agreement Number:	NASr-84
Time Period:	Feb., 1962 - Feb., 1963
Status:	Funded by Biosciences through FY 62
Amount:	$52,422
Technical Monitor:	F. H. Quimby
Description:	To determine the feasibility of detecting protein by means of "J" band formation. This in simple terms is the change in color which certain dyes undergo when brought into contact with protein. The "J" band is a narrow segment of the visible spectrum which is dark blue.

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Title:	Detection and Identification of Organic Matter by Mass Spectrometry
Principal Investigator:	K. Biemann
Organization:	M. I. T.

Agreement Number:	NsG-211-62
Time Period:	Dec., 1961 - Nov., 1964
Status:	Funded by Biosciences through FY 62
Amount:	$73,117
Technical Monitor:	F. H. Quimby
Description:	To determine the feasibility of identification of life or life related compounds by means of mass spectrometry. Techniques of controlling pyrolysis of samples and determining their mass spectra will be developed. Classes of compounds of interest include amino acids, peptides, carbohydrates, lipids and nucleic acids.

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Title:	Radioisotopic Biochemical Probe for Extraterrestrial Life
Principal Investigator:	G. Levin and N. Horowitz
Organization:	Resources Research, Inc.
Agreement Number:	NASr-10 (Amd 2 and 3)
Time Period:	Feb., 1962 - Feb., 1963
Status:	Funded by Biosciences through FY 62
Amount:	$262,599

Technical Monitor: F. H. Quimby

Description: To plan an experiment and develop a prototype device to accompany a Martian lander and relay information back to Earth concerning the presence and metabolic activity of microorganisms. The design relies on the production of $C^{14}O_2$ or other radioactive metabolically produced gases from tagged or labelled nutritional substrates in the culture medium.

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Title: Cytochemical Studies of Planetary Microorganisms

Principal Investigator: J. Lederberg

Organization: Stanford University
Address: Stanford, California

Agreement Number: NsG-81-60

Time Period: April, 1961 - April, 1964

Status: Funded by Biosciences through FY 61

Amount: $380,640

Technical Monitor: F. H. Quimby

Description: To conduct research, design and test a device ("multivator") comprising a variety of reagents, for detection of the presence of microbes. Methods for the detection of microbial enzymes, growth and metabolism for use in multivator chambers; methods for concentration of microbes; and for their characterization for DNA and protein by semi-microphotometry will be studied. Also, to design a scheme for the examination of single particles or microorganisms by means of optical microscopy and spectrophotometry of the particle or particles in the microscopic field. General studies of methods of detecting and characterizing Martian biota.

Evolutionary and Theoretical Biology

This program area covers a wide variety of investigations relating to the origin of life, molecular evolution, the development of significant steps in early evolution of planets and animals, symbiosis, cellular biochemistry, nature and mechanisms of cell replication, chemistry of terrestrial sediments, paleo-biochemistry, and refinement of methods for detection and study of biological substances and residues.

Title:	Synthesis of Porphine-Like Substances from Simple Precursors under Primeval Conditions
Principal Investigator:	A. Szutka
Organization:	University of Detroit
Address:	Detroit, Michigan
Agreement Number:	NsG-226-62
Time Period:	Dec., 1961 - Dec., 1964
Status:	Funded by Biosciences through FY 62
Amount:	$35,640
Technical Monitor:	F. H. Quimby
Description:	Porphine-like substances can be synthesized from pyrrole and aldehydes under the influence of gamma-irradiation. The availability of these as precursors in the primeval conditions can hardly be doubted. This research will use ultra-violet and electrical discharges as sources of energy. The porphines are the basis of respiratory pigments in plants and animals and it is believed that they were active in the very earliest of quasi-living organic structures. They, once formed, can use the energy of visible light in chemical transformations --

form complexes readily with metals, and are stable under high temperature and radiation.

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Title: Organic Cosmochemistry

Principal Investigator: J. Oro

Organization: University of Houston
Address: Houston, Texas

Agreement Number: NsG-257-62

Time Period: May, 1962 - May, 1965

Status: Funded by Biosciences through FY 62

Amount: $71,250

Technical Monitor: F. H. Quimby

Description: To synthesize purines and pyrimidines under possible primitive Earth conditions. Purines and pyrimidines along with ribose and deoxyribose constitute the building blocks of nucleic acids. These are the side groups on the long linear polymer fabricated from a single sugar-phosphate repeating unit.

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Title: Studies on Reflection Spectra, Meteorite Analysis, and Chemical Evolution

Principal Investigator: M. Calvin and H. Weaver

Organization:	University of California
Address:	Berkeley, California
Agreement Number:	NsG-101-61 (Suppl. 1)
Time Period:	Aug., 1962 - Aug., 1965
Status:	Funded by Biosciences through FY 63
Amount:	$252,500
Technical Monitor:	F. H. Quimby
Description:	To conduct work on the nature and physics of reflection spectra as a basis for studying extra-terrestrial life. To determine the chemical structure and amount of carbon compounds in meteorites. To conduct paleo-biochemical studies on Pre-Cambrian Rocks with respect to the origin of life and the fate of biological residues and to study chemical evolution utilizing UV energy at 2500 A° and identify the resultant compounds by means of paper chromatography and mass spectrometry.

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Title:	Molecular Evolution
Principal Investigator:	S. Blois and H. Pattee
Organization:	Stanford University
Address:	Stanford, California
Agreement Number:	NsG-218-62

Time Period:	Dec., 1961 - Dec., 1964
Status:	Funded by Biosciences through FY 62
Amount:	$86,800
Technical Monitor:	F. H. Quimby
Description:	To produce and study "proto-biological systems" or pre-cellular chemical systems incapable of reproduction but which may carry out complex metabolism. A search will be made for catalysts in Miller-type experiments by adding materials to such experiments which will make the appearance and action of low molecular weight organic or metallo-organic catalysts a possibility.

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Title:	Studies on extremely small self-replicating systems
Principal Investigator:	H. Morowitz
Organization:	Yale University
Agreement Number:	NsG-208-62
Time Period:	Nov., 1961 - Oct., 1963
Status:	Funded by Biosciences through FY 62
Amount:	$38,196

Technical Monitor: F. H. Quimby

Description: To obtain detailed knowledge of cell systems at the extreme limit of small size, i.e., 0.2 microns. This should be helpful in determining an ultimate criteria for what constitutes a life system. The study will accomplish a characterization of these small cells in terms of size, morphology, chemical composition and soluble macromolecules.

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Title: Analytical techniques for hydrocarbons in mineral aggregates

Principal Investigator: D. Stevenson

Organization: Shell Development Co.
Address: Emeryville, California

Agreement Number: NASw-438

Time Period: July, 1962 - July, 1963

Status: Funded by Biosciences through FY 62

Amount: $95,000

Technical Monitor: F. H. Quimby

Description: To develop and apply techniques to the analysis of representative samples of hydrocarbons present in low concentrations in terrestrial mineral aggregates, pending the availability of extraterrestrial aggregates.

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Title:	Development of microspectrophotometric instrumentation for the study of pigments and organic molecules within living cells
Principal Investigator:	J. Wolken
Organization:	Pittsburgh University
Agreement Number:	NsG-230-62
Time Period:	Jan., 1962 - Jan., 1965
Status:	Funded by Biosciences through FY 62
Amount:	$61,340
Technical Monitor:	F. H. Quimby
Description:	This is a basic study of photosensitivity in its various widespread forms in nature. The mechanism of photic response is not fully understood at any evolutionary level. Newly developed microspectrophotometric techniques will be applied to appropriate biochemical processes, photosensitive molecules, and pigment systems within plant and animal cells.

Physical Biology

PROJECTS AND TASKS:

Supporting Research:

Physiology and Bio-Mechanics

Ground-based and applied research into mechanisms and principles of systemic physiology (cardiovascular, respiratory and neurophysiology) and general physiology of living organisms, systems and processes. Studies on the effects of (individual and synergistic) and control of, physiological stresses, including vibration, noise, spin, weightlessness, environmental extremes, radiation and acceleration.

Area of Investigation:	Systemic and General Physiology
Title:	Study of the Pocket Mouse as an Experimental Organism for Space Biology
Principal Investigator:	R. G. Lindberg
Organization:	Northrop Corporation
Address:	Hawthorne, California
Agreement Number:	NASr-91
Time Period:	March, 1962 - Sept., 1963
Status:	Funded by Biosciences through FY 63
Amount:	$27,090
Technical Monitor:	G. J. Jacobs
Description:	To conduct biological and physiological studies of Perognathus (pocket-mice)

to determine their usefulness as animals for research in space.

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Area of Investigation:	Respiratory Physiology
Title:	Biological Effect of Chronic Exposure to Artificial Atmospheres
Principal Investigator:	E. P. Hiatt
Organization:	Ohio State University
Address:	Columbus, Ohio
Agreement Number:	NsG-295
Time Period:	Sept. 1962 - Aug. 1965
Status:	Funded for FY-63. $61,219 funded by Biosciences $58,781 funded by Grants and Research Contracts Office
Amount:	$120,000 for two years of a three-year study
Technical Monitor:	G. J. Jacobs
Description:	To investigate effects of prolonged exposure of small mammals to environments low in nitrogen, including control of total pressure, humidity, temperature and gas composition.

Space Metabolic Requirements

Metabolic alterations in terms of energy exchange and heat transfer incident to exposure to prolonged dynamic physiologic and psychologic stresses. This area includes nutritional studies in terms of basic requirements, both

physiological and psychological, for prolonged space travel. Information is required on the types and range of nutrients needed for minimal existence and full efficiency. Different and varying diets and methods for synthesizing diets and effects of diets over long periods of time are also being investigated.

Area of Investigation:	Nutrition
Title:	Development of a Superior Diet for Man-in-Space
Principal Investigator:	N. A. Rosenthal
Organization:	Schwarz Bio-Research Inc.
Address:	Orangeburg, New York
Agreement Number:	NASw-517
Time Period:	Oct., 1962 - Oct., 1963
Status:	Funded by Biosciences through FY 63
Amount:	$183,000
Technical Monitor:	G. J. Jacobs
Description:	To study chemically-defined diets which include essential and non-essential L-Amino and other necessary components (vitamins, minerals, fats, carbohydrates, etc.)

Bio-Instrumentation

Research and development for acquiring new, reliable and sophisticated instruments to measure and analyze standard and classical biological, biochemical, biophysical, bio-psychological and physiological parameters and for producing methods for acquiring biological data which have hitherto-fore been unattainable. Refinement in reliability of existing instruments is also being pursued. Development and research into newer methods and use of biological data, processing, storage, and analysis.

Area of Investigation:	Electronic Instrumentation for Behavioral Studies

Title:	Molecular Electronic Implant Stimulator Monitor System for Behavioral Pattern Studies
Principal Investigator:	R. Preston
Organization:	United Aircraft Corp. Systems Windsor Locks, Connecticut
Agreement Number:	NASw-542
Time Period:	Oct., 1962 - Nov., 1963
Status:	Funded through FY-63; $85,000 funded by transfer from Office of Space Sciences (Biosciences Program) to Office of Advanced Research & Technology (Instrumentation & Data Processing Program); $84,350 funded from Office of Advanced Research & Technology (Instrumentation & Data Processing Program)
Amount:	$192,508
Technical Monitor:	G. J. Jacobs W. Menzel
Description:	To develop instrumentation to stimulate the mammalian brain by remote control and telemetry system. The device will include permanent implantation into a monkey with laboratory experimentation.

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Area of Investigation:	Bioinstrumentation for Circadian Rhythms Study
Title:	Life Sciences Instrumentation
Principal Investigator:	R. Goodman
Organization: Address:	Franklin Institute Philadelphia, Pa.
Agreement Number:	NASr-146

Time Period:	Oct., 1962 - Oct., 1963
Status:	Funded by Biosciences through FY 63
Amount:	$82,330
Technical Monitor:	G. J. Jacobs
Description:	To provide instrumental systems suitable for study of circadian rhythms in small animals (hamsters and drosophila)

Biophysics

Research to describe biological systems at molecular and cellular levels. Studies directed towards the understanding and quantitative description of vital cellular processes including biosynthesis of molecular species. Chemical transformations and metabolic mechanisms that provide energy for maintenance and activity of protoplasmic structures, regulation of the local physical and chemical environment, enzyme activities and the intra-cellular aspects of radiation and effects of gravitational fields, will be investigated.

Area of Investigation:	Rhythmicity
Title:	An Experimental Investigation of Human Circadian Rhythms, Including Consideration of Natural and Artificial Zeitgeber
Principal Investigator:	J. Aschoff
Organization:	Max-Planck Institute
Address:	Erling-Andechs Uber Starnsberg/Obb, Germany

Agreement Number:	NsG 259-62
Time Period:	May, 1962 - May, 1964
Status:	Funded by Biosciences through FY 63
Amount:	$50,400
Technical Monitor:	G. J. Jacobs
Description:	To investigate circadian diurnal rhythms, stimulation on noise level, light intensity and other phenomena; to compare single isolated subjects with group isolated subjects and related studies.

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Area of Investigation:	Cellular Physiology
Title:	Investigation of Hypothermia for an Understanding of the Mechanism by which it Injures Living Cells
Principal Investigator:	H. T. Merryman
Organization:	U. S. Naval Medical Research Institute
Address:	Bethesda, Maryland
Agreement Number:	R-63
Time Period:	June, 1962 - June, 1963
Status:	Funded by Biosciences through FY 63
Amount:	$34,366

Technical Monitor: G. J. Jacobs

Description: To investigate the mechanism by which freezing or drying affects living cells.

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Area of Investigation: Cellular Biophysics

Title: Physics of Cellular Synthesis, Growth and Division

Principal Investigator: E. C. Pollard

Organization: Pennsylvania State University

Agreement Number: NsG-324-63

Time Period: Oct., 1962 - Oct., 1963

Status: Funded by Biosciences through FY 63 as part of proposed 5 year study.

Amount: $74,969

Technical Monitor: G. J. Jacobs

Description: To investigate structural and functional cellular physiology, biophysics, biochemistry and biology insofar as new phenomena and facts are concerned to incorporate these in the theoretic analysis of behavior of the cells and directed towards artificial synthesis of the living cell.

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Area of Investigation:	Biophysics
Title:	A Proposal for the Establishment of an Area of Concentration in Biophysics Within the Framework of the Life Sciences Division at Oklahoma City University.
Principal Investigator:	R. T. Clark
Organization:	Oklahoma City University
Address:	Oklahoma City, Oklahoma
Agreement Number:	NsG-300-63
Time Period:	Sept., 1962 - Aug., 1963
Status:	Funded by Biosciences through FY 63
Amount:	$141,450
Technical Monitor:	G. J. Jacobs
Description:	To study alterations in cell membrane permeability, bacteriological pathogenicity in animals exposed to simulated altitudes, rare gases and ionizing radiation.

Environmental Biology

OBJECTIVES:

The outer space environment offers a unique opportunity to study the basic properties and nature of living Earth organisms with new tools previously unavailable. The new components of the space environment of biological importance are decreased gravity and weightlessness, the imposition of an environment unequivocally disconnected from the Earth's rotation, and radiation fluxes and energies unmatched by anything produced artificially on Earth. There is still so much ignorance of biological organization and so little acceptable theory, that we are more likely to encounter unexpected results, to detect unanticipated relationships, and to be surprised by the behavior of biological systems to the unique aspects of the space environment, than is the case for non-biological systems. In addition to providing data of fundamental value in biological science, the studies will delineate hazards to astronauts, and determine and define effects on degradation of human performance. To study the effects of these factors it is necessary to use orbiting spacecraft. Highest priority of space studies will be on the effects of decreased gravity and weightlessness, and cosmic radiation, especially high energy heavy particles. Studies will also include effects of the entire electromagnetic spectrum, radiation from solar flares and trapped radiation, hard vacuum altered magnetism, and other exotic environmental factors on various forms of terrestrial plant and animal life and their rhythms.

TECHNIQUES AND INSTRUMENTS:

Environmental biology includes the study of the effects of simulated lunar and planetary environments on living Earth organisms. Plants and animals (including anaerobes and chemoautotrophs) from extreme ecological environments such as dry tundra, mountain tops, thermal springs, and high CO_2 habitats such as volcanoes are being studied under simulated

planetary conditions. Organisms are also being developed by genetic selection to survive simulated planetary environments.

Research is also being carried out on biological organisms for application and exploitation in space, such as, (a) use of organisms in space vehicles, space stations, planetary greenhouses, e.g., closed ecological systems, and food supply, (b) use of test organisms on other planets and space stations to determine presence and effects of lethal radiation, harmful biological organisms or substances, and other exotic environmental factors, (c) use of plants for modification of planetary atmospheres, (e.g., greenhouse effect), (d) use of specialized morphological and physiological adaptations, (e.g., hibernators for space travel), and (e) use or exploitation of life on other planets.

PROJECTS AND TASKS:

Supporting Research:

Area of Investigation:	Biosatellite Experiment
Title:	Conduct research directed toward the development of biopaks and experiments for use in a space environment
Principal Investigator:	A. Hollaender
Organization:	Oak Ridge National Laboratory
Address:	Oak Ridge, Tenn.
Agreement Number:	R-60
Time Period:	April 9, 1962 - April 8, 1963
Status:	Funded by Biosciences for 1 year of 3 year effort

Amount:	$115,000
Technical Monitor:	D. W. Jenkins
Description:	A series of experiments with different organisms to study space radiation effects.

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Area of Investigation:	Viability of organisms in Martian atmosphere
Title:	Research on Life in Extra-terrestrial Environments
Principal Investigator:	E. J. Hawrylewicz and R. Ehrlich
Organization:	Armour Research Foundation
Address:	Chicago, Illinois
Agreement Number:	NASr-22
Time Period:	Feb. 15, 1962 - Feb. 28, 1963
Status:	Funded by Biosciences through FY 62
Amount:	$28,520
Technical Monitor:	D. W. Jenkins
Description:	To determine whether plants, particularly bacteria, can grow and survive under simulated Martian conditions.

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Area of Investigation:	Viability of organisms in Martian and lunar atmosphere
Title:	Experimental and theoretical studies of the growth and

	biochemical activities of terrestrial microorganisms in simulated planetary environments.
Principal Investigator:	C. Sagan and S. Scher
Organization: Address:	University of California Berkeley, California
Agreement Number:	NsG 126-61
Time Period:	Feb. 1, 1961 - Feb. 1, 1964
Status:	Funded by Biosciences through FY 61 funds
Amount:	$198,000
Technical Monitor:	D. W. Jenkins
Description:	Duplicate Martian conditions and determine biochemical growth and survival of various plants, particularly bacteria.

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Area of Investigation:	Study of a physiological index for flight study
Title:	Study of the use of fungal luminescence as a physiological index
Principal Investigator:	H. P. Hovnanian and M. D. Berliner
Organization: Address:	AVCO Corporation Wilmington, Mass.
Agreement Number:	NASw-389

Time Period:	April 11, 1962 - April 10, 1963
Status:	Funded by Biosciences through FY 62
Amount:	$42,300
Technical Monitor:	D. W. Jenkins
Description:	To study the effects of anticipated extraterrestrial conditions of temperature, pressure, oxygen concentration, and radiation on light intensity of fungal luminescence.

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Area of Investigation:	Study of hibernating animals
Title:	Physiological affects of weightlessness and space radiations on hibernators
Principal Investigator:	X. J. Musacchia
Organization:	St. Louis University
Address:	St. Louis, Mo.
Agreement Number:	NsG-271-62
Time Period:	June 1, 1962 - May 31, 1964
Status:	Funded by Biosciences through FY 62 for two years
Amount:	$17,880
Technical Monitor:	D. W. Jenkins
Description:	To determine protective effect of hibernation by subjecting animals to radiation during space studies.

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Area of Investigation:	Simulation of decreased gravity
Title:	An investigation of the effects of plant growth hormones on plant development in the absence of gravitational effects.
Principal Investigator:	C. J. Lyon
Organization: Address:	Dartmouth College Hanover, New Hampshire
Agreement Number:	NsG-231-62
Time Period:	Sept. 1, 1962 - Aug. 31, 1964
Status:	Funded by Biosciences through FY 62 for two years
Amount:	$49,906
Technical Monitor:	D. W. Jenkins
Description:	Rotate plants in a clinostat and determine the amount and direction of plant growth movement with relation to gravity.

Area of Investigation:	Radiation effects on genetics of *Neurospora* fungi
Title:	Program of Research in Space Genetics
Principal Investigator:	A. G. DeBusk
Organization: Address:	Florida State University Tallahassee, Florida

Agreement Number:	NsG 103-61
Time Period:	1 Sept. 1960 - 31 Aug. 1963
Status:	Funded by Biosciences Program through FY 63
Amount:	$166,884
Technical Monitor:	D. W. Jenkins
Description:	Studies involving flight experiments of *Neurospora* fungi to determine genetic effects of space radiation.

Interest in Supporting Research

AREA OF INVESTIGATION:	Astronomy for lunar and planetary investigations.
TITLE:	The use of television techniques with telescopes above the atmosphere.
PRINCIPAL INVESTIGATOR:	M. Schwarzschild
ORGANIZATION:	Princeton University
ADDRESS:	Princeton, New Jersey
CONTRACT NUMBER:	NsG 69 (Suppl 4)
TIME PERIOD:	1 July 62 - June 30, 63
FUNDED BY:	Geophysics & Astronomy $200,000 Lunar & Planetary $200,000 Biosciences $100,000
TECHNICAL MONITOR:	R. C. Moore
ALTERNATE CONTACT:	J. M. Weldon
DESCRIPTION:	For some years to come, astronomical instruments above the atmosphere, which promises to revolutionize the entire study of astronomy, will probably be unmanned. To send full information to the ground, television promises to be a most useful tool; both for pointing the instruments at stars, the moon, or planets, and for transmitting the research data to the ground. The purpose of this grant is to design and construct the needed instruments.
DISCIPLINES:	Planetology (prime) Planetary Atmospheres (prime) Bioscience

Supporting Research

Agency	Area	Level of Effort (FY 63)	Principal Investigators
Ames Research Center	Exobiology	$646,000	H. Frommhagen H. Ginoza James Miquel Robert Painter C. A. Ponnamperuma J. Shapira H. J. Trurnit R. S. Young L. P. Zill
	Physical Biology	$355,000	H. Leon K. McDonald R. Schiffman K. Yokoyama D. R. Young
	Behavioral Biology	$188,000	J. Beasley R. Grindeland J. Huertas W. Mahler J. Shapira T. Verhave N. Weissman
	Environmental Biology	$582,000	C. C. Conley D. D. Feller H. A. Leon J. Miquel J. Oyama M. Parrott S. T. Taketa R. S. Young
Jet Propulsion Laboratory	Exobiology	$774,000	Dennis Croissette R. L. Heacock G. Hobby J. Soffen H. W. Washburn

Interest in Other Flight Experiments

PROJECT DESIGNATION:	Stratoscope II
VEHICLE:	High altitude, free balloon
DATE/SITE:	1963/ Palastine, Texas
TRAJECTORY:	25 km maximum altitude
DURATION:	About 12 hours
HEADQUARTERS CONTACT :	N. G. Roman
Alternate:	R. C. Moore
EXPERIMENTER:	M. Schwarzschild, Princeton University
PARAMETER:	Planets and star fields; IR spectrometry of Mars
EXPERIMENT:	Take high resolution photographs of planets and star fields. Make IR spectrometer observations of Mars.
TECHNIQUE:	Photography; spectrophotometry.
STATUS:	Funded by Bioscience Program (NASr-113) jointly with NSF & ONR for development and three flights
DISCIPLINES:	Planetology (prime) Planetary Atmospheres Biosciences

SUMMARY

The following section summarizes the approved experiments and supporting research which are detailed in the preceding discipline sections.

It is arranged as follows:

Satellites and Space Probes, by Projects;
Sounding Rockets and Other Flight Experiments, in numerical order by launch vehicle; and
Supporting Research, in numerical order by NASA agreements.

Within the tables are noted capsule descriptions of the experiments and supporting research, the names of the several experimenters and investigators, and their corresponding affiliations. For each experiment and supporting research listing there is an indication of the discipline having prime responsibility or merely having interest, as noted by X and ✓ respectively.

The discipline areas are as follows:

A	Astronomy
SP	Solar Physics
PA	Planetary Atmospheres
IRP	Ionospheres and Radio Physics
PF	Particles and Fields
P	Planetology
B	Biosciences

Experimenters' Affiliations and Abbreviations

NASA

Ames Research Center, (Ames), California
Flight Research Center, California
Goddard Space Flight Center, (GSFC), Maryland
Jet Propulsion Laboratory, (JPL), California
Langley Research Center, (Langley), Virginia
Lewis Research Center, (Lewis), Ohio
Marshall Space Flight Center, (MSFC), Alabama
NASA Headquarters, (NASA Hqs), District of Columbia

US Government

Air Force Cambridge Research Laboratory, (AFCRL), Massachusetts
Fort Detrick, (US Army), Maryland
National Bureau of Standards (NBS)
  Washington, DC, (DC), District of Columbia
  Central Radio Propagation Laboratory, (CRPL), Colorado
Naval Research Laboratory, (NRL), District of Columbia
Oak Ridge National Laboratory, Tennessee
Smithsonian Astrophysical Observatory, (SAO), Massachusetts
U. S. Geological Survey, (USGS), California
U. S. Naval Medical Research Institute, Maryland

Foreign

Auckland, University of, New Zealand
Cambridge University, England
Canterbury, University of, New Zealand
Commonwealth Scientific and Industrial Research Organization, (CSIRO), Australia
Defence Research Telecommunications Establishment, (DRTE), Canada
Dominion Observatory, Canada
Italian Space Commission
Manchester, University of, England
Manila Observatory, Philippines
Max-Planck Institute, Germany
Meteorological Office, UK Air Ministry
New Zealand, University of
Paris, University of, France
Radio Research Laboratory, Japan

Universities and Non-profit Organizations

Applied Physics Laboratory, (APL), Maryland
Arkansas, University of
Armour Research Foundation, Illinois
Arizona, University of
Boston University, Massachusetts
California, University of,
- Berkeley (UC Berkeley)
- La Jolla (UC La Jolla)
- Lawrence Radiation Laboratory (UCLRL)
- Los Angeles (UCLA)
- San Diego (UCSD)

California Institute of Technology, (CIT)
Chicago, University of, Illinois
Colorado, University of
Columbia University (Lamont Geophysical Laboratory) New York
Communication Research Institute, Florida and Virgin Islands
Cornell University, New York
Dartmouth College, New Hampshire
Detroit, University of, Michigan
Florida State University
Franklin Institute, Bartol Research Foundation, Pennsylvania
Geophysical Institute of Alaska
Georgia Institute of Technology
Graduate Research Center of the Southwest, (GRCSW), Texas
Harvard College, Massachusetts
Harvard University, Massachusetts
Haverford College, Pennsylvania
Hawaii, University of
Houston, University of, Texas
Illinois, University of
Iowa, State University of, (SUI)
Johns Hopkins University, (JHU), Maryland
Maryland, University of
Massachusetts Institute of Technology, (MIT)
Mellon Institute, Pennsylvania
Michigan, University of
Minnesota, University of
New Hampshire, University of

Universities and Non-profit Organizations (Contd.)

New Mexico, University of
New Mexico, State University
New York University
North Carolina, University of
Ohio State University
Oklahoma City University, Oklahoma
Oklahoma State University
Pennsylvania State University
Pittsburgh University, Pennsylvania
Polytechnic Institute of Brooklyn, New York
Princeton University, New Jersey
Purdue Research Foundation, Indiana
RAND Corporation, California
Rensselaer Polytechnic Institute, (RPI), New York
Rochester, University of, New York
Stanford Research Institute, (SRI), California
Stanford University, California
St. John's University, New York
St. Louis University, Missouri
Texas A & M
Texas, University of
University Corporation for Atmospheric Research (High Altitude Observatory), Colorado
Washington University, Missouri
Western State College of Colorado
Wisconsin, University of
Yale University, Connecticut
Yerkes Observatory, Wisconsin

Industry

Advanced Kinetics, California
Aeronutronic, California
Airborne Instruments Laboratory, (AIL), New York
AVCO Corporation, Massachusetts
Ballistics Research Laboratory, (BRL), Michigan
Bell Telephone Laboratories, Inc., New York
Conductron Corporation, Michigan
Ewen Knight Corporation, Massachusetts
General Mills Inc., Minnesota
Geophysics Corporation of America, (GCA), New York
International Telephone and Telegraph Corporation, (ITT), New Jersey
Lockheed Missile and Space Division, (Lockheed), California
National Research Corporation, Massachusetts
North American Aviation Inc., California
Northrop Corporation, California
Resources Research Inc., District of Columbia
Schwarz Bio-research Inc., New York
Shell Development Company, California
Space Technology Laboratories, (STL), California
United Aircraft Corporation Systems, Connecticut
Wilmot Castle Corporation, New York

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ATMOSPHERIC STRUCTURE SATELLITE (S-6, S-6a) (Fellows/Ehrlich)									
Measure distribution of electron temperature and density (10^3/cc to 4 x 10^6/cc) using a swept voltage electron probe	Spencer,NW Brace,L	GSFC			✓	X			
Direct measurement of the distribution of the neutral gas species using a double-focusing sector mass spectrometer	Reber,C	GSFC			X	✓			
Direct measurement of atmospheric density, pressure, and temperature using Bayard-Alpert and Redhead ionization gauges	Horowitz,R Newton,G	NASA Hqs GSFC			X	✓			
FIXED-FREQUENCY TOPSIDE SOUNDER (S-48, S-48a) (Schmerling/Aucremanne)									
Measure electron density height profile by pulse delay (300 to 1,000 km) and measure cosmic noise level (3 to 9 Mc)	Knecht,RW Russell,S	NBS, CRPL AIL				X			
POLAR IONOSPHERE BEACON (S-66, S-66a) (Schmerling/Aucremanne)									
Ground-based measurements of Faraday rotation, Doppler, and scintillations, using multifrequency beacon	U Ill Penn State U Stanford U NBS,,CRPL International participants					X			

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ORBITING SOLAR OBSERVATORY (OSO-B; S-17) (Roman/Mitchell)									
Solar UV spectrophotometry (500-1500Å)	Liller,W Goldberg,L	Harvard U		X					
Solar X-ray emmissions. Pinhole scan of sun (8-20Å and 44-60Å) Monitor X-ray bursts (2-8Å, 8-20Å, and 44-60Å)	Chubb,T	NRL		X					
White light coronagraph measurements to study the structure of the outer solar atmosphere & its relation to the inter-planetary medium	Tousey,R	NRL		X					
Solar UV scanning (304Å, 584Å and 1215Å)	Tousey,R Purcell,D	NRL		X					
Intensity and degree of polarization of zodiacal light at 4750Å and 8500Å	Ney,EP Huch,WF Maas,R	U Minn	X	✓					
Arrival direction and energies of primary cosmic rays (50 Mev and up)	Leavitt,CP	U NMex	✓	X					
Search for solar gamma ray flux (0.1 Mev to 7 Mev)	Frost,K Rothe,E White,W Thornwall,J	GSFC		X					
UV stellar and nebular spectrophotometry (900-3800Å)	Hallam,KL White,WA Young,R Mangus,J	GSFC	X						

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ORBITING SOLAR OBSERVATORY (OSO C; S-57) (Roman/Mitchell)									
Monochromator measurements of solar extreme UV photon fluxes (1300 to 60Å)	Hinteregger, HE	AFCRL		X					
Measure spectral intensity of earth-reflected solar radiation (1000Å to 30 microns)	Neel, CB Robinson, GC	Ames		/	X				
Study energy spectrum and time dependence of bursts from the sun (15 to 600 kev)	Peterson, L	UCLaJolla		X					
Studies of the solar spectrum (1 to 400Å)	Neupert, WM Behring, WE White, WA Lindsay, JC	GSFC		X					
Gamma ray astronomy (above 100 Mev)	Kraushaar, WL	MIT	X	/					
Measure solar X-ray flux (8 - 20Å)	Teske, RG	U Mich		X					
Measure charge and energy spectra of particles of energies ~3.3 Mev/nucleon	Hafner, EM Kaplon, MF	U Rochester		/			X		
Distinguish between emissions from a thermally excited coronal plasma and the Bremsstrahlung X-rays produced by fast electrons into a relatively low temperature corona	Friedman, H Chubb, TA	NRL		X					

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ORBITING SOLAR OBSERVATORY (OSO C; S-57) (Roman/Mitchell) (Contd.)									
Detect and identify electrons and protons	Bloom, S Schrader, C Waggoner, J Kaifer, R	UCLRL					X		
(C) Study solar X-rays (2-8Å, 8-20Å, 44-60Å) (T) Map white light corona and scan solar UV	Chubb, TA Tousey, R	NRL		X					
ORBITING SOLAR OBSERVATORY (OSO B; S-17) (Roman/Mitchell)			Of concern to other than space sciences disciplines						
Emissivity stability of surfaces in a vacuum environment	Neel, CB Robinson, GC	Ames							
ORBITING SOLAR OBSERVATORY (OSO C; S-57) (Roman/Mitchell)									
Emissivity stability of low temperature coatings	Neel, CB Robinson, GC	Ames							

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ORBITING ASTRONOMICAL OBSERVATORY (OAO; S-18) (Roman/Sures)									
Mapping stellar UV radiation (3,000 -1,700Å, 2,000 -1,050Å, 1,500-1,050Å)	Whipple,F Davis,R	SAO	X						
Broadband photometric studies of stellar energy distribution (800 to 3,000Å)	Code,AD	U Wisc	X						
ORBITING ASTRONOMICAL OBSERVATORY (OAO; S-58) (Roman/Sures)									
Absolute spectrophotometry measurements (1,000 to 4,000Å with 2Å resolution)	Milligan,J	GSFC	X						
ORBITING ASTRONOMICAL OBSERVATORY (OAO; S-68) (Roman/Sures)									
Interstellar absorption measurements (800 to 3,000Å with 0.1Å resolution)	Spitzer,L	Princeton U	X						

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ECCENTRIC ORBITING GEOPHYSICAL OBSERVATORY (EGO; S-49, S-49a) (Cahill/Ashworth)									
Measure solar cosmic ray protons (3 to 30 Mev) and solar X-rays using scintillation detectors	Anderson,KA	UC Berkeley		✓			X		
Detect and measure positrons (0 to 3 Mev) and monitor solar proton bursts (30 kev to 1.2 Mev)	Cline,TL Hones,EW	GSFC		✓			X		
Using an ion-electron scintillation detector study spacial and temporal fluctuations by observing trapped electrons with directional energy flux, 10 kev $\leq$ E $\leq$ 100 kev, and of protons with directional intensity, 120 kev $\leq$ E $\leq$ 4.5 Mev	Davis,LR	GSFC					X		
Determine charge and energy spectra of the primary radiation using a cosmic ray telescope	McDonald,FB Bryant,DA	GSFC					X		
Curved plate spectrometer used as plasma probe to measure proton concentrations (10^{-2} to 10^{-4} particles/cm^3) as a function of proton energy (0.2 to 20 kev)	Bader,M	Ames				✓	X		
Proton and electron Faraday cup plasma probes to measure proton flux and energy spectrum, and their variations (10 ev to 10 kev)	Bridge,H Bonetti,A Rossi,B Lazarus,AJ Scherb,F	MIT				✓	X		

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ECCENTRIC ORBITING GEOPHYSICAL OBSERVATORY (EGO;S-49, S-49a) (Cahill/Ashworth)(Contd.)									
Using charged particle telescope, investigate low energy galactic cosmic radiation and study protons above 0.2 Mev and other nucleii at higher energies	Simpson,JA Fan,CY Meyer,P	U Chicago					X		
Measure omnidirectional intensities of outer belt electrons	Van Allen,JA Frank,LA	SUI					X		
Study injection, trapping, and loss mechanisms in the trapped radiation belts	Winckler,JR Arnoldy,RL	U Minn					X		
Detect and investigate fluctuations in vector magnetic field (0.01 to 1,000 cps), using triaxial search coil magnetometer	Smith,EJ Holzer,RE	JPL UCLA					X		
Radio beacon to radiate linearly polarized signals (40 to 360 Mc) toward the earth to measure electron content and scintillations as functions of position & time.	Lawrence,RS Chivers,HJA	NBS, CRPL				X			
Ion mass spectrometry to obtain direct measurements of positive ions (1-50 AMU and from 10 to 10^5 ions/cc)	Taylor,H Spencer,NW	GSFC			X	✓			
Micrometeoroids; vector velocity distribution, cumulative mass distribution, effect of geocentric distance	Alexander,WM McCracken,CW	GSFC			X				

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ECCENTRIC ORBITING GEOPHYSICAL OBSERVATORY (EGO;S-49, S-49a) (Cahill/Ashworth) (Contd.)									
Spherical three-electrode probe to measure densities and energy distributions of charged particles (to 1.0 kev) as functions of position and time	Sagalyn,RC Smiddy,M	AFCRL				X	✓		
Planar ion and electron trap to measure densities, temperatures and energy distributions of charged particles of both polarities as functions of position and time	Whipple,EC Jr.	GSFC				X	✓		
Mapping VLF noise and propagation (0.2 to 100 kc/s) as function of time, location, and frequency	Helliwell,RA Rorden,LH	Stanford U SRI				X			
Radio astronomy (2 to 4 Mc/s) primarily to measure the dynamic radio spectra of solar bursts	Haddock,FT	U Mich	X	✓					
Use Rb vapor and fluxgate magnetometers to measure magnitude and direction of magnetic field (1 to 50,000 gammas)	Heppner,JP	GSFC				X			
Lyman-alpha scattering in the geocorona	Mange,PW	NRL			X				
BACKUP EXPERIMENT			✓		✓				
Investigation of the Gegenschein	Hallam,K Wolff,CL Wyatt,SP	GSFC U Ill	X		✓				

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
POLAR ORBITING GEOPHYSICAL OBSERVATORY (POGO; S-50) (Fellows/Ashworth)									
Measure cosmic noise between 2 and 4 Mc/s	Haddock,FT	U Mich	X						
Map VLF noise and propagation conditions as functions of place and time (0.2 to 100kc)	Helliwell,RA	Stanford U				X			
Obtain diurnal and latitude variations of VLF spectra (high resolution) both in orbit and on the ground (0.5 to 15 kc)	Morgan,MG Laaspere,T	Dartmouth College				X			
Correlation between VLF emissions and high energy electron bunches in the magnetosphere	Winckler,JR Gallet,R	U Minn NBS, CRPL				✓	X		
Measure magnetic field fluctuations in the low and sub audio range using a triaxial search coil magnetometer	Holzer,RE Smith,EJ	UCLA JPL					X		
Measure scalar magnetic field for World Magnetic Survey, using a Rb vapor magnetometer	Heppner,JP Boroson,HR Cain,J	GSFC					X		
Monitor cosmic and trapped radiation using an integrating ionization detector	Neher,HV Anderson,HR	CIT JPL					X		

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
POLAR ORBITING GEOPHYSICAL OBSERVATORY (POGO; S-50) (Fellows/Ashworth) (Contd.)									
Study low energy protons and nucleons (0.3 to 30 Mev) using a scintillation telescope	Simpson,JA	U Chicago					X		
Measure rigidity and charge spectrum of galactic and solar cosmic rays	Webber,WR	U Minn	✓				X		
Study origin and fluctuation mechanisms for the trapped radiation belts by measuring trapped and dumped electrons, using Geiger tubes as detectors	Van Allen,JA	SUI					X		
Study fluctuations in the trapped radiation by measuring low energy trapped radiation and auroral particles (electrons, 10-100 kev; protons, 100 kev to 4.5 Mev) using an ion-electron detector	Hoffman,RA Davis,LR Konradi,A Williamson,JM	GSFC					X		
Photometric airglow measurements (6300Å, 5577Å, 2500Å, 5893Å, 4860Å and 3914Å)	Blamont,J Reed,E	U Paris GSFC		X					
Airglow studies in the Lyman-alpha, far UV (1230Å-1350Å) with UV ion chamber	Mange,PM Chubb,TA Friedman,H	NRL		X					
High resolution scan in the UV (between 1100Å and 3400Å)	Barth,CA Wallace,L	JPL Yerkes Obsv		X					

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
POLAR ORBITING GEOPHYSICAL OBSERVATORY (POGO; S-50) (Fellows/Ashworth) (Contd.)									
Use Paul Massenfilter spectrometer tube to obtain neutral and ionic composition of atmosphere (0-6 AMU and 0-40 AMU)	Jones,LM Schaefer,EJ	U Mich		X	✓				
Bennett RF ion mass spectrometer for direct measurement of ion composition and density (1-45 AMU)	Taylor,H Brinton,HC	GSFC		X	✓				
Measure atmospheric density with Bayard-Alpert ionization gauge (10^{-5} to 10^{-10} mmHg)	Newton,GP	GSFC		X	✓				
Measure flux, momentum, and mass of dust particles in the zodiacal light (10^{-13} to 10^{-9} gm)	Alexander,WM McCracken,CW Berg,OE Secretan,L	GSFC		X					
Measure electron temperature (800 to 3,000 K) ion or neutral gas temperature (800 to 3,000 K); charged particle density (10^3 to 5×10^6) using a combined retarding potential analyzer	Bourdeau,RE	GSFC			✓	X			

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
INTERPLANETARY MONITORING PROBE (S-74a, S-74b, S-74c) (Cahill/Ehrlich)									
Magnetic field measurements using Rb vapor and fluxgate magnetometers	Ness,NF	GSFC					X		
Measure flux and energy of interplanetary plasma; electrons and protons (0 to 8 kev)	Bridge,H Rossi,B	MIT					X		
Measure solar and galactic protons and alpha particles (5 to 200 Mev)	Simpson,JA	U Chicago					X		
Planar trap ion-electron detector for plasma measurements in thermal energy range (0 - 10 ev)	Serbu,GP	GSFC		✓			X ✓		
Identify and measure energies and pitch angle distributions of trapped particles	Anderson,KA	UCBerkeley					X		
Measure solar and galactic protons (10 to 100 Mev)	McDonald,FB	GSFC					X		
Measure interplanetary plasma flux and velocity protons (0.2 to 2 kev)	Bader,M	Ames					X		

S A T E L L I T E S

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
RIGIDIZED PASSIVE COMMUNICATIONS SATELLITE (A-12) (Dubin)									
Using orbit data, measure the atmospheric density and scale height as a function of time and altitude	O'Sullivan,WJ	Langley		X					
RELAY, COMMUNICATIONS SATELLITE (A-15,16,19) (Jaffe)									
Determine proton energy spectrum ($1.5 \leq E \leq 25$ Mev)	Brown,W.	Bell Telephone Lab					X		
Determine electron energy spectrum ($0.2 \leq E \leq 2$ Mev)	Brown,W	Bell Telephone Lab					X		
Determine integral omnidirectional flux of protons ($E \geq 35$ Mev)	McIlwain,C	SUI and UCSD					X		
Determine directional intensity and energy distribution of electrons ($0.5 \leq E \leq 1$ Mev)	McIlwain,C	SUI and UCSD					X		
Determine directional intensity and energy distribution of protons ($1 \leq E \leq 3$ Mev)	McIlwain,C	SUI and UCSD					X		
Determine directional intensity and energy distribution of protons ($18 \leq E \leq 60$ Mev)	McIlwain,C	SUI and UCSD					X		

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
MICROMETEOROID SATELLITE (S-55b) (D'Aiutolo/Dubin)									
Using piezoelectric detectors, determine number of impacts in or greater than momentum ranges of 1.0 gm-cm/sec; 0.1 gm-cm/sec; and 0.01 gm-cm/sec	Beswick,AG Smith,GL	Langley			X				
Determine under micrometeoroid impacts, the lifetime of pressurization of cylindrically-shaped containers	Gurtler,CA Smith,GL	Langley			X				
Determine rate of penetration of 300-micron and 150-micron stainless steel foil from breaking of strain gages backing the foil	Davison,EH Conger,CC	Lewis			X				
Determine rate of destruction of wire grid impact detectors by micrometeoroids	Secretan,L	GSFC			X				
Determine micrometeoroid abrasive rate on opaque coatings	Secretan,L	GSFC			X				
ITALIAN - NASA COOPERATIVE PROGRAM (Fellows/Ginter)									
Determine the atmospheric density in the equatorial region and the variations from solar heating and other geophysical phenomena		Italian Space Commission			X				
Using 20Mc/s transmitter and ground-based receiver, determine electron content and ducted propagation		Italian Space Commission				X			

SATELLITES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
INTERNATIONAL SATELLITE (S-52) (Fellows/Halpern)									
Galactic radio noise in frequency range, 0.75 Mc to 3.0 Mc and exploration of upper ionosphere	Smith,FG	Cambridge U England	✓			X			
Measure distribution of atmospheric ozone at twilight, with filtered photocells and spectrometer	Frith,R Stewart,KH	Met. Office, UK Air Ministry			X				
Measure the impact rate, distribution, and effects of micrometeorites	Jennison,RC	U Manchester England			X				

SPACE PROBES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
RANGERS 6 - 9 (P-53 through P-56) (Cunningham/Jakobowski)									
Determine lunar topography using an RCA TV system consisting of 6 1-inch vidicon cameras	Kuiper,G Urey,HC Shoemaker,EM Hibbs,A Heacock,R Dobies,E	U Ariz UCSD USGS JPL JPL JPL						X	
Measurement of the absolute electron flux in the energy range 250 kev to a few Mev	Pieper,GF	APL					X		
Detect magnitude and direction of proton flux in solar plasma, using a low energy solar proton detector	Bader,M Fryer,TB	Ames					X		
Study of low energy charged particles (0.1 to 30 ev)	Bourdeau,RE Serbu,GP	GSFC					X		
Measure dust particle flux in cislunar space	Alexander,WM	GSFC			X			✓	
Measure particle flux (electrons E > 0.5 Mev and > 35 kev; protons E > 10 Mev and > 0.5 Mev) using GM counters and an integrating ionization chamber	Anderson,HR McDonald,WS Neher,HV Van Allen,JA	JPL JPL CIT SUI					X		
Electron-proton spectrometer	Farley,TA Sanders,N	UCLA STL					X		
Survey of lunar electrodynamics (1 to 1,000 cps) using search coil magnetometer	Smith,EJ	JPL					X		

SPACE PROBES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
MARINER II (Kochendorfer/Reiff)									
A curved plate electrostatic analyzer will measure the flux and energy spectrum of interplanetary plasma	Snyder,CW Neugebauer,M	JPL					X		
Study solar and galactic cosmic rays, using ionization chamber and Geiger-Mueller tubes	Anderson,HR Neher,HW Van Allen,JA	JPL CIT SUI					X		
Using a fluxgate magnetometer, measure the magnitude and direction of the ambient magnetic field	Coleman,PJ,Jr Davis,L. Smith,EJ Sonett,CP	UCLA CIT JPL Ames					X		
Cosmic dust detection, using a large-area acoustical detector with a division of impacts into two momentum categories of the impacting particles	Alexander,WM	GSFC			X			✓	
Microwave radiometer will obtain information on the nature of the Venus atmosphere, including determinations of the composition and the presence of water vapor below the cloud layer by measurements of the microwave-brightness temperature in the vicinity of the planet. Also expect to obtain information on the surface temperature and other surface characteristics	Barrett,A Lilley,AE Copeland,J Jones,DE	MIT Harvard U Ewen Knight Corp JPL			X			✓	
Measure the intensity of the IR radiation from the vicinity of Venus to give temperature; map cloud coverage	Kaplan,LD Sagan,C Neugebauer,G	JPL UCBerkeley JPL			X	✓		✓	

SPACE PROBES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
SURVEYOR (P-42 through P-48) (Milwitzky/Swetnick)									
TV surveillance of lunar surface features	Kuiper,GP Shoemaker,EM	U Ariz USGS						X	
Determine hardness, bearing & shear strength of lunar surface material using a bevameter	Clark,SP Press,F Ingerson,FE Kennedy,GC Shoemaker,EM	Yale U CIT U Texas UCLA USGS						X	
Identify minerals on lunar surface, using an X-ray diffractometer	Hess,H Goldberg,E	Princeton U UCSD						X	
Measure flux of secondary particles generated by meteorite impacts on lunar surface	To be selected							X	
ALTERNATES									
Determine body properties of the moon	Ewing,M Press,F	Columbia U CIT						X	
Determine thermal diffusivity of lunar surface material	Clark,SP Ingerson,FE Kennedy,GC Shoemaker,EM Press,F	Yale U U Texas UCLA USGS CIT						X	
Elemental analysis of lunar surface material	To be selected							X	

SPACE PROBES

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
SURVEYOR (P-42 through P-48) (Contd.)									
Determine magnetic properties of lunar surface material	Clark,SP	Yale U						X	
	Press,F	CIT							
	Ingerson,FE	U Texas							
	Kennedy,GC	UCLA							

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
ARCAS (3 rockets) (Fellows/Holtz)									
Determine correlation with RF radar information of shears and turbulence in the 60 to 90 km region	Gregory,P	U New Zealand			X	/			
ARCAS, LOKI II, and HASP (Spreen/Dubin)									
NASA support of Project IRIG. Synoptic measuring program using small rockets (30 to 80 km altitude) to map structure of the atmosphere above balloon altitudes	Tolefson,HB Vaughn,WW Taiani,AR Murrow,HN	MSFC Langley			X				
ARGO D-4									
8.14 (Schmerling/Holtz)									
Elucidation of problems connected with interpretation of topside sounder data (electron density and radio noise); development tests for next generation topside sounder	Molozzi,AR	DRTE Canada			X				
8.18 (Schmerling/Holtz)									
Elucidation of problems connected with the interpretation of topside sounder data (electron density and radio noise). Tests of next generation topside sounder techniques	Knecht,RW Russell,S	NBS, CRPL AIL			X				

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
8.19, 8.20 (Schmerling/Holtz)									
Measure ion and electron density, electron temperature, and magnetic field in auroral conditions	Nagy,A	U Mich/BRL				X			
8.25, 8.26, 8.27 (Schmerling/Holtz)									
In conjunction with a separate, simultaneous measurement of solar flux, measure the individual quantities which enter into the continuity equation. Some cross-checking with topside sounder data is also planned	Bourdeau,RE Spencer,NW Bauer,SJ Taylor,HA	GSFC				X			
8.28,8.30 (Schmerling/Holtz)									
Accurate determination of electron density profile by radio wave propagation between rocket and separating capsule	Nisbet,JS	Penn St U				X			
ARGO D-8									
11.06 (Cahill/Holtz)									
Identification and measurement of positrons (0.5 Mev) in the inner belt	Cline,T	GSFC					X		
Measurement of electron flux and energy spectrum (0.05 - 3 Mev). Development and testing of similar systems for satellite use	Winckler,JR	U Minn					X		

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
JAVELIN 8.03 (Dubin/Gracely) Determine composition, density, and energy distribution of the atmosphere to 1,000 km	Sharp,G McKibben,D	Lockheed		X/					
NIKE-CAJUN 10.53-10.55; 10.58-10.61; 10.62, 10.63, 10.71, 10.73, 10.74, 10.75, 10.86-10.89 (Spreen/Dubin) Measure wind and temperature profiles between 30 and 95 km to investigate seasonal, geographical, and diurnal patterns and their causes	Nordberg,W Smith,W	GSFC		X					
2 rockets to be assigned (Fellows/Dubin) Study chemiluminescent reaction efficiences and determine atmospheric motion during darkness	Hord,R	Langley		X					
NIKE-CAJUN or other rockets (12 to 30 rockets) (Dubin/Spreen) Systematic measurements of atmospheric structure and its variations with time of day and season from 110 km and below, using sphere drag	Jones,LM Peterson,L	U Mich		X					

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
NIKE-APACHE									
14.06, 14.07, (Cahill/Holtz) Determine structure and intensity of the equatorial electrojet current in the ionosphere	Cahill,LJ White,A	U NH				/	X		
14.08, 14.09 (Dubin/Horowitz) Determine chemical and ionic composition of the atmosphere and the generation and loss mechanisms of atmospheric constituents. Measure atmospheric structure variations as affected by solar radiation and particle bombardment.	Schaefer,E Jones,LM	U Mich		X			/		
14.22 through 14.25 (Dubin/Horowitz) Investigate atmospheric structure parameters (pressure, temperature, density and winds) expecially for diurnal dependence above 100 km	Horvath,J	U Mich		X					
14.26 through 14.29 (Dubin/Fellows) Investigate the tidal and dynamo motions and current systems between 80 and 200 km altitude. Determine latitudinal, seasonal and diurnal variation of atmospheric temperature and density	Manring,ER Blamont,JE	GCA U Paris		X	/				

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
14.33, 14.34 (Schmerling/Holtz)									
E region study to correlate flux measurements with measurements of electron density	Bauer,SJ	GSFC				X			
14.79 through 14.85 (Cahill/Holtz)									
Determine structure and intensity of the equatorial electrojet current in the ionosphere	Cahill,LJ White,A	U NH				✓	X		
14.86,14.87 (Schmerling/Holtz)									
Development test for eclipse experiment to determine electron density, X-ray and UV flux	Smith,LG	GCA				X			
14.88 through 14.94 (Schmerling/Holtz)									
Measure changes in the ionosphere during an eclipse by correlating electron density, X-ray and UV flux	Smith,LG	GCA				X			
14.102, 14.103 (Dubin/Fellows)									
Determine chemical mechanisms for airglow emissions	Potter,AE	Lewis			X				

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
14.107, 14.108, 14.109 (Schmerling/Holtz) D region investigation - simultaneous measurement of ion and electron densities and electrical conductivity; and monitor solar UV and X-ray emissions	Whipple,EC,Jr	GSFC				X			
14.110 (Dubin/Gracely) Determine composition, density, and energy distribution of the atmosphere to 1,000 km	Sharp,G McKibben,D	Lockheed			X	✓			
AEROBEE 1.14 (Moore/Dubin) Determine altitude variation of the dayglow fluorescence spectrum (2000 to 3400Å) and atmospheric composition in the chemosphere	Barth,CA	JPL			X				
6.06, 6.07, 6.08 (Dubin/Horowitz) Determine altitude profile of atmospheric structure parameters and ionic content and determine function of diurnal, seasonal, or latitude dependence	Brace,LH	GSFC			X				
AEROBEE-HI Numbers to be assigned: (Dubin/Moore) Determine the composition, albedo, and airglow condition of atmospheres of Venus, Mars and Jupiter by UV spectroscopy	Dunkelman,L Fowler,R	GSFC			X				

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
Numbers to be assigned: (D'Aiutolo/Dubin) Measure actual micrometeorite penetration rates and hypervelocity effects, using large area paraglider detector	Hopko,RW Kinard,WH	Langley			X				
AEROBEE 4.22 (Roman) Flight test solar UV S-17 experiment to measure intensity of radiation coming from the sun. (500 to 1500Å)	Liller,W	Harvard U		X					
4.24 (Roman/Ott) Measure the energy of the solar spectrum (between 50 and 1500Å)	Rense,WA	U Colo		X					
4.30 (Skolnik/Boggess) Make directional and altitudinal survey of earth's Lyman-alpha nebulosity to 250 km	Skolnik,R Boggess,A	GSFC			X				
4.37 (Roman/Holtz) Measure spectra of hot stars in the winter sky (1300-4000Å)	Stecher,T Milligan,J	GSFC	X						
4.44, 4.45 (Schmerling/Holtz) Compare different techniques for measuring electron density, and investigate electroacoustic mode	Bauer,SJ Whale,HA	GSFC				X			

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP PA	IRP	PF	P B
4.50, 4.51 (Roman/Holtz)							
Observe stellar spectra of the hot star Gamma Pegasi to study its UV radiation with moderate dispersion	Rogerson,J	Princeton U	X				
4.58, 4.59 (Schmerling/Holtz)							
Investigate entry and exit of whistler mode signals by measuring signals on six frequencies as a function of altitude	Rorden,LH	SRI			X		
4.61, 4.62 (Roman)							
Measure intensity and structure of solar corona in white light out to about ten solar radii; Scan solar disc to EUV (304Å, 584Å and 1216Å)	Packer,DM Purcell,JD Koomen,MJ Tousey,R	NRL		X			
4.64, 4.65 (Schmerling/Holtz)							
Joint US-Japanese experiment in the lower ionosphere to investigate the processes occuring in the lower ionosphere and to cross-check different measuring techniques	Serbu,GP	GSFC and Radio Research Labs, Japan			X		
4.70 (Roman/Holtz)							
X-ray mapping of night sky (1 to 100Å)	Fisher,PC	Lockheed	X				

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
4.73, 4.75, 4.76 (Dubin/Fellows)									
Determine spectrum of the day and night airglow in the UV and effect of latitude, energetic particle excitations, atmospheric composition and reaction mechanisms	Fastie,W Dieke,GH	JHU			X				
4.77 (Roman/Holtz)									
Detect and measure solar radiation (1100 to 3500Å); to obtain an accurate spectrum of the solar continuum from the center of the sun; Experimental studies of the extended solar corona in visible wave lengths to determine coronal structure and intensity distribution; Photograph entire solar disc in the light of Lyman-alpha (1216Å)	Hallam,K Wolff,C	GSFC			X				
4.80 (Schmerling/Holtz)									
Investigate the mechanism whereby VLF signals enter into the whistler mode in the lower ionosphere	Cartwright,DG	CSIRO, Australia				X			
4.83, 4.84 (Dubin/Fellows)									
Determine airglow intensities as a function of altitude and derive composition and atomic and molecular reaction conditions (1700 to 3200Å)	Dunkelman,L Hennes,JP	GSFC			X				

SOUNDING ROCKETS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P.	B
4.85 (Moore/Dubin)									
Determine altitude variation of the dayglow fluorescence spectrum (2000 to 3400Å) and atmospheric composition in the chemosphere	Barth,CA	JPL			X				
SATURN									
SA-3, SA-4 (Fellows)									
Determine density-altitude profile using ionization gauges	Vaughn,W Holderer,O	MSFC			X				
SATURN (Fellows/Miller)									
Study evaporation rates, chemiluminescent effects, rate of dispersion and comet stimulation by release of water in the atmosphere and ground observations	Johnson,W	MSFC			X				

OTHER FLIGHT EXPERIMENTS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
X-15 (Ott/Martin) Record stellar UV radiation (1800 to 4200Å)	Code,AD Houek,T Bless,T McNall,J Schroeder,D	U Wisc	X						
X-15 (Ott/Martin) Measure relative brightness of sky and earth background	Code,A	U Wisc	X						
BALLOON (Cahill/Gracely) Measure low energy protons to understand the production and propagation of solar protons	Anderson,KA	UC Berkeley		/			X		
BALLOON (Cahill/Gracely) Measure the charge and energy spectra of cosmic rays at several geomagnetic latitudes during the solar minimum period	Webber,WR Winckler,JR Arnoldy,R	U Minn		/			X		
BALLOON (Cahill/Gracely) Investigate properties of the primary cosmic radiation at low altitudes near the South African magnetic anomaly	Friedlander,MW	Washington U					X		

OTHER FLIGHT EXPERIMENTS

Project Designation and Contacts	Experimenters	Affiliations	A	SP	PA	IRP	PF	P	B
BALLOON (Cahill/Gracely)									
Measurement of abundance of helium isotopes	Kaplon,MF	U Rochester					X		
STRATOSCOPE II (Roman/Moore)									
High-resolution photography of planets and star field; IR spectrometry of Mars	Schwarzschild,M	Princeton U			/		X		✓

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NTF-84 (Amd 2) (Seddon)									
Continue to improve high-speed computer techniques for obtaining electron density profiles from ionograms, furnishing such profiles for the NASA Ionosphere Program upon request, and make closely-related ionospheric investigations	Wright,JW	NBS, CRPL				X			
W11 391B (Roman/Ott)									
Maintain a network for collection of current data on solar flares and associated phenomena and on various kinds of ionospheric and magnetic disturbances.	Shapley,A Lincoln,V	NBS, CRPL		X					
S7964G (Roman/Ott)									
Design and construct a 35 ft vacuum spectrograph	Kessler,K	NBS, DC	X						

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
R-18 (Moore) Support of U of Hawaii-U of Colorado research on zodiacal light and airglow (icw NsG-135)	Roach,FE	NBS, CRPL	X	/					
R-30 (Amd 1) (Schmerling/Bourdeau) Continuation of IGY Project 32.41. Faraday and Doppler observations are being made on the Russian satellites and planned for S-66. Electron content, scintillations and propagation path effects are to be studied.	Little,CG Chivers,HJA	NBS, CRPL				X			
R-35 (Amd 1) (Quimby) Studies and development of methods for the decontamination of spacecraft	Phillips,C	Ft Detrick							X
R-60 (Jenkins) Conduct research directed toward the development of biopaks and experiments for use in a space environment	Hollaender,A	Oak Ridge Natl Lab							X
R-63 (Jacobs) Investigate the mechanism by which freezing or drying affects living cells	Merryman,HT	US Naval Medical Research Inst							X

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
R-64 (Miller/Dunkelman) Studies of the vacuum UV spectra of atoms and small molecules containing elements such as hydrogen, carbon, nitrogen, and oxygen.	Bass,AM	NBS, DC			X				
R-65 (Weldon/Moore) Study and development of reasonable models of the Mars and Venus ionospheres in support of topside sounding experiment to be flown on later Mariner spacecraft. Also supports some experiment design studies in connection with future planetary ionosphere sounding.	Knecht,RW	NBS, CRPL				X			
R-66 (Bryson / Fryklund) Photogeological lunar mapping	Shoemaker,EM	USGS						X	
R-67 (Andrus/Burke) Investigate interference to radio astronomy observations due to operation of communications satellite systems	Rice,P	NBS, CRPL	X						
R-73 (Roman/Gill) Far UV and soft X-ray radiation physics	Madden,R	NBS	X						

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
R-74 (Cahill)									
Support studies of solar cosmic ray emission events, by ionospheric forward scatter observations in the Antarctic during IQSY	Bailey,DK	NBS, CRPL				/	X		

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP PF	P	B
NASw-37 (Amd 3) (Roman/Ott) Detect gamma rays and study their energies and direction of arrival	Kraushaar,W Clark,TW	MIT	X					
NASw-56 (Amd 4) (Cahill/Lindsay) Research in galactic and solar cosmic radiation, trapped radiation, and zodiacal light.	Winckler,JR Ney,EP	U Minn				X		
NASw-59 (Amd 4) (Cahill/Naugle) Develop coincidence telescope for study of primary cosmic radiation	Shearin,PE	U NCarolina				X		
NASw-66 (Amd 3) (Ott/Roman) Stellar spectra-photometry in the far UV, including preliminary design studies of a satellite-borne telescope and consideration of data recovery and processing problems	Code,AD	U Wisc	X					
NASw-75 (Amd 5) (Liddel) Design, construct, and test a prototype apparatus to measure plasma density and motion within the solar system as a function of time and position	Bridge,HS Rossi,B	MIT				X		

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASw-81 (Amd 7) (Allenby/Fryklund)									
Reduction of Ranger seismic data; develop three-component low frequency seismometer, develop controlled explosive seismic systems, and theoretical studies of lunar models	Press,F	CIT						X	
NASw-82 and Amds 1 and 2 (Allenby/Fryklund)									
Planetary seismic research and instrument development	Ewing,M Oliver,J Sutton,GH	Columbia U						X	
NASw-107 (Amd 2) (Ott/Roman)									
Experimental research on optical and electronic properties of solid materials	Hopkins,RE	U Rochester	X						
NASw-138 (Amd 4 & 5) (Dubin/Spencer)									
Special investigation of rocket instrumentation packages for measuring the properties of the upper atmosphere	Jones,LM	U Mich			X				
NASw-155 (Amd 2) (Cahill/Naugle)									
Develop, construct, and test fluxgate magnetometers to be flown on eccentric orbiting satellites	Cahill,LJ,Jr	U NH					X		

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASw-286 (Moore/Weldon) For Mars, determine average surface temperature from radiative equilibrium considerations. Compute effects of ozone heating on temperature profile. For Venus, evaluate available information and analysis of existing models of the atmosphere.	Ohring,G	GCA			X				
NASw-389 (Jenkins) Study effects of anticipated extraterrestrial conditions of temperature, pressure, oxygen concentration, and radiation on light intensity of fungal luminescence	Hovnanian,HP Berliner,MD	AVCO Corp							X
NASw-394 (Dubin/LaGow) Study & analyze average structure and variability of the Earth's atmosphere above meteorological balloon levels	Minzner,RA	GCA			X				
NASw-395 (Dubin/Dunkelman) Laboratory and theoretical studies in the vacuum UV for the investigation of chemical physics of planetary atmospheres	Marmo,FF	GCA			X				
NASw-424 (Allenby/ Fryklund) Investigate the sputtering effects of solar radiation on the moon's surface	Wehner,GK	General Mills Inc						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASw-427 (Liddel) Laboratory simulation of the interaction of solar plasma with the geomagnetic field	Waniek,RW	Advanced Kinetics					X		
NASw-430 (Weldon/Moore) Millimeter-wave converter studies	Blanchard,RJ	ITT			X				
NASw-438 (Quimby) Develop and apply techniques to the analysis of representative samples of hydrocarbons present in low concentrations in terrestrial mineral aggregates, pending availability of extraterrestrial aggregates	Stevenson,D	Shell Development Co							X
NASw-457 (Allenby/Bryson) Study of rock dust in a vacuum	Green,J	North American Aviation Inc						X	
NASw-490 (Weldon/Brown) Radar data analysis	Siegel,KM	Conductron Corp						X	
NASw-513 (Weldon/Moore) Design studies for instrumenting an experiment to sound the Venus ionosphere from the topside	Sperber,AO	AIL				X			

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASw-517 (Jacobs) Develop superior diet for man in space	Rosenthal,NA	Schwarz Bio-research Inc							X
NASw-542 (Jacobs/Menzel) Develop molecular electronic implant stimulator monitor system for behavioral pattern studies	Preston,R	United Aircraft Corp Systems							X
NASw-550 (Quimby) Develop and define conditions necessary to achieve sterility of various components of space probes by means of heat	Fritzsching,E	Wilmot Castle Corp							X
NASw-593 (Weldon/Moore) Investigate radiometric characteristics of Venus and the moon to assist in determining their brightness temperatures	Copeland,J	Ewen Knight Corp						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASr 5 (Roman/Ott)									
Design, construct, and test a prototype, high-speed, high-resolution, rocket stigmatic spectrograph useful in the region 1000 to 3000 Å	McAllister,H	U Hawaii		X					
NASr-7 (Amd 3) (Alexander/Dubin)									
An analytical and limited experimental study of the mechanisms of impact, penetration, and light emission for micrometeorites on an aluminum-coated photomultiplier	Todd,FC	Okla St U			X				
NASr-10 (Amd 2 & 3) (Quimby)									
Develop a radioisotopic biochemical probe for extraterrestrial life	Levin,G Horowitz,N	Resources Research Inc							X
NASr-21 (05) (Cahill/Naugle)									
Study energetic particles of the Van Allen radiation belts in connection with the polar regions and with aurora and magnetic disturbances	Vestine,RH	RAND Corp					X		
NASr-22 (Jenkins)									
Viability of organisms in Martian atmosphere	Hawrylewicz,EJ Ehrlich,R	Armour Research Foundation							X

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASr-26 (Cahill/Gracely)									
Investigate low energy solar particle radiation	Anderson,KA	UC Berkeley					X		
NASr-41 (Quimby)									
Viability of organisms in simulated space	Keller,WH Silverman,G	National Research Corp							X
NASr-42 (Amd 1 and 2) (Kupperian/Roman)									
Design, construct and test a prototype temperature-compensated rugged high-resolution scanning spectrometer for OAO	Spitzer,L	Princeton U	X						
NASr-49 (07) (Gilbert/Fellows)									
Theoretical research on low energy electronic, ionic and atomic impact phenomena	Smith,FT	SRI			X				
NASr-65 (01) (Amd 2) (Moore/Weldon)									
Radiative energy transfer on entry into Mars and Venus	Davies,WO	Armour Research Foundation			X				

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASr-79 and Amd 1 & 2 (Cahill) Reduction and analysis of the ionization chamber data from Explorer VII	Pomerantz,M	Franklin Inst, Bartol Research Foundation				X			
NASr-81 (Quimby) Determine distribution and nature of micro-organisms in the upper terrestrial atmosphere at various altitudes up to 26 km	Greene,V	General Mills Inc							X
NASr-82 (Moore) Construction of a 60-inch lunar and planetary telescope	Kuiper,GP	U Ariz	✓		✓			X	
NASr-84 (Quimby) Detection of extraterrestrial life by means of 'J' bands	Kay,R Walwick,E	Aeronutronic							X
NASr-86 (Roman/Ott) Investigate spectrographically, in space environment, the solar UV radiations	Rense,W	U Colo		X					
NASr-87 (Weldon/Moore) Radio astronomy research on millimeter wave lengths	Straiton,AW	U Texas						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NASr-91 (Jacobs) Study of the pocket mouse as an experimental organism for space biology	Lindberg,RG	Northrop Corp							X
NASr-101 (Weldon/Moore) Design and develop microwave spectral line radiometer for taking simultaneous measurements from space probes of planetary atmospheres, over 18-34 KMc range, using a single antenna	Barrett,AH	MIT			X				
NASr-116 (Cahill/Brown) Experimental and theoretical investigation of geomagnetically trapped particles	McIlwain,CE	UCSD					X		
NASr-146 (Jacobs) Bioinstrumentation for circadian rhythms study (hamsters and drosophlia)	Goodman,R	Franklin Inst							X

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-24 (Suppl 3) (Seddon)									
Continue to study the total electron content of the ionosphere and small scale irregularities in the F region by Faraday rotation and differential Doppler measurements	Swenson,GW,Jr Yeh,KC	U Ill				X			
NsG-29 (Suppl 1) (Moore)									
Research on problems of satellite and planetary motion	Brouwer,D	Yale U	X						
NsG-30 (Suppl 2) (Seddon)									
Continuation of present program of data collection and analysis in support of the S-66 and other satellites with suitable transmissions. Faraday rotation and differential Doppler measurements are used for electron content determinations and observations on irregularities.	Helliwell,RA Garriott,OK	Stanford U				X			

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-54 (Suppl 2) (Seddon) Continue the study of antipodal propagation by rotating interferometer to determine bearing and elevation of signals. Determine electron density profiles by measuring bearing, elevation and Doppler shift	Titheridge,JE	U Auckland New Zealand				X			
NsG-56 (Allenby/Fryklund) Improve our knowledge of the geology, geochemistry, and geophysics of the moon	Brown,H	CIT						X	
NsG-57 (Suppl 1) (Bryson/Allenby) Research on tektites and meteorites, and radiation damage in related silicate materials. Study nature, distribution, composition, and properties of various metallic and non-metallic phases in the meteorites	Cohen,AJ Massalski,TB	Mellon Inst						X	
NsG-58 (Dubin/Alexander) Detailed theoretical studies of interplanetary dust and gas utilizing available data and newly-acquired information from direct space probe measurements	Singer,SF Opik,EJ	U Md			X				
NsG-64 (Suppl 1) (Moore) Research program for the study of infrared instrumentation for thermal photography of the moon	Menzel,DH	Harvard U						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-69 (Suppl 4) (Moore/Weldon)									
Design and construct TV system with telescopes for use above Earth's atmosphere	Schwarzschild,M	Princeton U			X			X	/
NsG-81 (Quimby)									
Conduct research, design and test a device ("multivator") comprising a variety of reagents, for detection of the presence of microbes. Also, cytochemical studies of planetary microorganisms	Lederberg,J	Stanford U							X
NsG-82 (Suppl 1) (Roman/Gill)									
Theoretical studies of the steady state interaction of matter and radiation in stellar atmospheres	Wildt,R	Yale U	X						
NsG-89 (Moore/Allenby)									
Multicolor photoelectric photometry of the moon and planets	Menzel,DH de Vaucouleurs,G	Harvard College							X
NsG-92 (Suppl 1 and 2) (Roman/Ott)									
Research on new techniques by which to investigate solar phenomena	Zirin,H Warwick,J	UCAR (HAO)	X						

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-96 (Suppl 2) (Liddel)									
Investigate the theoretical aspects of magneto-hydrodynamic phenomena in space	Parker,EN	U Chicago					X		
NsG-97 (Suppl 1) (Allenby/Fryklund)									
Studies of inert gases in meteorites; X-ray diffraction studies of meteorites	Arnold,JR Suess,HE Arrhenius,GOS	UCSD						X	
NsG-101 (Suppl 1) (Quimby)									
Studies on reflection spectra, meteorite analysis, and chemical evolution	Calvin,M Weaver,H	UC Berkeley							X
NsG-103 (Jenkins)									
Program of research in space genetics	DeBusk,AG	Florida St U							X
NsG-104 (Suppl 1) (Quimby)									
Detection, collection and study of micro-organisms existing in the upper atmosphere	Oswald,W Elberg,S	UC Berkeley							X
NsG-109 (Naugle)									
High altitude balloon monitoring for cosmic rays and solar terrestrial phenomena	Winckler,JR Ney,EP	U Minn					X		

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-113 (Roman/Ott)									
Investigate properties of the interstellar dust	Greenberg,J	RPI	X						
NsG-114 (Seddon)									
Continue research to determine the electron content of the ionosphere by Faraday rotation and differential Doppler measurements on satellite signals and studies of the seasonal, diurnal, and other variations of the electron content and equivalent slab thickness	Ross,WJ	Penn St U				X			
NsG-119 (Allenby/Fryklund)									
Study of possible lunar materials under bombardment by energetic protons and soft X-rays in a vacuum system	Gold,T	Cornell U						X	
NsG-120 (Suppl 1) (Roman/Gill)									
Investigate generation and detection of ultra-long X-rays and quantitative studies of their interactions with matter	Wyckoff,R	U Ariz		X					
NsG-126 (Jenkins)									
Experimental and theoretical studies of the growth and biochemical activities of terrestrial microorganisms in simulated planetary environments	Sagan,C Scher,S	UC Berkeley						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-127 (Allenby/Easter) Elemental chemical analysis by the technique of alpha particle scattering	Turkevich,A	U Chicago						X	
NsG-129 (Weldon/Brown) Research concerning electromagnetic-scatter theory	Koepsel,WW	U NMex						X	
NsG-134 (Suppl 1) (Schmerling/Bourdeau) Scientific portion of the program to develop the separating capsule experiment which is designed to give accurate, high-resolution electron densities by sending signals between the rocket and the separated capsule	Nisbet,JS	Penn St U				X			
NsG-135 (Moore) Study on zodiacal light selected lines in the airglow spectrum (icw R-18)	Steiger,WR	U Hawaii	X	/					
NsG-136 (Suppl 1)(McDonald) Research on physics of solar flares and the relationships of solar corpuscular emissions to optical and radio features of the sun	Warwick,JW Athay,RG	U Colo		X					

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-142 (Suppl 2) (Moore/Weldon)									
Continual photographic patrol and study of the physical conditions of the moon and planets	Tombaugh,CW	NMex St U						X	
NsG-151 (Suppl 1) (Liddel)									
Theoretical investigation of magnetic fields and energetic charged particles in planetary exospheres and interplanetary space	Davis,L	CIT					X		
NsG-153 (Taylor/Horowitz)									
Basic experimental research leading to improved cold electron sources and new types of velocity filter mass spectrometers	Testerman,MK	U Ark			X				
NsG-158 (Fellows/Miller)									
Research in fundamental atom chemistry with application to the chemistry of the upper atmosphere	Harteck,P	RPI			X				
NsG-161 (Moore/Weldon)									
Selenodetic and physical studies of the lunar surface	Kuiper,GP	U Ariz						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-162 (Suppl 1) (Naugle)									
Conduct investigation of the abundance of helium isotopes and other selected nuclei in low-energy primary cosmic radiation	Kaplon,MF	U Rochester					X		
NsG-163 (Suppl 1) (Levine)									
Theoretical research in relativity, cosmology and the physics of stellar interiors	Hughes,VW	Yale U		X					
NsG-165 (Suppl 1) (Levine)									
Conduct theoretical study of the forces acting on bodies in rarefied ionized environments	Abele,M	Polytechnic Inst of Brooklyn				X			
NsG-171 (Roman/Gill)									
Theoretical research on the collisions of particles in the interstellar gas	Joseph,J	St John's U	X						
NsG-173 (Quimby)									
Space Bioscience Institute	Fox,S	Florida St U							X
NsG-176 (Schmerling)									
Theoretical investigation of the interaction of solar flare particles with coronal plasma	Oster,L	Yale U					X		

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-179 (Cahill/McDonald/Ludwig) Experimental and theoretical studies of energetic particles and electrodynamical processes in interplanetary space and in the vicinity of planets	Simpson,J	U Chicago					X		
NsG-181 (Suppl 1) (Moore) Conduct research on space probe techniques for possible measurements of electromagnetic phenomena	Haddock,FT	U Mich	X			✓			
NsG-185 & Suppl 1 and 2 (Cahill/Fichtel) Determine some characteristics of high altitude primary cosmic radiation at low and/or southern latitudes	Friedlander,MW	Washington U					X		
NsG-192 (Easter/Allenby) Conduct research on methods of improving the sensitivity and reliability of gas chromatographs	Lipsky,SR	Yale U						X	
NsG-193 (Dubin/Depew) Rocket and laboratory experiments and analysis of the UV spectra of the upper atmosphere (1000 - 2400 Å)	Dieke,GH	JHU			X				
NsG-196 (Fryklund/Allenby) X-ray diffraction studies of lunar-like material	Hess,H	Princeton U						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-201 (Suppl 1) (Cahill/Naugle)									
Interpretive and theoretical study of ring current effects and geomagnetic field phenomena	Akasofu,S Chapman,S	Geophysical Inst Alaska					X		
NsG-208 (Quimby)									
Studies on extremely small self-replicating systems	Morowitz,H	Yale U							X
NsG-211 (Quimby)									
Detection and identification of organic matter by mass spectrometry	Biemann,K	MIT							X
NsG-216 (Allenby/Fryklund)									
Theoretical calculations on the internal structure of the planets and the structure of their atmospheres	MacDonald,GJF	UCLA						X	
NsG-217 (Fellows)									
Photochemistry in the far UV	Taylor,HA	NYU			X				
NsG-218 (Quimby)									
Produce and study "probiological systems" or precellular chemical systems incapable of reproduction but which may carry out complex metabolism	Blois,S Pattee,H	Stanford U							X

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-219 (Dubin/Alexander) Radar investigation of the variations in the rate of incidence of meteors on the Earth at high incident rates	Ellyett,C	U Canterbury, New Zealand			X				
NsG-220 (Schmerling/Gracely) Theoretical studies in the following areas of low density plasma physics: Waves in a plasma and instabilities; Structure of shock waves; Radiation processes in plasmas; and Applications to space physics	Harris,I	U Md				X			
NsG-222 (Bryson/Fryklund) Research on tektites; Determine amount of trace elements in tektites of the MIT meteorite collection	Pinson,WH	MIT						X	
NsG-223 (Moore) Research in planetary and stellar spectroscopy, including studies of the IR spectra of diatomic molecules, and of techniques for the detection and analysis of extremely tenuous planetary atmospheres	Meinel,AB	U Ariz	/		X				

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-224 (Weldon/Moore)									
Study of polarization of the decametre-wave radiation from Jupiter	Barrow,CH	Florida St U		X					
NsG-226 (Quimby)									
Synthesis of porphine-like substances from simple precursors under primeval conditions	Szutka,A	U Detroit							X
NsG-230 (Quimby)									
Development of microspectrophotometric instrumentation for the study of pigments and organic molecules within living cells	Wolken,J	Pittsburgh U							X
NsG-231 (Jenkins)									
Investigation of the effects of plant growth hormones on plant development in the absence of gravitational effects	Lyon,CJ	Dartmouth College							X
NsG-232 (Allenby/Fryklund)									
Study of the abundance and composition of cosmic dust and cosmic spherules found in ocean sediments	Ewing,M Cassidy,WA	Columbia U (Lamont Geological Obsv)						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-233 (Cahill) Theoretical and experimental studies related to the particles and fields associated with the major bodies of the solar system and with interplanetary space	Van Allen,JA	SUI					X		
NsG-246 (Bryson/Fryklund) Study of lunar craters	Hawkins,GS	Boston U						X	
NsG-249 (Liddel) Design, develop, and construct a single flight prototype of a low energy proton detector	Farley,TA	UCLA					X		
NsG-250 (Weldon/Moore) Theoretical investigation of the microwave properties of Venus	Barrett,AH	MIT			X				
NsG-255 (Smith) Infrared planetary observatory in the stratosphere (joint with Princeton NASr-113)	Weaver,H Sagan,C	UC Berkeley							X
NsG-256 (Allenby/Fryklund) Investigate feasibility of, and design equipment capable of, performing neutron activation analysis of the lunar surface	Wainerdi,RE	Texas A&M						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-257 (Quimby) Synthesize purines and pyrimidines under possible primitive earth conditions	Oro,J	U Houston							X
NsG-258 (Weldon/Moore) Develop a submillimeter interference spectrometer	Rivers,WK,Jr	Ga Inst of Tech			X				
NsG-259 (Jacobs) Experimental investigation of human circadian rhythms, including consideration of natural and artificial Zeitgeber	Aschoff,J	Max-Planck Inst, Germany							X
NsG-261 (Weldon/Moore) Laboratory investigations of the composition and chemical behavior of the Venus atmospheres	Harteck,P	MIT			X				
NsG-263 (Fellows) Quantum mechanical calculations and studies on atomic systems of astrophysical interest	Matsen,FA Scherr,CW	U Texas			X				
NsG-264 (Moore) Experimental investigation of the terrestrial atmosphere utilizing balloon-borne millimeter radiometers	Barrett,AH Graham,W Rafuse,RP	MIT			X				

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-269 (Holloway/Holmes) Fundamental research in earth and planetary sciences	Berkner,LV	GRCSW						X	
NsG-271 (Jenkins) Physiological affects of weightlessness and space radiations on hibernators	Musacchia,XJ	St Louis U							X
NsG-276 (Ott/Roman) Research on image converters for OAO	Burns,J	U Chicago	X						
NsG-278 (Belleville) Basic research on interspecies communications high sonic frequencies (4kc & above) are of prime concern	Lilly,JC	Communication Res Inst, Fla & Virgin Islands							X
NsG-280 (Moore) Theoretical study of periodic motion and stability in the restricted problem of three bodies	Bartlett,JH	U Ill	X						
NsG-281 (Cahill/Gracely) Analytical and experimental research in galactic and solar cosmic radiation, trapped radiation, and zodiacal light	Winckler,JR Ney,EP	U Minn					X		

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-282 (Fryklund/Allenby) Study of the minor and accessory constituents of stony meteorites in the Harvard meteorite collection	Frondel,C	Harvard U						X	
NsG-283 (McDonald) Techniques for extraterrestrial measurement of low energy charged particle fluxes in the interplanetary plasma	Wilkerson,TD	U Md					X		
NsG-286 (Moore/Horowitz) Experimental research on mass spectrometer techniques for the study of planetary atmospheres	Nier,A	U Minn			X				
NsG-287 (Roman/Gill) Investigate wave functions and transition probabilities for light atoms	Greene,L	Haverford College	X						
NsG-288 (Gill/Roman) Ground-based investigation of solar phenomena and solar monitoring	Miller,RA	Manila Obsv		X					
NsG-291 (Dubin/Moore) Systematic in-flight photography and subsequent recovery of meteorites	Whipple,FL	SAO			X			/	X

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-295 (Jacobs) Investigate biological effect of chronic exposure to artificial atmospheres	Hiatt,EP	Ohio St U							X
NsG-297 (Moore/Weldon) Determine the unevenness of the lunar surface by photographing the shadows cast by irregularities	Kopal,Z	U of Manchester England						X	
NsG-300 (Jacobs) Study alterations in cell membrane permeability, bacteriological pathogenicity in animals exposed to simulated altitudes, rare gases and ionizing radiation	Clark,RT	Okla City U							X
NsG-301 (Roman/Gill) High precision spectroscopy	Andrew,KL	Purdue Research Foundation	X						
NsG-303 (Fryklund/Allenby) Develop reliable and ultra-sensitive magnetometers to make magnetic measurements of lunar rocks	Vacquier,V	UCSD						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-304 (Fellows/Miller)									
Laboratory and theoretical studies in the application of chemical release techniques to investigations of the upper atmosphere	Edwards,HD	Ga Inst of Tech			X				
NsG-308 (Ott/Roman)									
Investigate the properties and design criteria of multilayer optical filters	Baumeister,W	U Rochester	X						
NsG-311 (Gill/Roman)									
Investigate techniques for rocket-borne spectrographic studies of the solar UV spectrum (950 to 1050Å) and use of a prototype instrument for laboratory studies of the absorption of such radiation by nitrogen and oxygen	Violett,TD	Western St College of Colo	X						
NsG-312 (Allenby/Fryklund)									
Theoretical studies of the internal constitution of the planets with emphasis on the Jovian planets	Wildt,R	Yale U						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-313 (Fryklund/Allenby) Investigate the isotopic chemistry of meteorites	Wetherill G	UCLA						X	
NsG-314 (Fryklund/Allenby) Study the solid phases of noble gases and hydrogen, methane, ammonia, and CO_2 at high pressures	Kennedy,GC	UCLA						X	
NsG-317 (Allenby/Fryklund) Study of the petrography and composition of meteorites, and of the effects of shock waves on rock	Arrhenius,GOS	UCSD						X	
NsG-319 (Allenby/Fryklund) Determine the relative abundances of eleven trace elements in various meteorites	Goles,GG	UCSD						X	
NsG-320 (Roman/Gill) Monitor solar chromosphere	Gaizauskas,V	Dominion Obsv Canada		X					
NsG-321 (Allenby/Fryklund) Study the interaction of meteorites and cosmic rays and consider the origin and history of meteorites	Arnold,JR	UCSD						X	

SUPPORTING RESEARCH

Project Designation and Contacts	Investigators	Affiliations	A	SP	PA	IRP	PF	P	B
NsG-322 (Allenby/Fryklund) Determine cosmic abundance of elements	Suess,HE	UCSD						X	
NsG-323 (Allenby/Fryklund) Study the relative isotopic abundances of various elements in meteorites, extract and study the inert gases in meteorites, and determine meteorite ages	Urey,HC	UCSD						X	
NsG-324 (Jacobs) Physics of cellular synthesis, growth and division	Pollard,EC	Penn St U							X
NsG-328 (Ott/Roman) Investigate emission, conductivity, and luminescence properties of solid materials	Pong,W	U Hawaii	X						
NsG-329 (Weldon) Radio propagation techniques for the study of planetary ionospheres and interplanetary medium	Garriott,OK	Stanford U				X			

Supporting Research

Agency	Area	Level of Effort (FY63)	Principal Investigators
Langley Research Center	Geophysics-related to lunar work	$125,000	J.E. Stitt G.W. Brooks C.H. Nelson
	Planetary astronomy	70,000	C.H. Nelson
	Planetary Atmospheres	75,000	R. Hord
Lewis Research Center	Planetary Atmospheres	103,000	A. Potter
Marshall Space Flight Center	Tektite studies	5,000	E. Adams R. Huffaker
Flight Research Center	Planetary Atmospheres	20,000	M.A. Covington
Ames Research Center	Astronomy	200,000	J. Miller G. Augason
	Tektite studies	14,000	D.R. Chapman
	Micrometeorite detector	15,000	V. Rogallo
	Hypervelocity impact studies	10,000	D.E. Gault

Agency	Area	Level of Effort (FY63)	Principal Investigators
Langley Research Center	Geophysics-related to lunar work	$125,000	J.E. Stitt G.W. Brooks C.H. Nelson
	Planetary astronomy	70,000	C.H. Nelson
	Planetary Atmospheres	75,000	R. Hord
Lewis Research Center	Planetary Atmospheres	103,000	A. Potter
Marshall Space Flight Center	Tektite studies	5,000	E. Adams R. Hullaker
Flight Research Center	Planetary Atmospheres	20,000	M.A. Covington
Ames Research Center	Astronomy	200,000	J. Miller C. Augason
	Tektite studies	14,000	D.R. Chapman
	Micrometeorite [illegible]	15,000	V. Rodallo
	[illegible]	[illegible],000	[illegible] Gault

Supporting Research

Agency	Area	Level of Effort (FY63)	Principal Investigators
Ames Research Center (Contd.)	Planetary Atmospheres	$ 80,000	G.C. Augason J.H. Miller
	Exobiology	646,000	H. Frommhagen H. Ginoza J. Miquel R. Painter C.A. Ponnamperuma J. Shapira H.J. Trurnit R.S. Young L.P. Zill
	Physical Biology	355,000	H. Leon K. McDonald R. Schiffman K. Yokoyama D.R. Young
	Behavioral Biology	188,000	J. Beasley R. Grindeland J. Huertas W. Mahler J. Shapira T. Verhave N. Weissman
	Environmental Biology	582,000	C.C. Conley D.D. Feller H.A. Leon J. Miquel J. Oyama M. Parrott S.T. Taketa R.S. Young

Supporting Research

Agency	Area	Level of Effort (FY63)	Principal Investigators
Goddard Space Flight Center	Solar Physics	$ 457,400	J. Gilbert J.C. Lindsay
	Meteorite and micrometeorite studies	383,500	M. Alexander M. Lipschutz O. Berg
	Tektite studies	70,000	J. O'Keefe P. Lowman B. Shute L. Walter
	Space chemistry	89,000	B. Donn
	Lunar studies	15,000	P. Lowman L. Walter W. Cameron J. O'Keefe
	Planetary Atmospheres	1,055,300	W.M. Alexander B. Donn A. Levine J. Gilbert N. Spencer A. Temkin
	Astronomy	133,600	A. Boggess L. Dunkelman J. Milligan
	Astrophysics	135,600	A.L. Levine

Supporting Research

Agency	Area	Level of Effort (FY63)	Principal Investigators
Goddard Space Flight Center (Contd.)	Ionospheres & Radio Physics	$353,100	J.A. Kane A.L. Levine K.W. Ogilvie R.G. Stone H.A. Whale E.C. Whipple, Jr.
	Theoretical Studies on Cosmic Rays	14,000	A.L. Levine
	Theoretical Studies in Particle Motion	30,000	J. Gilbert
	Development of Particle Detectors	671,000	F.B. McDonald
	World Magnetic Survey Theoretical Studies	56,000	J.C. Cain
	Theoretical Studies in Magnetic Fields	38,000	I. Harris
	Theoretical Studies in Magnetohydrodynamics and Magnetic Fields in Space	92,000	A.L. Levine
	Advanced Magnetometer Development	101,400	N.F. Ness

Supporting Research

Agency	Area	Level of Effort (FY63)	Principal Investigators
Jet Propulsion Laboratory	Geology-lunar studies	$100,000	R. Speed
	Geology-other planets	100,000	H.W. Washburn
	Geophysics-lunar studies	82,000	H.W. Washburn
	Geochemistry-lunar studies	67,000	H.W. Washburn
	Planetary Atmospheres	428,000	C. Barth F. Estabrook H. Ford R.L. Heacock L. Kaplan H. Trostle H.W. Washburn
	Astronomy	40,000	H. Spinrad
	Exobiology	774,000	D. Croissette R.L. Heacock G. Hobby J. Soffen H.W. Washburn