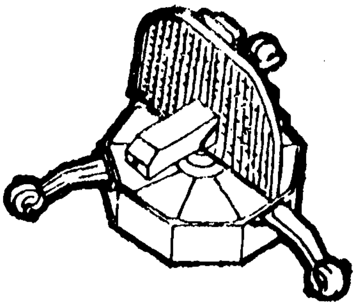
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

TELS. WO 2-4155
WO 3-6925

FOR RELEASE: SUNDAY
August 3, 1969

RELEASE NO: 69-112

PRESS KIT



PROJECT: OSO-G

contents

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NEWS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 TELS: (202) 962-4155 (202) 963-6925

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SIXTH ORBITING SOLAR OBSERVATORY

The sixth spacecraft in the Orbiting Solar Observatory (OSO) program is scheduled to be launched by the National Aeronautics and Space Administration no earlier than August 8, 1969 at 3:52 a.m. EDT, from Cape Kennedy, Fla.

Designated OSO-G (to be called OSO 6 if orbit is achieved), the 640-pound, spin-stabilized observatory will be launched by a two-stage Delta N rocket. The planned orbit is circular, 350-statute miles above the Earth, with an inclination of 33 degrees to the Equator and an orbital period of 96 minutes.

OSO-G carries seven different scientific experiments weighing a total of 227 pounds. Providing the experiments are the Harvard College Observatory, Rutgers University, the University of New Mexico, the Italian University of Bologna, the University College London, the U. S. Naval Research Laboratory and the Los Alamos Scientific Laboratories.

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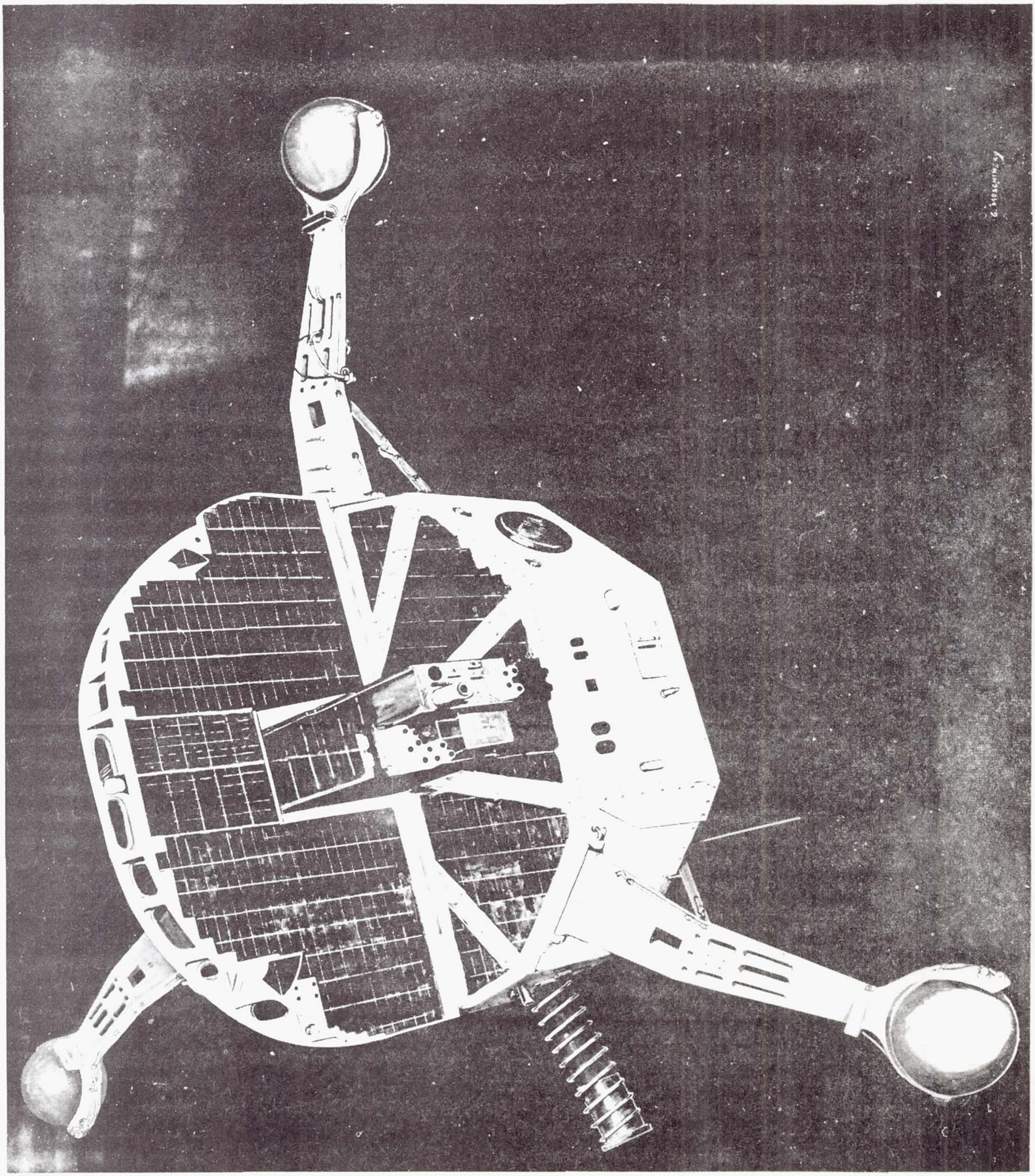


As the first series of spacecraft designed exclusively to study the Sun, the OSOs are the most important aspect of NASA's Solar Physics Program.

The program, begun in March 1962 with the launching of OSO 1, consists of eight spacecraft.* Studies are currently underway to add three advanced observatories to the program.

Understanding the mechanics of the Sun is of vital importance not only to science but to all of mankind. This is because the Sun dominates our existence and sustains life on Earth. Only a slight increase in its energy could melt the polar ice caps and submerge all the major cities of the world. A slight decrease in its energy could bring about another ice age. Solar storms disrupt communications and navigation systems. The enormous gravitational attraction of the Sun affects everything in the solar system.

Study of the Sun by ground-based instruments is hampered--and in some cases impossible--because of the Earth's atmosphere which screens out major portions of the Sun's radiation. Thus, the Sun must also be observed from above the atmosphere if the complete nature of solar radiation, particularly in the ultraviolet, X-ray and gamma-ray regions, is to be determined and correlated.

*OSO 3, launched August 25, 1965, did not achieve orbit.

The experiments carried by OSO-G, as a continuation of earlier OSO scientific objectives, are designed to study evolutionary changes in various features of the Sun, with special emphasis on solar active regions. These experiments will operate during a time of near peak activity in the current 11-year solar cycle.

A new feature of OSO-G is that for the first time in the program an OSO has the capability to perform an offset point and small offset raster scan to study in detail ultra-violet and X-ray spectra at any point on the solar disc and within a few arc minutes above the limb or edge of the Sun's disc.

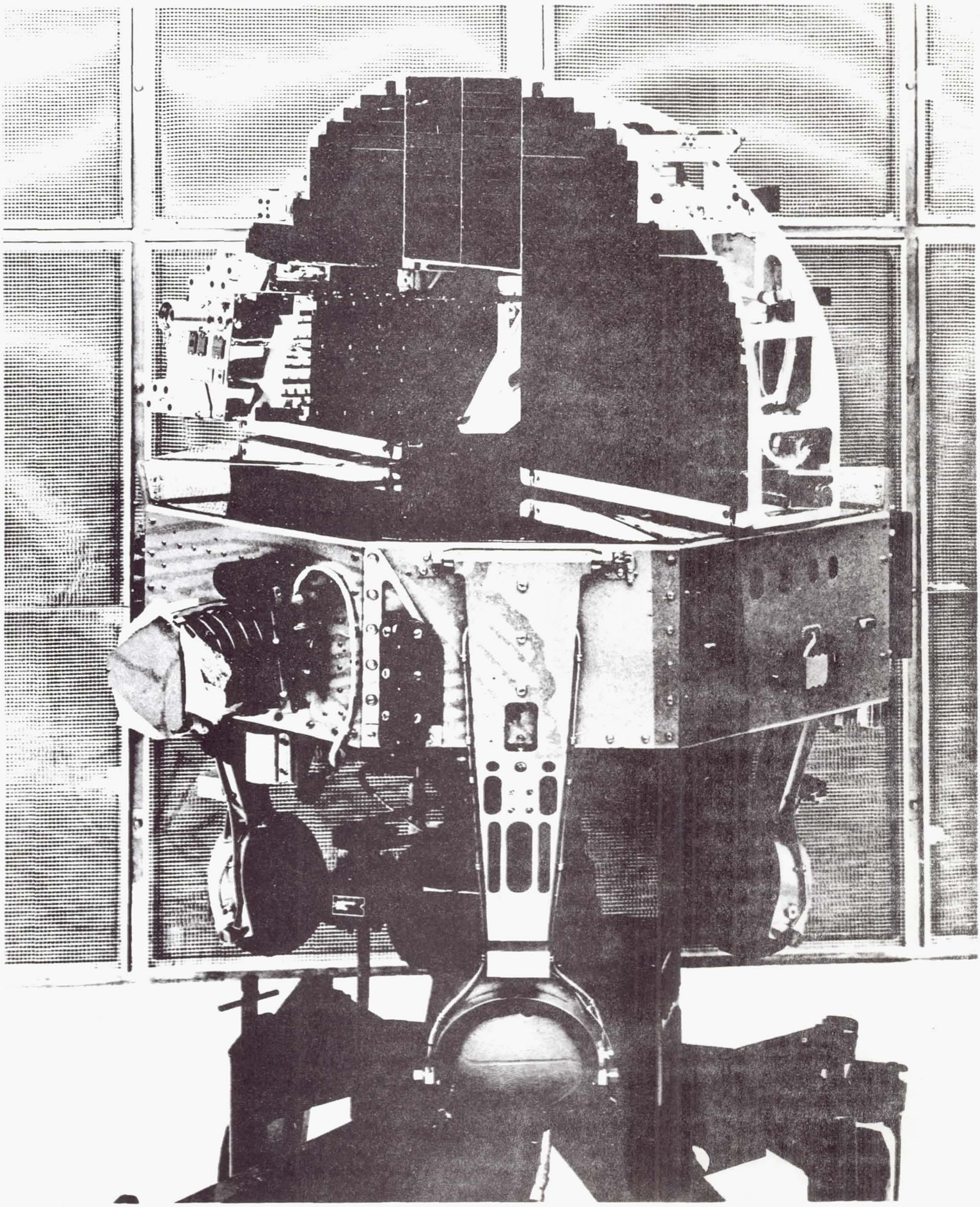
This capability, with its enhanced time and spatial resolution, should allow significant advances to be made in our knowledge of conditions in the Sun's chromosphere--the solar atmosphere--as well as in the corona--the outermost layer of the Sun visible only through special instruments or during a total solar eclipse.

As with its predecessors, the design lifetime of OSO-G is six months.

As was the case with earlier spacecraft in the series, OSO-G is designed in two sections: an upper sail-like structure which carries experiments to be pointed toward the Sun; and a nine-sided base section called the wheel which carries non-directional scanning experiments and the basic spacecraft support equipment.

The spacecraft is stabilized in orbit by its wheel section which spins like a gyroscope at about 30 rpm. When the spacecraft is in view of the Sun, the sail section automatically points toward it. Simultaneously, the spin axis of the spacecraft is maintained roughly perpendicular to the direction of the Sun by using gas jets and a magnetic coil. The pointing accuracy of OSO is better than one minute of arc. This is roughly equivalent to sighting a globe 18 inches in diameter from a distance of one mile.

The first two OSO spacecraft were launched successfully from Cape Kennedy on March 7, 1962 (OSO 1) and February 3, 1965 (OSO 2). The third OSO, launched August 25, 1965, failed to orbit. A fourth OSO (OSO 3) was successfully launched March 8, 1967. OSO 4 was launched successfully October 18, 1967, and it was followed by OSO 5 on January 22, 1969.



Both OSO 1 and 2, surpassed their designed lifetimes and together provided more than 8,600 hours of scientific information including the first long duration observations of the X-ray and ultraviolet spectra of the Sun.

OSO 3 recently passed its second year in orbit and continues to operate well. The satellite is now providing seven and one-half hours of real time data daily.

OSO 4 recently passed its 20th month of successful operation and is also providing seven and one-half hours of real time data daily.

OSO 5 has been operating successfully in orbit for six months. The spacecraft, including both tape recorders and seven of eight experiments continues satisfactory operation.

OSO-H is scheduled to be launched late in 1970.

The OSO program is directed by Physics and Astronomy Programs, Office of Space Science and Applications, NASA Headquarters, Washington, D.C. Project management is under the Goddard Space Flight Center, Greenbelt, Md., which is also responsible for the tracking and data acquisition and the Delta launch vehicle. Launch of the Delta is supervised by Kennedy Space Center's Unmanned Launch Operations (ULO).

The OSO spacecraft are designed and built by Ball Brothers Research Corp., Boulder, Colo. The Delta launch vehicle is built by McDonnell-Douglas Astronautics Co., Santa Monica, Calif.

END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS

OSO: THE ENGINEERING FEATURES

The OSO program pioneered the observatory satellite concept. In the process it has achieved a major success for space astronomy. It has been estimated that each OSO obtained about the same amount of information on the Sun as would be obtained from the launch of 12,000 sounding rockets.

The OSO-G spacecraft consists of two major sections: a sail, carrying two pointed experiments which always face the Sun, and a wheel with three arms which rotates at 30 rpm to stabilize the spacecraft. The wheel section carries five experiments.

The sail, approximately semicircular in shape, is 23 inches high and 44 inches wide. It is covered with light-sensitive solar cells to charge the on-board batteries. The wheel, built of aluminum, is 44 inches in diameter, and attached to the sail section by a bearing lubricated shaft. The wheel section, in addition to the five experiments, carries telemetry and other satellite subsystems.

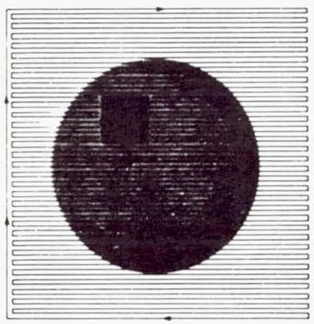
Nitrogen gas jets in the three arms maintain the proper wheel rotation rate. Since the instruments in the wheel view the Sun every two seconds (when the spacecraft is in sunlight) and the rest of the sky at other times, they also are able to make comparative measurements of solar and spatial phenomena.

Pointing, Scanning Characteristics

An important OSO-G first to the program is that it will have the additional capability to offset point to any of the 16,384 points on a 128 x 128 point grid pattern. It will also be able to perform a 7 x 7.5 arc-minute raster about any of these grid points.

OSO I and OSO III could only point directly at the center of the Sun. OSO II, IV and V could point at the center of the Sun and perform a scan across the solar disc.

OSO-G will have four point and scan modes of operation. In the first, called the pointed or oriented mode, the sail experiment instruments are kept pointed to the center of the Sun within one arc minute of the solar direction during the spacecraft day.



POINT MODE

(1) NORMAL ORIENTATION TO THE CENTER OF THE APPARENT SOLAR DISK, WITHIN ± 1 ARC MINUTE
(2) USED BY BOTH POINTED EXPERIMENTS ON SELECTED WAVELENGTHS AT CERTAIN TIMES

LARGE RASTER MODE

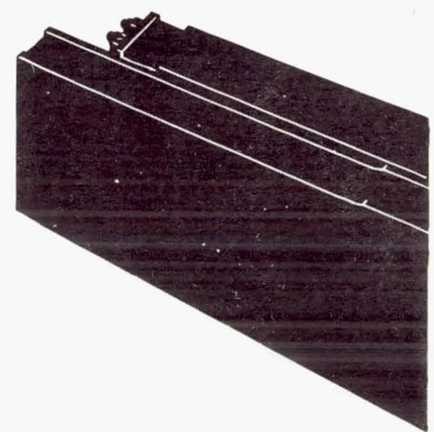
(1) ACTUATED BY GROUND COMMAND
(2) 64 LINES; 0.72 ARC MINUTE APART
(3) LINE SWEEP RATE: 46 ARC MINUTES PER 7.68 SECONDS
(4) TOTAL RASTER TIME: 491.52 SECONDS
(5) USED BY BOTH POINTED EXPERIMENTS ON SELECTED WAVELENGTHS AT CERTAIN TIMES

SMALL RASTER MODE

(1) ACTUATED BY GROUND COMMAND
(2) 16 LINES; 7 ARC MINUTES WIDE; 7½ ARC MINUTES HIGH
(3) LINE SWEEP RATE: 7 ARC MINUTES PER 1.92 SECONDS
(4) TOTAL RASTER TIME: 30.72 SECONDS
(5) CAN BE CENTERED ON ANY OFFSET POINT POSITION
(6) USED BY BOTH POINTED EXPERIMENTS ON SELECTED WAVELENGTHS

OFFSET POINT MODE

(1) ACTUATED BY GROUND COMMAND
(2) ANY POINT CAN BE SELECTED WITHIN A 128 BY 128 POINT GRID (16384 POINTS) THAT COVERS A SQUARE 46 BY 46 ARC MINUTES
(3) USED BY BOTH POINTED EXPERIMENTS ON SELECTED WAVELENGTHS AT CERTAIN TIMES



POINTED INSTRUMENT OPERATIONAL MODES

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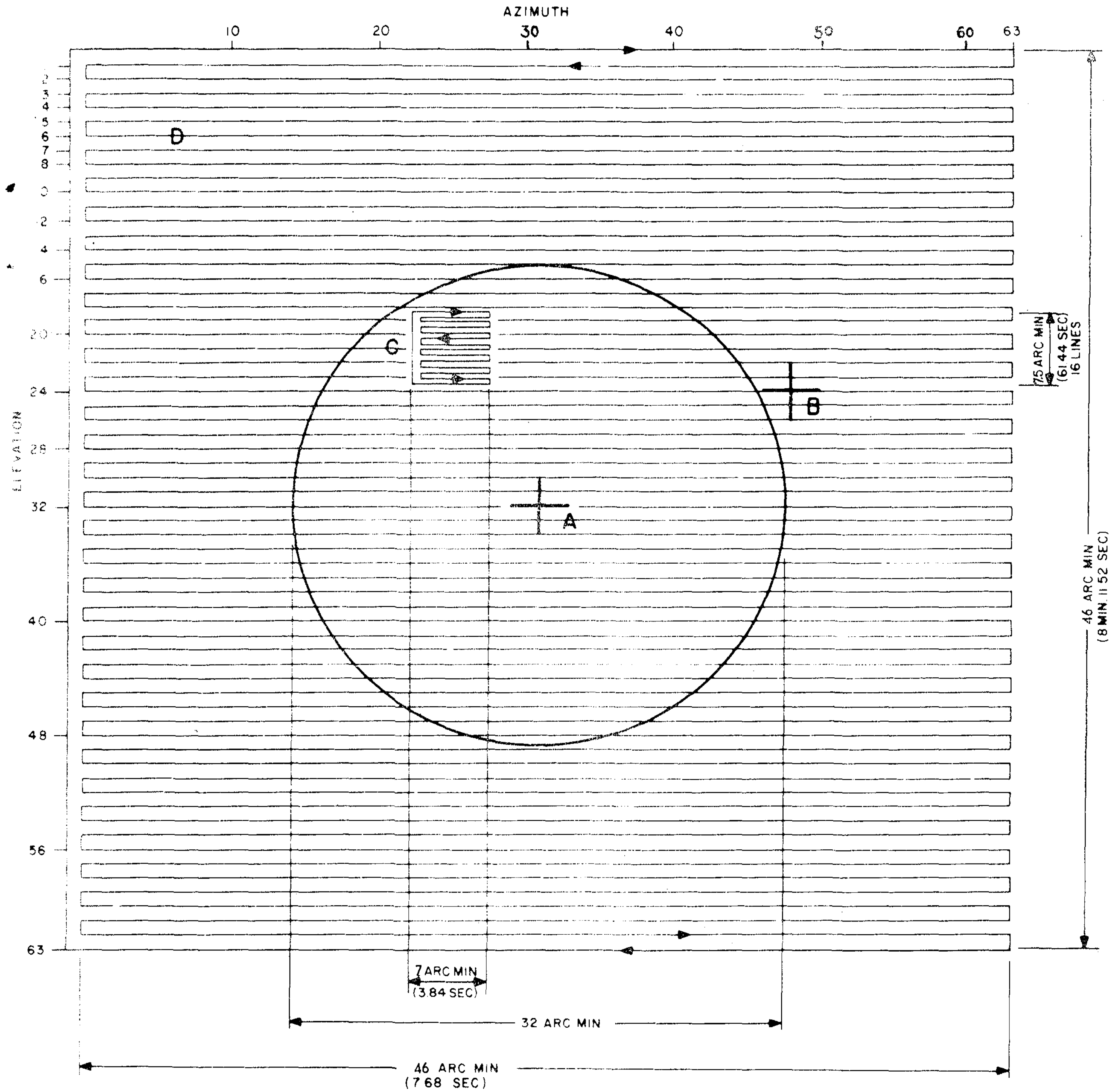


A = POINT MODE
B = OFFSET POINT 7.5' UP ELEVATION & 15' RIGHT AZIMUTH (24 BITS ELEVATION & 48 BITS AZIMUTH)
C = SMALL RASTER
D = LARGE RASTER

In the second, called the offset point mode, the sail experiment instrument will be pointed to any one of the 16,384 intersections on the 128 x 128 grid pattern which is centered on and covers more than the active solar disc.

In the third mode, called the large raster scan, the pointing section will perform a 46 (azimuth) x 46 (elevation) arc minute scan of the solar disc and corona.

In the fourth mode, called the offset scan, the pointing section will lock on to any of the 16,384 points on the grid pattern and perform a 7 (azimuth) x 7.5 (elevation) arc minute scan. The resolution of the large (46 x 46 arc minute) raster is 64 lines, whereas it is 16 lines for the small (7 x 7.5 arc minute) raster. The frame period for the large raster mode is 491.5 seconds (24 MF/line) and 30.72 seconds (6 MF/line) for the small raster.

OSO-G EXPERIMENTS

Two of the OSO-G experiments are located in the sail portion of the spacecraft and are designed to be pointed toward the Sun. The remaining five experiments are mounted in compartments of the nine-sided rotating wheel section and they will scan the solar disc every two seconds when the spacecraft is in sunlight.

Organizations providing OSO-G experiments include the Harvard College Observatory, Rutgers University, the University of New Mexico, the University of Bologna (Italy), the University College London (England), the U.S. Naval Research Laboratory, and the Los Alamos Scientific Laboratories. Individual experiment descriptions are listed below.

Dr. L. Goldberg, Harvard College Observatory -- Solar Ultraviolet Spectrometer-Spectroheliograph. To obtain the ultraviolet spectrum from 300Å to 1300Å and the spatial distribution of selected wavelengths.

R. W. Kreplin, Naval Research Laboratory -- Solar X-ray spectral, burst and mapping spectrometer. To measure solar X-rays in the 0.13 - 27Å wavelength region using a variety of instruments, some of which give high spectral resolution in the 0.6 - 25Å band.

Dr. A. L. Rouy, Rutgers University -- Zodiacal Light Polarimeter. Determine the brightness, polarization, and ellipticity of zodiacal light.

Dr. H. V. Argo, Los Alamos Scientific Laboratories -- Solar X-ray Emission Line Spectrometers. Observe solar X-ray emission lines in the 16 to 40Å spectral range.

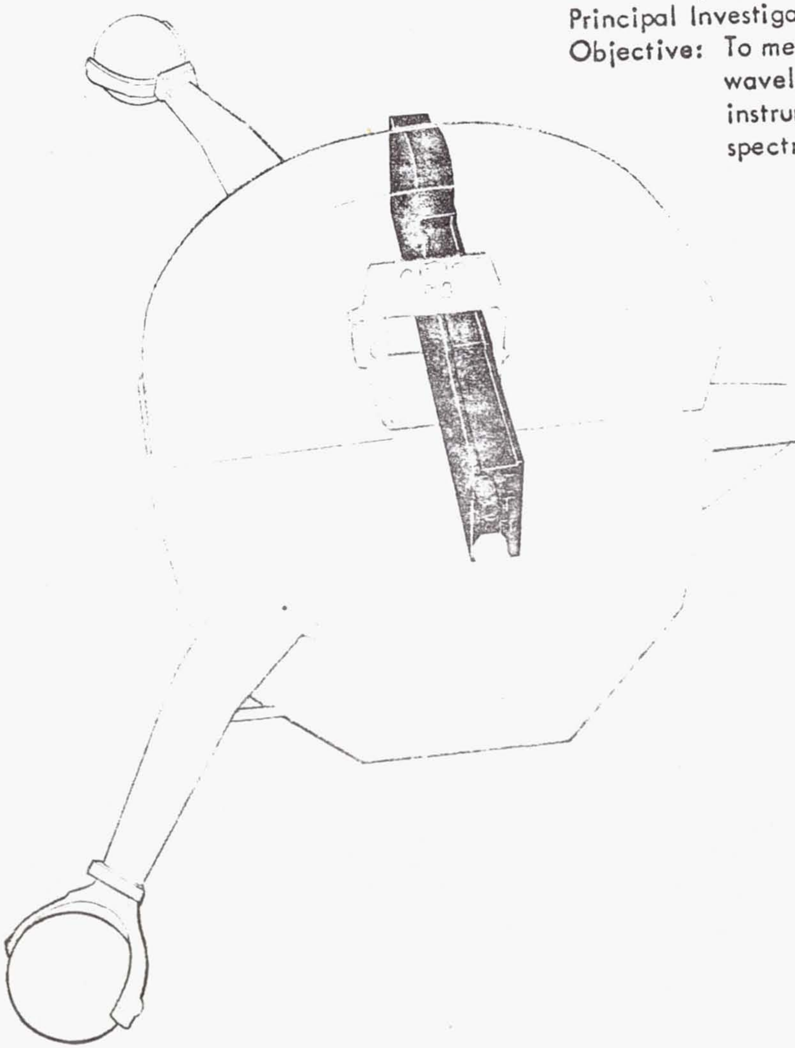
Dr. C. P. Leavitt, University of New Mexico -- High Energy Neutron Telescope. Determine high energy neutron flux in the 20 to 130 MeV energy range.

Dr. D. Brini, University of Bologna, Italy -- 20-200 KeV X-ray Telescope. Observe solar and cosmic X-rays in the 20 to 200 KeV range and measure the albedo in this range.

Dr. R. L. F. Boyd, University College, London, England -- Solar Ultraviolet Polychrometer. Study the MeI (584Å), HeII (304Å), O II (833Å), O IV (790Å), and N III (922Å) resonance line radiation.

- more -

Naval Research Laboratory
Solar X-ray Spectral, Burst, and Mapping Spectrometer
Principal Investigator: R. W. Kreplin
Objective: To measure solar X-rays in the 0.13 - 27Å wavelength region using a variety of instruments, some of which give high spectral resolution in the 0.6 - 25Å band.



Description: *Consists of four individual experiments: (1) pulse height analyzer, (2) Bragg spectrometer, (3) raster experiment, and (4) burst experiment.*
The pulse height analyzer uses a sodium iodide scintillator and a proportional counter to monitor rapid energy changes in the 2 to 90 kev (0.14 to 6 Å) region. The scintillator covers the high energy region of 20 to 90 kev and the PC covers the low energy region of 2 to 20 kev.

The Bragg spectrometer uses three crystal spectrometers to provide fine spectral resolution through the soft x-ray region of 0.6 to 25 Å. The ranges of the spectrometers are: 0.6 to 4 Å, 1.4 to 8.4 Å, and 18 to 25 Å. The photon flux passed by each crystal is measured by a geiger counter.

The raster experiment consists of three geiger counter detectors. One determines the photon spatial distribution in the 8 to 20 Å region. The second pinpoints hot spots in the 1 to 8 Å region. The third detects and measures the lateral velocity of flares in the 8 to 20 Å region.

The burst experiment uses two geiger counter detectors to monitor the solar disc for very short duration bursts in the 18 to 25 Å region and to detect cosmic background radiation in the 2 to 8 Å region.

LEFT HAND POINTED INSTRUMENT

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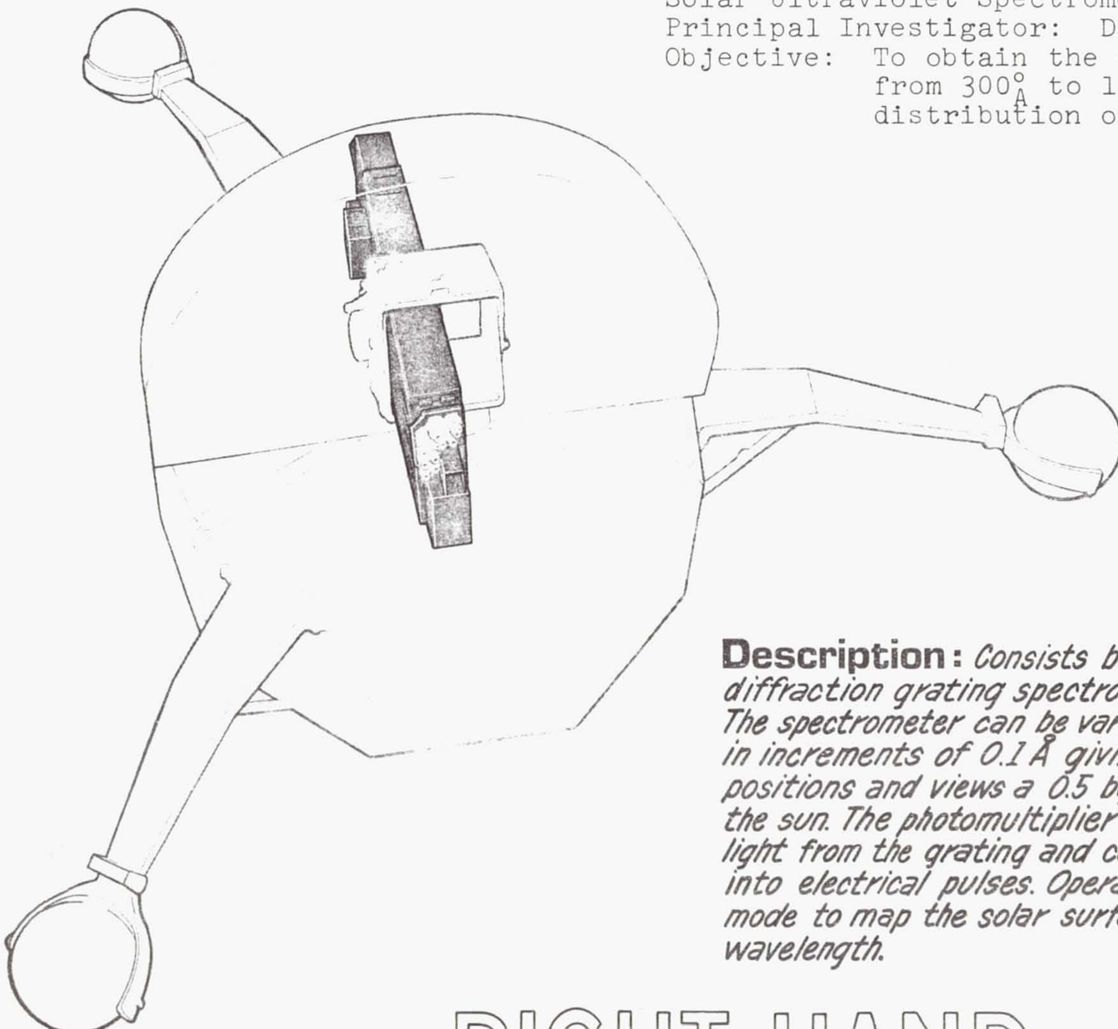
Harvard College Observatory
Solar Ultraviolet Spectrometer-Spectroheliograph
Principal Investigator: Dr. L. Goldberg
Objective: To obtain the ultraviolet spectrum from 300Å to 1300Å and the spatial distribution of selected wavelengths.



Description: *Consists basically of a rotating diffraction grating spectrometer and a photomultiplier. The spectrometer can be varied between 300 and 1,300 Å in increments of 0.1 Å giving about 10,000 discrete positions and views a 0.5 by 0.5 arc minute section of the sun. The photomultiplier receives the diffracted light from the grating and converts the photon energy into electrical pulses. Operated mostly in the raster mode to map the solar surface in any selected wavelength.*

RIGHT HAND POINTED INSTRUMENT

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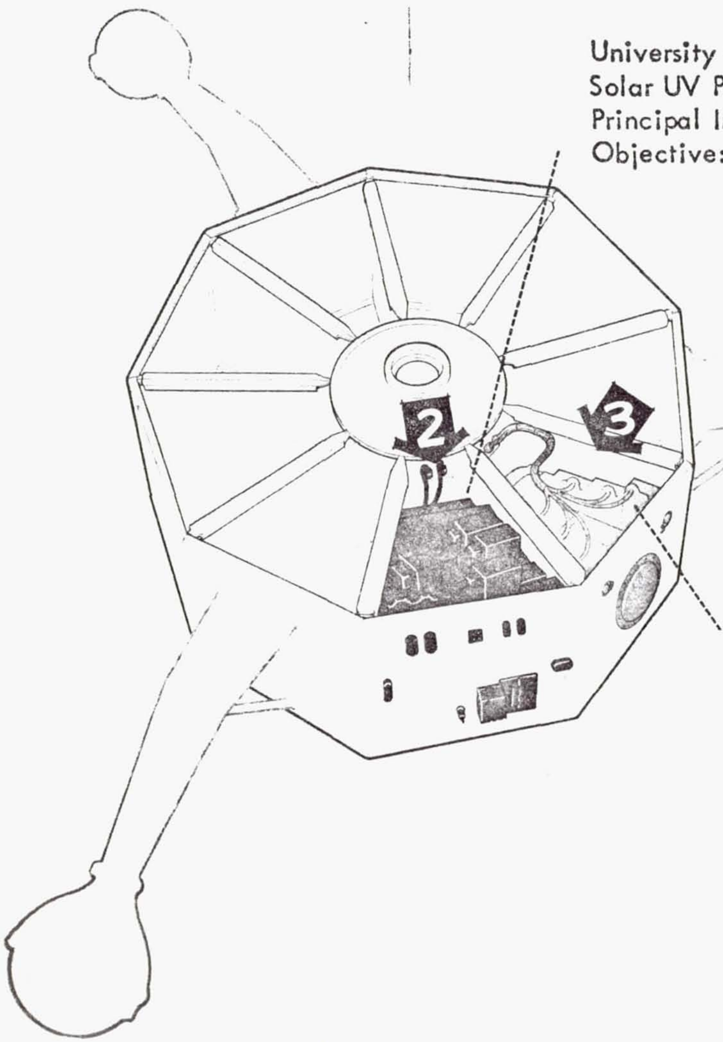

University College London
Solar UV Polychromator
Principal Investigator: R. L. F. Boyd
Objective: Study the He I (584Å), He II (304Å), O II (833Å), O IV (790Å), and N III (922Å) resonance line radiation.

Description: *Consists of a grating spectrometer and eleven channel electron multipliers (CEM's). Light enters and impinges on a diffraction grating and then passes through nine slits placed on a Rowland circle at positions corresponding to nine of the emission lines that are to be observed. The light intensity passing through the slits is then measured by nine CEM's. The other two CEM's are used to measure scattered light behind the spectrometer and background noise from high energy electrons.*

University of Bologna
20-200 Kev X-ray Telescope
Principal Investigator: D. Brini
Objective: Observe solar and cosmic X-rays in the 20 to 200 Kev range and measure the albedo in this range.

Description: *Consists of a sodium iodide scintillator detector and a photomultiplier. The scintillator converts entering x-ray protons into light pulses. The photomultiplier and logic circuits then convert these light pulses into electrical pulses in four ranges corresponding to photon energy ranges of 20 to 40, 40 to 70, 70 to 110 and 110 to 200 kev.*

WHEEL INSTRUMENTS-I

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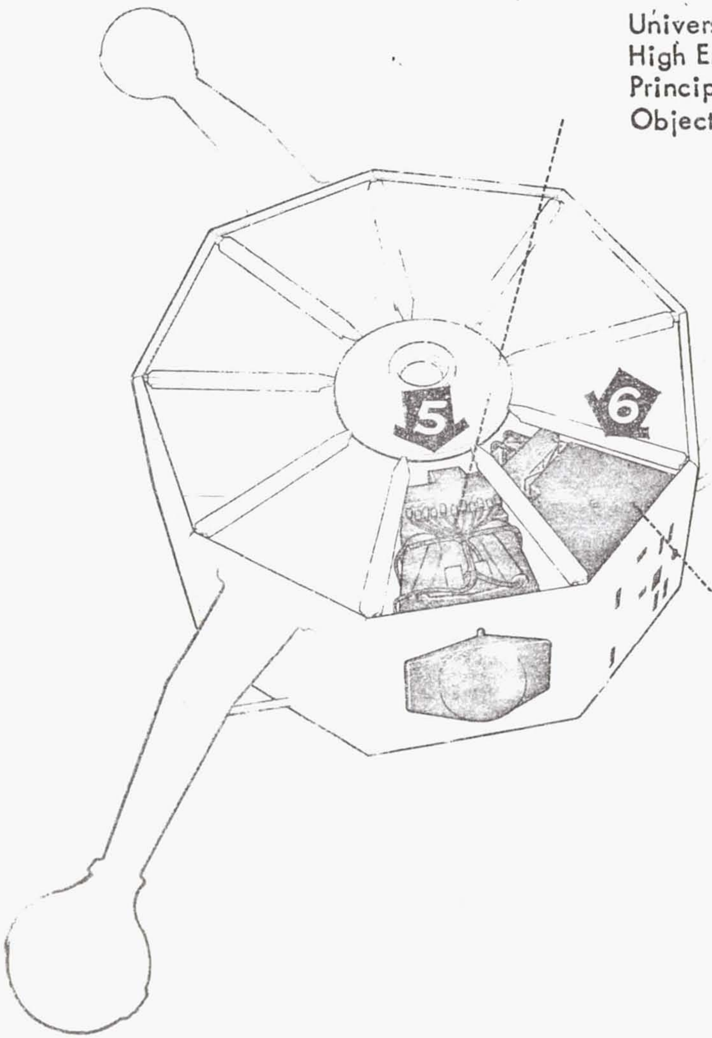

University of New Mexico
High Energy Neutron Telescope
Principal Investigator: C. P. Leavitt
Objective: Determine high energy neutron flux in the 20 to 130 Mev energy range.

Description: *Consists of a "neutron telescope" which is composed of a plastic proton recoil converter, three plastic scintillators, and* eight *photomultipliers. The telescope is designed such that only neutrons with energy levels of 20 to 130 mev are detected. The photomultipliers detect and measure the energy of the neutron events that occur in the scintillators. The directional resolution is about 30 degrees. Whenever neutron events are detected, the angle between the solar vector and the detector axis is computed so that the source can be determined. When neutron events do not occur, proton events are detected identically.*

Los Alamos Scientific Laboratories
Solar X-ray Emission Line Spectrometers
Principal Investigator: H. V. Argo
Objective: Observe solar X-rays emission lines in the 16 to 40Å spectral range.

Description: *Consists of six fixed-crystal spectrometers which measure the intensity of specific emission lines at 16, 18, 19, 22, 34, and 40 Å. Three mica crystals are used for short wavelengths and three lead stearate crystals are used for longer wavelengths. Each diffracting crystal is installed in a Johan-type spectrometer and spectral resolution is obtained by using the Bragg principle. Photon counts from each spectrometer are stored and read out about every 2.5 seconds.*

WHEEL INSTRUMENTS-II

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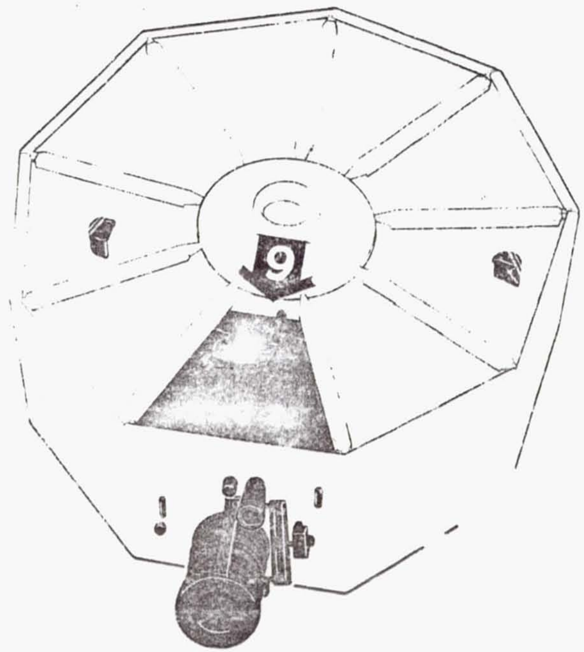
Rutgers University
Zodiacal Light Polarimeter
Principal Investigator: A. L. Rouy
Objective: Determine the brightness, polarization, and ellipticity of zodiacal light

Description: *Consists of a collimating telescope, quartz rotators, retardation plates, polarizing prism, monochromating filters and photomultiplier. Zodiacal light (which may be polarized) is first collected and collimated by the telescope which is equipped with a sun-shield that produces a look-angle of less than two degrees. The light passes through an optical system in which the polarization axis of the light is rotated in increments of 45°. The light then passes through a Rouy prism and the resulting intensities are measured by the photomultiplier at the various angles. Additional measurements are made when the light in one axis is retarded in phase by the retardation plate. This data is then used to calculate the degree and angle of polarization of the zodiacal light.*



WHEEL INSTRUMENT-III

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THE SUN: BACKGROUND INFORMATION

The Sun is a turbulent, brilliant mass of gases burning with an intensity far greater than a blast furnace. By astronomical standards it is a relatively small star among the estimated one-hundred billion stars that make up our galaxy--one of the hundred million galaxies in the cosmos.

As the star closest to Earth, it is of great scientific interest. If the distance from the Earth to the Sun were 8.25 inches, the distance from Earth to the nearest star would be 4.25 miles, and at this scale the Sun would be about the size of a pinhead.

The Sun is so immense that if the Earth were placed at its center, the Moon would be located slightly over half-way to its outer edge. Ninety-three million miles--one astronomical unit--separate Earth from the Sun. The Sun's rays must travel eight minutes at the speed of light to reach us.

Energy from the Sun is the principal support to life on Earth. It literally dominates the solar system with electromagnetic radiations, protons, electrons, other charged particles, and magnetic fields. Scientific investigation of the Sun--restricted until the space age primarily to the limited window of Earth-bound investigation--is essential to understanding the weather, the behavior of the atmosphere, the ionosphere, and the influence it exerts over interplanetary space is also essential for the advancement of our capabilities in manned space flight and the area of space applications.

The OSO program has contributed significantly to man's knowledge of the Sun/Earth/celestial relationship. Instruments to study solar activity above the turbulent, opaque sea of air we know as the Earth's atmosphere, have made possible first-hand, unrestricted solar studies.

SOLAR GLOSSARY

Age:	Estimated 10 billion years
Diameter:	About 864,000 (109 times that of Earth)
Volume:	1,300,000 times that of Earth
Mass:	333,000 times that of Earth
Surface Temperature:	10,300°F (earth, average of 32°F)
Interior Temperature:	35 to 50 million degrees F. (earth, 5000oF)
Rotation:	Varies, more rapid near the equator where average is 24.65 days; in higher latitudes average is 35 days
Distance from Earth:	93 million miles or 1 Astronomical Unit
Specific Gravity:	1.41 (earth, 5.52)
Surface Gravity:	28 (earth, 1)
Chromosphere:	The rosy red (light pinkish) layer, or atmosphere which extends out several thousand miles. Visible only during solar eclipse because it is overwhelmed by brilliance of the photosphere.
Corona:	The sun's outermost layer visible only through a coronagraph or during total solar eclipse when it appears as a varying white halo against the dark silhouette of the Moon. When there are relatively few sunspots, the corona has an almost smooth outline. During disturbances, however, its streamers can extend outward for millions of miles.
Cosmic Ray Particles:	Mostly protons with energies ranging from less than 10 MeV (million electron volts) to 50 BeV (billion electron volts).

Cosmic Year: The period of time, about 200 million Earth years, required for the Sun to be carried completely around the center of the Milky Way galaxy by the rotation of the galaxy. Our Sun is just now reaching voting age of 21 cosmic years.

Gamma Ray: A quantum of electromagnetic radiation emitted by a nucleus as a result of a quantum transition between two energy levels of the nucleus. Energies range from 100,000 to 1 million electron volts.

Granulations: Usually elliptical in shape and resembling grains of rice, they appear over the entire surface of the sun. Constantly in motion, they have a turbulent life of only a few minutes.

Limb: The edge of the sun's disk, darker than the center of the disk.

Penumbra: The grayish-filament-like structures surronding the umbra.

Photosphere: The visible disk of the Sun, diameter 1/2°.

Plages: The bright or dark calcium clouds that are found near sunspots. Sometimes called flocculi. The general form for any chromospheric turbine.

Prominences: Geysers of bright hydrogen that come up from the surface, or photosphere. Flame-like in appearance they sometimes shoot outward a million miles. The more spectacular seem to be associated with sunspots.

Spectrometer: An instrument which measures intensity in various wavelengths. A dispursing element, such as a diffraction-grating is employed to give the various wavelengths.

Sunspots: The dark areas in the photosphere having extremely strong magnetic fields. Apparently they are the venting valve for the tremendous forces at work below the photosphere. Some of the larger ones have a total area of several million miles. Temperature within a sunspot is believed to be several thousand degrees less than that at the surface. The number of sunspots varies over a solar cycle of 11.3 years between maximum and minimum sunspot activity.

Umbra: The dark central portion of a sunspot.

OSO PROGRAM SCIENTIFIC RESULTS

OSO 1

OSO 1 was launched Mar. 7, 1962. This pioneering observatory provided valuable scientic data for over 1,000 of its orbits. As the first of the OSO series it clearly established the capability to operate successfully a complex scientific observatory for an extended period of time.

The contribution of OSO 1 to the study of active regions is demonstrating that extreme ultraviolet observations carried out over several solar rotations give direct evidence of changing conditions in the corona above an active region.

On OSO 1 the average atmospheric temperature and approximate density of the upper atmosphere between 124 and 248 statute miles were determined at sunrise and sunset for a period of one week each of high and low levels of solar activity. The results obtained by observing the attenuation of solar spectrum lines from 170 to 400 Angstroms with the Goddard solar spectrometer showed some disagreement with the older models of the atmosphere. For example, the difference in temperature between sunrise and sunset was not as much as obtained from the satellite drag results.

In another study, daily values of atmospheric temperature have been compared with extreme UV radiation data and also with indices of geomagnetic activity. The analysis of both phases and amplitudes favors the UV rather than the solar wind effect as being principally responsible for the 27-day variations in atmospheric temperature for the months of March and April 1962.

Also on OSO 1 a number of "warm" spots which lie below the lower Van Allen belt were observed by the University of California Lawrence Radiation Laboratory proton-electron experiment. These were observed at the satellite altitude of 357 statute miles between the latitudes of 33 degrees N and 33 degrees S.

OSO 2

OSO 2 was launched into orbit on February 3, 1965. Some of the major scientific results include:

*There are no rapid changes in the brightness of the sky as seen from above the airglow layer. Changes within periods of days to weeks of as much as 30 per cent are definitely ruled out.

*From the standpoint of space astronomy, OSO 2 observations show that the zodiacal light will be the principal contaminant for orbiting observatories, and that it is comparable with the sky brightness from the ground, where both the airglow and zodiacal light combine to form the background.

*There is no appreciable contribution to the zodiacal light from a local (geocentric) cloud of dust.

*The majority (at least 80 per cent) of the airglow, as seen in our optical bandwidth of about 4,000 to 6,000 Angstroms, arises in the 56-statute-mile layer.

*The airglow shows "meteorological" day-to-day variations in brightness and color of about one astronomical magnitude, which seem to be uncorrelated with latitude, longitude, or time of night.

*The scale of the airglow pattern is very much like the scale of a meteorological system, i.e., of the order of 1,000 miles.

OSO 3

OSO 3, launched Mar. 8, 1967, has been an outstanding success. Both tape recorders operated satisfactorily from time of launch until they failed May 26, 1967 and June 28, 1968, respectively. All nine of the experiments operated as designed.

The Goddard Space Flight Center pointed experiment had ion chambers which monitor at the 2 to 8 Angstrom and 10 to 20 Angstrom regions of the solar spectrum; two spectrometers which cover the range of about 1 to 4 Angstroms and 8 to 25 Angstroms; and a grazing incidence spectrometer which covers the 20 to 400 Angstrom portion of the spectrum.

The grating spectrometer could be stopped on any desired line and observations made on the changes of intensity in the selected line to give "light curves." The comparison of light curves for spectral lines of various elements and of various levels of ionization was important in understanding the mechanism of transport of energy through the corona generated by solar activity. In addition to its scientific value, the X-ray data were forwarded to the Flare Warning Network of Environmental Science Services Administration (ESSA. Of particular interest to scientists have been the observations of the changes in the ultraviolet spectrum during the solar flares. Two moderately strong new emission lines have been observed during moderately large flares.

The pointing section also has a scanning spectrometer used as a monochromator and provided by the Air Force Cambridge Research Laboratories. This instrument operated successfully for more than six months. It scanned the solar spectrum from about 250 to 1,300 Angstroms and provided solar spectra of the best reproducibility to date in this region, although the instrument had no spatial resolution.

In addition to obtaining solar spectra, this experiment measured the atmospheric absorption of the solar ultraviolet as a function of latitude, season and heights in the atmosphere. These data are extremely significant for aeronomy since from these absorption spectra the physical processes occurring in the upper atmosphere can be studied in detail.

The University of Michigan has, in the wheel section, an ion chamber that measures the integrated solar flux from 8 to 12 Angstroms. Some interesting variations have been found; not all large increases in the flux correlate well with optical and radio observations of solar activity. It has been observed that all optical flares produce X-rays. On the other hand, out of 42 X-ray events observed before mid-September, 1967, in the "quick look" data, only 36 were correlated with optical flares. Also, there is a large range of X-ray enhancements for a flare of given importance. In addition to its research value, this information is also provided to the Space Disturbance Laboratory of the Environmental Science Services Administration.

The University of California at San Diego has, in the wheel section, a sodium iodide scintillation counter to detect solar and celestial X-rays from about 7 to 190 kilovolts. This experiment has produced some interesting and important results for solar physics.

In this energy range the Sun is characterized by its variability -- there exists no "quiet" Sun. Studies have also been made of the rise time of solar X-ray bursts and of the correlation of the spectrum with burst activity. The latter shows that the more intense the burst, the harder the X-rays.

The Massachusetts Institute of Technology has, in the wheel section, a gamma-ray telescope for the detection of celestial gamma-ray sources with energies above 50 MeV. This experiment requires extremely long observation times as the telescope detects on the average about 1 photon per day from the sky and about 200 per day from the Earth. As a result, the interpretation of data from this experiment is just beginning. However, one extremely significant observation clearly has been made. The center of our galaxy is a source of gamma-rays of energy greater than 50 MeV. This is important for models of galactic structure and evolution, and theories on the energetics of cosmic radiation.

The University of Rochester has, in the wheel section, a particle-counting telescope to study solar and galactic high energy cosmic rays. As this experiment also has a very low counting rate, it too needs a long lifetime for good statistics. An upper limit to the isotropic flux of hard gamma-rays (energies higher than 50 MeV) has been determined and is a factor of three lower than the limit determined from earlier observations. For very high energy particles the proton (hydrogen nuclei) spectrum seems to be flatter than the alpha particle (helium nuclei) spectrum. There is an indication that the ratio of hydrogen to helium increases with energy for these very energetic nuclei.

OSO 4

OSO 4, launched Oct. 18, 1967, carried instrumentation for nine experiments. Both tape recorders operated satisfactorily from time of launch until they failed on March 15, 1968 and May 12, 1968. All nine of the experiments operated as designed.

There are three experiments in the pointing section of OSO 4. A crystal spectrometer provided by the Naval Research Laboratory is studying solar X-rays in the 1 to 8 Angstrom region. A scanning spectrometer provided by the Harvard College Observatory was able to scan the solar spectrum in the 300 to 1,300 Angstrom region and to scan spatially the Sun at fixed wavelengths with spatial resolution elements of about one minute of arc. The third pointed experiment is an X-ray spectroheliograph provided by American Science and Engineering, Inc. This experiment provides "pictures" of the Sun in wavelengths from less than 8 to above 70 Angstroms.

The Harvard College Observatory ultraviolet spectroheliometer failed and was turned off about Nov. 30, 1967. Over 4,000 spectroheliograms of the solar atmosphere between 300 and 1,300 Angstroms were obtained. These data will permit the development and assessment of realistic models of the solar atmosphere and will provide insight into the problem of energy transport through the chromosphere and corona.

Other results from OSO 4 include:

* Differences have been noted between emissions from a "hot" corona and a relatively low temperature corona.

* Significant data on hot spots in the solar corona and valuable spectroheliograms on the "quiet" sun were obtained.

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* Important data regarding the density and scale of height of the geocorona were obtained.

* Valuable observations on the distribution of X-ray flux due to flares were made which show the "hardening: of the flux caused by solar activity.

* Considerable data have been obtained related to particle energy spectra for electrons and protons

* Spectroheliograms in the lines of various ionic species of oxygen, magnesium and hydrogen and in the continuum. These data represent a major step forward in the science of solar physics.

OSO 5

OSO 5 was launched on January 22, 1969, and was officially classified a success by NASA after achieving its primary objectives on February 26. The primary objective of the eight experiments of this mission was to obtain high spectral resolution data from the pointed experiments within the range of from about 1 to 1,250 Angstroms, during solar rotation, including raster scans of the solar disc in selected wavelengths. The secondary objective, also achieved, was to obtain useful data from the non-directional experiments as well as from the pointed experiments beyond one solar rotation with extended observations of single lines and solar flares.

Status of the individual experiments as of July 1969 was as follows:

X-ray Spectrometer-Goddard Space Flight Center

Now operating only partially, this experiment obtains high spectral resolution data on solar X-ray emission lines in the range 1 to 400 Angstroms region; observations of the quiet sun have indicated the presence of emission lines previously undetected. This is due to the increased sensitivity and reduced background susceptibility of the present instrument compared with earlier experiments. Enhancements of solar emissions have been detected during periods of flare activity, particularly during a class two event observed during orbit 159 on Feb. 2, 1969. This instrument has obtained about 2400 high-resolution spectral scans in the 1-25Angstrom region and 800 in the 25-400 Angstrom region.

<u>Extreme Ultraviolet Spectroheliograph - U. S. Naval Research Laboratory</u>

Approximately 9600 high spatial resolution extreme ultraviolet pictures of the solar disc at six wavelengths (1216 Angstroms, 304Å , 465Å, 284Å, 335Å, and 499Å) have been produced by this experiment. During the flare event of February 2, 1969, enhanced ultraviolet emissions were noted.

<u>Solar X-ray Spectroheliograph - University College London</u>

This instrument is observing the intensity and variation of the solar X-ray spectrum in the 3-9Å and 8-18Å range and has obtained about 2400 spectroheliograms. During the flare event of Feb. 2, 1969, the active region of the solar disc showed flux enhancement by a factor of 50 at 9Å. The X-ray active region coincided with a region of enhanced ultraviolet emission mapped by the NRL spectroheliograph.

<u>Zodiacal Light Telescopes - University of Minnesota</u>

This experiment designed to determine the intensity and polarization of zodiacal light in the blue and visual regions has measured the intensity of polarized light from the terrestial airglow layer and has observed stars which have passed in the field of view of the telescopes.

<u>X-ray Monitor - U.S. Naval Research Laboratory</u>

This experiment is monitoring the X-ray energy from the solar disc in four spectral bands -- 0.5 to 3Å, 2 to 8Å, 8 to 16Å, AND 0.1 to 1.6Å. Enhancements associated with changes in solar activity have been observed.

<u>Solar Far-Ultraviolet Radiation Monitor - University of Colorado</u>

This experiment is monitoring the total solar energy flux in three EUV bands -- 280-370Å, 465-630Å, and 760-1030Å. To date, ultraviolet absorption measurements have been obtained at satellite dawn and dusk which will permit determination of atmospheric gas temperatures.

<u>Low Energy Gamma-Ray Scintillation Detector - Goddard Space Flight Center</u>

This experiment has observed the solar gamma-ray radiation in the 5-150 KeV range. Strong solar bursts of about 15 minutes duration were observed during the February 2, 1969 solar event.

Solar Lyman-Alpha Line Atomic Hydrogen Cell - University of Paris

This experiment is monitoring the line shape of the solar Lyman-alpha line using the optimal resonance of hydrogen and deuterium gases. To date, observations utilizing the deuterium cell have indicated a broadening of the line shape compared with observations made earlier in the solar cycle.

THE DELTA LAUNCH VEHICLE

OSO-G will be launched by the Delta launch rocket. This will be the 72nd orbital mission for Delta which has become the workhorse for the automated satellite program conducted by NASA.

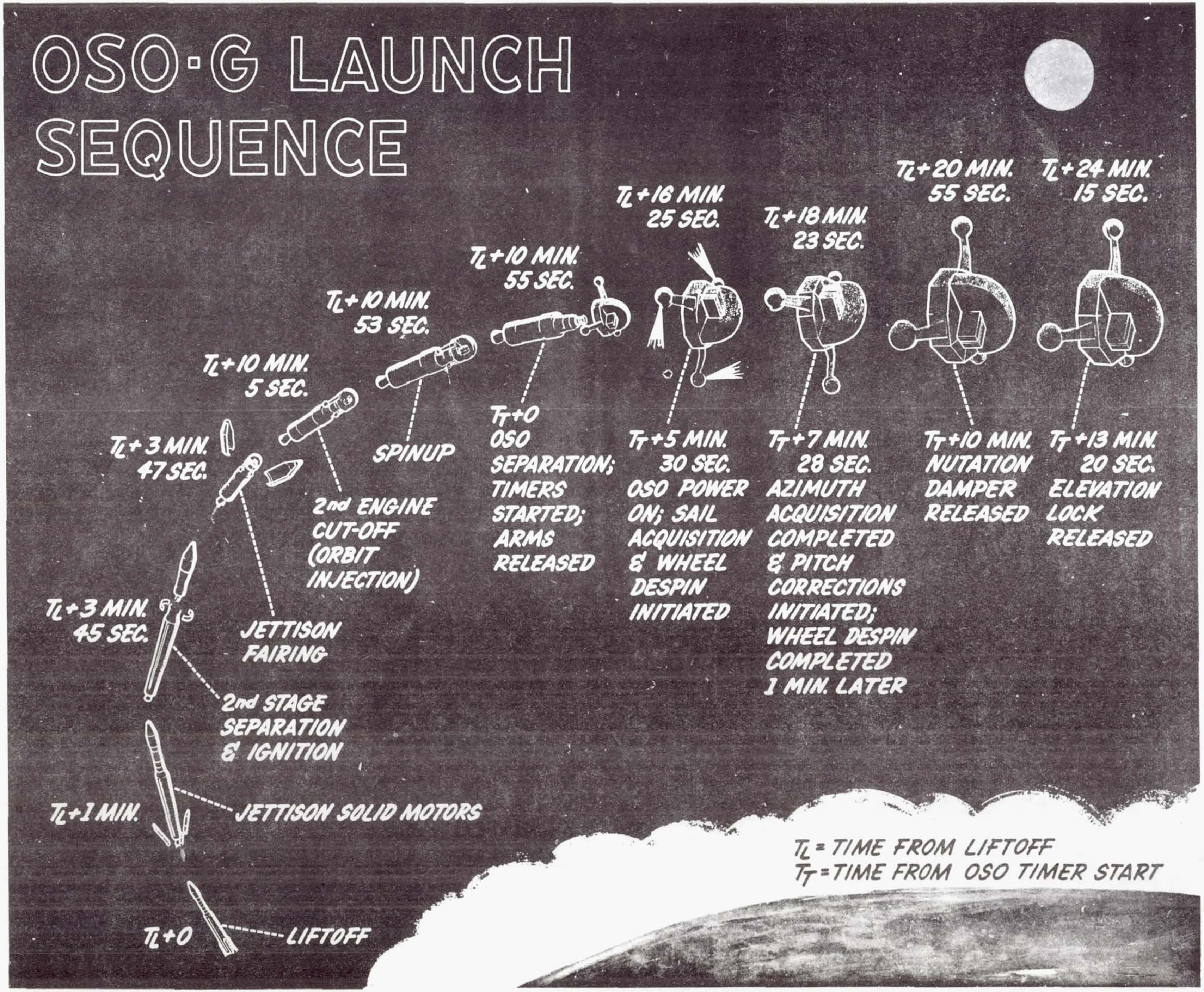
For the OSO mission a two-stage version of the Delta, called Delta N will be used. This incorporates the "long tank" first stage which is 14.42 feet longer than a conventional Delta first stage. The OSO will be launched from Complex 17 at Cape Kennedy, Fla., into a circular 350-mile orbit at an inclination of 33 degrees and a nominal orbital period of 96 minutes.

Delta is 106 feet high (including shroud). Its liftoff weight is about 100 tons. Liftoff thrust is 363,000 pounds, including thrust of three strap-on solid propellant rockets. Delta prime contractor is the McDonnell Douglas Astronautics Co., Santa Monica, Calif. The Goddard Space Flight Center, Greenbelt, Md., is responsible for Delta project management.

Engines for the kerosene-liquid oxygen fueled first stage are built by the Rocketdyne Division, North American Rockwell Corp. The three solid rockets which strap on the first stage are by Thiokol Chemical Corp. The UDMH-IRFNA fueled liquid engines of the second stage are by Aerojet General Corp.

The first stage is eight feet in diameter, 65 feet high, weighs 93 tons (including strap ons), and has 172,000 pounds of thrust. The second stage is 16 feet high, 4.7 feet in diameter, weighs seven tons, and has about 7,800 pounds of thrust.

Major autopilot contractors for Delta are Honeywell, Inc., Texas Instruments, Inc. and Electro-Solids Corp. The guidance contractor is Western Electric Co.


OSO-G LAUNCH SEQUENCE
TL+0
LIFTOFF
TL+1 MIN.
JETTISON SOLID MOTORS
TL+3 MIN. 45 SEC.
2nd STAGE SEPARATION & IGNITION
TL+3 MIN. 47 SEC.
JETTISON FAIRING
TL+10 MIN. 5 SEC.
2nd ENGINE CUT-OFF (ORBIT INJECTION)
TL+10 MIN. 53 SEC.
SPINUP
TL+10 MIN. 55 SEC.
TT+0
OSO SEPARATION; TIMERS STARTED; ARMS RELEASED
TL+16 MIN. 25 SEC.
TT+5 MIN. 30 SEC.
OSO POWER ON; SAIL ACQUISITION & WHEEL DESPIN INITIATED
TL+18 MIN. 23 SEC.
TT+7 MIN. 28 SEC.
AZIMUTH ACQUISITION COMPLETED & PITCH CORRECTIONS INITIATED; WHEEL DESPIN COMPLETED 1 MIN. LATER
TL+20 MIN. 55 SEC.
TT+10 MIN.
NUTATION DAMPER RELEASED
TL+24 MIN. 15 SEC.
TT+13 MIN. 20 SEC.
ELEVATION LOCK RELEASED
TL = TIME FROM LIFTOFF
TT = TIME FROM OSO TIMER START

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NOMINAL OSO-G FLIGHT EVENTS

EVENT	TIME	ALTITUDE STATUTE MILES	SURFACE RANGE STATUTE MILES	VELOCITY MILES PER HOUR
Main Engine Cutoff	3 min. 40 sec.	86	121	10,000
Second Engine Cutoff	10 min. 6 sec.	330	1,185	17,000
Spacecraft Separation	12 min.	330	1,633	17,000

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OSO-G FACT SHEET

Observatory

Weight:	About 640 pounds (227 pounds of scientific instruments and associated equipment), 35 per cent experiment weight to total observatory weight.
Shape:	Base section: nine-sided wheel with three arms carrying spin control gas supply; top section: fan-shaped with pointing instrumentation.
Size:	Wheel diameter: 44 inches, increased to 92 inches with three arms extended. Overall height: 37 inches.
Lifetime:	Designed for six months useful lifetime.

Launch Phase

Site:	Complex 17A, Cape Kennedy, Eastern Test Range.
Date:	No earlier than August 8, 1969
Vehicle:	Two-stage Delta N launch rocket.
Azimuth:	108 degrees.
Launch Window:	0352 a.m. EDT to 0432 a.m. EDT.
Orbital plan:	Circular orbit about 350 miles (statute) altitude.
	Period: About 96 minutes. Inclination: 33 degrees to the Equator.

Observatory Power Subsystem

Solar power supply:	Maximum 38 watts provided by 4.0 square feet of N/P solar cells arranged in 37 parallel strings 56 cells each on Sun-facing side of sail section.
Typical Maximum load:	About 26 watts including 13 watts for experiments. About 7 watts required at night.

Tracking, Command and Data Acquisition

Prime Stations:	Fort Myers, Fla.; Rosman, N.C.; Quito, Ecuador; Lima, Peru; Santiago, Chile; Orroral, Australia; Johannesburg, South Africa; and Tananarive, Malagasy.

All stations are part of the Space Tracking and Data Acquisition Network (STADAN) operated by the Goddard Space Flight Center, Greenbelt, Md.

SATELLITE NETWORK

Tracking Network for OSO-F

OTDA-STADAN
7/22/69

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THE OSO-G TEAM

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