Department of Physics and Astronomy

THE UNIVERSITY OF IOWA

Iowa City, Iowa 52242

RESEARCH IN SPACE PHYSICS

AT THE UNIVERSITY OF IOWA

ANNUAL REPORT FOR 1982

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July 1983

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1.0 General Nature of the Work

1.1 Our broad objective is the extension of knowledge of the energetic particles and the electric, magnetic, and electromagnetic fields associated with the earth, the sun, the moon, the planets, comets, and the interplanetary medium.

1.2 Primary emphasis is (a) on observational work using a wide diversity of instruments of our own design and construction on satellites of the earth and on planetary and interplanetary spacecraft and (b) on phenomenological analysis and interpretation.

1.3 Secondary emphasis is on basic theoretical and experimental study of plasma physical processes relevant to solar, planetary, and interplanetary phenomena.

1.4 Matters under current investigation are the following:

(a) All aspects of the energetic particles that are trapped in the earth's magnetic field and are transiently present in the outer magnetosphere including the magnetospheric tail of the earth; and of the solar, interplanetary, and terrestrial phenomena that are associated with these radiations -- solar flares, interplanetary magnetic fields and plasmas, aurorae, geomagnetic storms, corpuscular heating of the atmosphere, electromagnetic waves and magnetostatic and electrostatic fields (both constant and variable) in the magnetosphere, plasma flows in the magnetosphere, and the ionospheric effects of particle precipitation. This field of research was originated to a major extent by this laboratory.

(b) Origin and propagation of very low frequency radio waves and electrostatic waves in the earth's magnetosphere and ionosphere.

(c) Corresponding studies for the magnetospheres of Jupiter, Saturn, and prospectively Uranus and Neptune.

(d) Diffusion of energetic particles in Saturn's magnetosphere and their absorption by rings and satellites.

(e) Radio emissions from Jupiter and Saturn and the relationship of same to their magnetospheres.

(f) Solar modulation and the heliocentric radial dependence of the intensity of galactic cosmic rays.

(g) Energetic electrons, protons, alpha particles, and heavier nuclei emitted by the sun; the interplanetary propagation and acceleration of these particles, including the effects of shock waves and the generation of electrostatic and electromagnetic waves in the interplanetary medium; and the access of such particles to planetary magnetospheres.

(h) The theory of wave phenomena in turbulent plasmas including the interplanetary medium and of the origin of super-thermal particles.

(i) Basic wave-particle-chemical processes in the ionospheric plasma, as stimulated and diagnosed by active experiments from the Shuttle/Spacelab.

2.0 Currently Active Projects

2.1 Hawkeye 1 (Explorer 52, 1974-040A)

This entire satellite and its principal scientific instruments were designed and built at the University of Iowa and launched into a highly eccentric (21 R_E apogee), nearly polar orbit from the Western Test Range on 3 June 1974. Hawkeye 1 re-entered the earth's atmosphere, as predicted, on 28 April 1978 after 667 orbits and nearly forty-seven months of successful in-flight operation. Current analyses of the magnetometer data are concerned with establishing the electrical current system on the magnetopause and an observationally based model of the high latitude magnetic field of the earth.

[Van Allen, Adnan, and Randall]

(Data analysis support by the Office of Naval
Research and NASA Headquarters)

2.2 Pioneers 10 and 11

Both of these Ames Research Center/NASA spacecraft and most of the scientific instruments (including the University of Iowa's energetic particle instruments) continue to operate properly. Pioneer 10 was launched on 3 March 1972 and Pioneer 11 on 6 April 1973. Data are being received currently from both spacecraft on a daily basis (8-14 hours of data per day). Pioneer 10 is on a hyperbolic escape orbit from the solar system with heliocentric distances as follows: October 1979, 20 AU; July 1981, 25 AU; May 1983, 30 AU;

January 1987, 40 AU; and August 1990, 50 AU. On 13 June 1983, the heliocentric distance of Pioneer 10 will exceed that of every known planet and will continue to do so thereafter. It is judged technically feasible to continue to receive data of good quality (at bit rates ≥ 8 bits/sec) through 1992. Since its flyby of Saturn in August-September 1979, Pioneer 11 is also on a hyperbolic escape orbit out of the solar system with heliocentric distances as follows: 1 January 1981, 9.7 AU; 1 January 1983, 13.2 AU; 1 January 1985, 17.7 AU; 1 January 1987, 22.5 AU; and 1 January 1991, 32.5 AU. The present expectation is that the diminishing output of the RTG power supply of Pioneer 11 will limit its useful flight life to about 1988.

During 1982, analysis of the Saturn encounter data of Pioneer 11 was continued with emphasis on the particle-sweeping effects of the rings and inner satellites of the planet and the diffusion coefficients for energetic electrons and protons in Saturn's inner magnetosphere. The areal mass densities of Rings G, E, F, A, and B are being determined by energetic particle data.

The continued flow of interplanetary data at unprecedentedly great distances from the sun has been used to progressively update knowledge of the dependence of galactic cosmic ray intensity on solar activity and on heliocentric radial distance. An improved set of RTG background corrections has been developed with the help of in-flight calibration of Pioneer 11's detector rates during the passage of the spacecraft under Saturn's Rings A and B. Our best current value of the integral radial gradient of galactic cosmic ray intensity $E_p > 80$ MeV is + 1.9 (± 0.2) percent per astronomical unit over the range 1 to 28 AU, suggesting a scale size of ~ 50 AU for the radius of the heliosphere. The gradient has been remarkably constant despite a variation of the absolute intensity by a factor of 2 during the past eleven years. The solar activity modulation of the intensity has been found to be primarily of an episodic nature, with episodic decreases of intensity associated with brief periods (~ few days) of unusually great solar activity. Recovery from such decreases occurs on a time scale of months. Impulsive proton ($E_p \sim$ 1 MeV) and electron ($E_e > 0.040$ MeV) events continue to be present, providing further understanding of the interplanetary propagation and shock-wave acceleration of such particles.

An important capability of Pioneer 11 is to provide data on interplanetary conditions in the vicinity of Uranus at the time of Voyager 2's flyby of that planet in January 1986.

[Van Allen and Randall]

(Support by Ames Research Center/NASA and
the Office of Naval Research)

2.3 Voyagers 1 and 2

The plasma wave instruments for both of these planetary flyby missions were designed and constructed at the University of Iowa. Voyager 1 was launched on 5 September 1977 and flew by Jupiter on 5 March 1979 and Saturn on 12-13 November 1980. Voyager 2 was launched on 20 August 1977 and flew by Jupiter on 9 July 1979 and Saturn on 25 August 1981. Voyager 2 is presently on course for a flyby of Uranus on 24 January 1986. The plasma wave instruments on both spacecraft continue to operate satisfactorily.

During the past year the main emphasis in the Voyager data analysis was on specialized topics not investigated in the initial analysis of the Jupiter and Saturn encounter data and interpretational analyses of certain controversial questions. Some of the specialized studies that have been completed include observations of Jupiter's distant magnetotail and wake, detection of narrowband electromagnetic emissions from Jupiter (similar to those detected at Saturn), and observations of chorus-related electrostatic bursts at Jupiter and Saturn. Two interpretational studies of waves in the Io torus have been completed, one having to do with the possible presence of lower hybrid noise in the torus and the other having to do with the possible generation of ion cyclotron waves by polarization reversal of whistler mode noise. As an extension of this last study, a computer program is being developed to compute the pitch angle diffusion coefficients for electrons and ions in the torus using the whistler mode intensities observed by Voyager 1. Several of these studies have been completed as part of the NASA Jupiter Data Analysis Program (JDAP).

[Gurnett, Goertz, Kurth, Reinleitner, and Seery]

(Support by the Jet Propulsion Laboratory, NASA Headquarters, and the Office of Naval Research)

2.4 IMP 8 (Plasma Analyzer)

On October 26, 1983 IMP 8 will celebrate its tenth anniversary. The Lepedea plasma instrument measures the directional, differential intensities of protons and electrons over the energy range 50 eV to 45 keV and is still returning usable information at this date (June 1983). Our studies during the past year have concentrated on magnetotail structure and dynamics with correlative measurements from ISEEs-1 and -2. IMP 8 provides observations at ~ 40 R_E whereas the ISEE spacecraft survey the magnetotail to radial distances of ~ 20 R_E. Using simultaneous measurements from these two spacecraft we have shown that magnetospheric substorms can be spatially isolated events in the magnetotail and do not necessarily corroborate the existence of a neutral line extending across the entire magnetotail at these radial distances during the onset of a substorm. Simultaneous measurements of the proton velocity distributions at two positions in the plasma sheet boundary layer show that the bulk speeds of the streaming plasmas increase with decreasing geocentric radial distance. Our previous analyses of these ion velocity distributions have shown that the distortions of the distribution functions relative to those for streaming Maxwellians can be accounted for by a field-aligned potential difference over radial distances ~ 20 to 40 R_E. Linear theory for anomalous resistivity has shown that the amplitudes of broadband electrostatic noise in the boundary layer as reported by Gurnett and others are insufficient to yield sufficient resistivity to support the field-aligned electric fields. Recently there are indications from the results of nonlinear theory that such resistivity may be possible. This issue is extremely important in that ion acceleration in the magnetotail could occur as a distributed field-aligned process rather than within the relatively small diffusion zone at a presumed site for reconnection further into the magnetotail.

Several current and planned future efforts are to be directed toward (a) resolving the mechanism for ion acceleration in the magnetotail (as above), (b) correlations with ISEE measurements at lesser radial distances in the magnetotail in order to delineate spatial structure and temporal variations at radial distances ~ 15 to 40 R_E, and (c) initial investigations of the coupling of the magnetotail with the earth's ionosphere via the simultaneous global auroral images with DE-1.

[Frank, Eastman, DeCoster, and Huang]

(Support by Goddard Space Flight Center/NASA, NASA Headquarters, and the Office of Naval Research)

2.5 International Sun-Earth Explorer (ISEE) (Plasma Analyzers)

Numerous aspects of plasma dynamics and spatial distributions in the earth's magnetosphere are being investigated currently with measurements with the ISEEs-1 and -2 Quadrispherical Lepedeas. The software programming for these instruments is now sufficiently comprehensive and complete to calculate the electric fields, field-aligned currents and pressure tensors for many of the diverse regions in the magnetosphere. Among the primary areas of research for the past year are the boundary layers of the plasma sheet, field-aligned currents at the dayside magnetopause and in the magnetotail, the direct detection of currents in the neutral sheet, and the acceleration mechanism for ion beams in the magnetotail.

The boundary layers contiguous to the plasma sheet have been shown to be the primary plasma transport regions in the earth's magnetotail. These plasma sheet boundary layers are typically ~ 0.5 to several R_E in thickness. The boundary layers are identified with observations of field-aligned flows of ions that are directed away from the ionosphere and higher speed flows of ions from deep within the magnetosphere that are directed toward the ionosphere. Plasma bulk flows within the plasma sheet proper are significantly less than those within the boundary layers. Typical bulk flows in the boundary layers range from ~ 100 to 1000 km/sec whereas bulk flows in the plasma sheet are tens of km/sec. Intense field-aligned current densities are found in field-aligned current sheets in the boundary layer. Current densities are directed either into or out of the ionosphere and are associated with the high-latitude Region 1 current system that is observed at low altitudes. Magnetic field lines threading inverted-V events at low altitudes, and thus also discrete arcs in the ionosphere, are topologically extended into the plasma sheet boundary layer in the magnetotail.

One example of an inverted-V electron event at great altitudes, ~ 11 R_E, has been detected with ISEE-1. The inverted-V event coincided with a large discontinuity in the bulk flow of ions and a substantial field-aligned current directed away from the ionosphere. The discontinuity in ion bulk flows was such that the corresponding $\nabla \cdot \vec{E}_\perp < 0$, where $\vec{E}_\perp$ is the perpendicular electric field vector, in agreement with the expectation that electrons are accelerated into the atmosphere. In order to establish that the observations were consistent with interpretation in terms of field-aligned potential differences the ISEE measurements were applied as the upper boundary conditions for a two-dimensional model of the current systems associated with this event. A constant Pedersen conductivity in the ionosphere was invoked and the field-aligned currents and potentials were calculated with the assumption that $\nabla \cdot \vec{j} = 0$ where $\vec{j}$ is the field-aligned current density. The calculated current at the ionosphere was in general agreement with previous measurements. Calculated maximum values for the field-aligned potential difference were ~ 40 kV, i.e., at the center of the inverted-V event. Thus the ISEE observations further support the existence of the magnetically field-aligned potentials and at this date provide the only set of observations for the high-altitude boundary conditions.

The first direct detection of the current densities in the neutral sheet of the magnetotail has been accomplished recently with the ISEE Lepedea. This plasma analyzer provides sufficiently accurate determinations of the proton and electron three-dimensional velocity distributions to reveal the small proton and electric fluid drifts that contribute to the current. The hot proton plasma was found to be unmagnetized in the vicinity of the neutral sheet; the electron plasma is only partially magnetized. This nonadiabatic motion of protons and electrons in the weak magnetic and electric fields at the neutral sheet produces a net current directed generally from dawn to dusk across the magnetotail. The magnitudes of the cross-field current densities and the dimensions of the current sheet are sufficient to provide the current sheet intensity that produces the magnetotail.

Several planned research topics for the coming year are (a) a large-scale survey of plasma bulk flows and electric fields in the magnetotail for comparison with results from theoretical MHD models, (b) an investigation of the plasma distributions and temporal behavior in the magnetotail during occurrences of Θ-auroras as measured simultaneously with the imaging instrumentation on DE-1 and (c) a preliminary analysis of field-aligned currents at the dayside magnetopause and their relationship with the auroral current systems.

[Frank, Eastman, Huang, DeCoster, Sentman/UCLA, and Kennel/UCLA]

(Support by Goddard Space Flight Center/NASA and NASA Headquarters)

2.6 International Sun-Earth Explorer (ISEE) (Plasma Waves)

The University of Iowa provided plasma wave instrumentation for all three of the ISEE spacecraft. ISEE-1 and -2 were launched in October 1977 into nearly identical highly eccentric orbits with apogee radial distances of about 22 R_E. ISEE-3 was launched in August 1978 and placed at the Lagrangian point of the earth-sun system, at a distance of about 235 R_E sunward of the earth. In late 1982 the ISEE-2 trajectory was modified to send it through the distant regions of the earth's magnetotail and then away from the earth for a flyby of the comet Giacobini-Zinner in September 1985. The plasma wave instruments on all three spacecraft are functioning normally and the data obtained continue to be processed on a routine basis.

During the past year one student, Mr. Steve Fuselier, completed his M.S. thesis using the ISEE data. For his thesis, Mr. Fuselier studied short wavelength electrostatic waves generated by ion beams upstream of the earth's bow shock. Because these waves have wavelengths shorter than the electric antenna on ISEE-1, interference patterns can be seen in the frequency-time spectrograms of these waves. The interference effects provide a precise determination of the wavelength. Once the wavelength is known, the Doppler shift due to the motion of the solar wind can be computed and the rest frame frequency determined. These measurements provide an experimental determination of the dispersion relation of the waves.

The dispersion relation obtained using this technique clearly shows that the waves are ion acoustic waves, thereby settling a long standing uncertainty about the mode of propagation of this noise. Further studies are now under way to try to establish the exact mechanism by which these waves are produced.

For his Ph.D. thesis, Mr. Robert Tokar, working under the direction of Dr. Gurnett, is studying the generation of whistler mode noise in the earth's bow shock as a collaborative project with the Los Alamos Scientific Laboratory using data from ISEE-1 and -2. This study is focusing on the recent discovery of electron beams accelerated in the shock. These electron beams are a possible free energy source for generating whistler mode turbulence in the shock. Using electron distribution functions measured by the fast plasma analyzer on ISEE-1, it has been shown that whistler mode noise is generated over a broad range of frequencies. The onset time and spectrum predicted are in good agreement with observed whistler mode intensities in the bow shock. Further studies of the generation and propagation of this noise are under way, including studies of interplanetary shocks.

As an extension of his Ph.D. research, Dr. Lee Reinleitner, working with Dr. Gurnett, has continued the investigation of electrostatic waves produced by electrons trapped in Landau resonance with whistler mode chorus emissions. These studies have focused on the possibility that electrons can be accelerated to high energies via a process called dispersive acceleration. This process operates in a manner analogous to a linear accelerator, with electrons being trapped near the leading edge of a chorus wave packet, accelerated as they are carried through the packet, and ejected at the trailing edge of the packet. Electron acceleration processes of this type are believed to have been observed in the ISEE data.

Continuing earlier ISEE investigations of narrowband electromagnetic emissions from the terrestrial magnetosphere, Dr. William Kurth has completed a detailed investigation of the relationship between intense $(n + 1/2)f_c$ electrostatic electron cyclotron emissions and narrowband electromagnetic emissions. His studies clearly show that narrowband electromagnetic emissions are produced when the upper hybrid resonance frequency matches a half-integral harmonic of the electron cyclotron frequency. No measurable frequency shift (< 100 Hz) can be detected between the electron cyclotron emission and the electromagnetic radiation, implying that if the electromagnetic radiation is produced by a nonlinear interaction between the electron cyclotron emission and a low frequency wave, then the low frequency wave must be at frequencies less than 100 Hz. The generation of narrowband electromagnetic emissions in the terrestrial magnetosphere is continuing to be pursued because this emission process appears to be one of the relatively few basic mechanisms for generating escaping electromagnetic radiation from a a plasma. Similar emissions have been observed by Voyagers 1 and 2 at Jupiter and Saturn.

[Gurnett, Anderson, Kurth, Reinleitner, Tokar, and Fuselier]

(Support by Goddard Space Flight Center/NASA and the Office of Naval Research)

2.7 International Sun-Earth Explorer (ISEE) (Interferometer)

Both ISEE-1 and ISEE-2 are equipped with wideband analog plasma wave receivers. A 10 kHz bandwidth signal from each receiver is transmitted to ground stations and tape recorded. When combined, these two signals give an interferometer response. Terrestrial Auroral Kilometric Radiation events at 125 kHz are currently being processed. The processing includes finding the correct time delay between the signals that maximizes the correlation and correcting the correlation for uncorrelated noise. Ten cases have been completely processed yielding correlation coefficients of 0.6 to 0.85 for satellite separations of approximately 200 km. These correlations suggest that the radiation is emitted from a source region less than 0.3 R_E in size (assuming a single Gaussian distributed source). More cases with larger satellite separations are being processed to increase the resolution of the interferometer. Mr. Baumback is using this research as part of a Ph.D. thesis.

[Shawhan and Baumback]

(Support by NASA Headquarters, including special guest investigator grant)

2.8 Dynamics Explorer (DE-1) (Global Imaging)

The imaging instrumentation on board the high-altitude spacecraft Dynamics Explorer-1 continues to provide the first series of global auroral images at visible and vacuum-ultraviolet wavelengths. The instrumentation has continued to operate flawlessly from initial operational turn-on during October 1981 to the present date (June 1983). In addition to the prime filters for auroral observations, the instruments are equipped with the appropriate filters for studies of the earth's geocorona, total columnar ozone and marine bioluminescence. A massive software effort is being undertaken in order to process in an efficient and economical manner the current library of approximately 100,000 images. Such software includes spatial filtering, cinematic frame interpolation, coordinate grid and coastline mapping, tomography, radiation transfer and color coding along continuous curves in the Munsell color solid. During the past year or so we have produced preliminary results in the areas of (a) auroral zone responses to fluctuations in the solar wind, (b) discovery and analysis of the exciting Θ-aurora, (c) global maps of total ozone, (d) a general search for marine bioluminescence, (e) models for geocoronal atomic hydrogen densities, (f) computer tomography of auroral emissions, (g) SAR-arcs, and (h) relationships of field-aligned currents with auroral emissions. We discuss briefly several of these results here.

The correlation of the onsets of auroral substorms with fluctuations in the direction of the interplanetary field has produced important results concerning the dynamics of the magnetotail. Magnetic field measurements for the solar wind were provided by ISEE-1 (Russell) and ISEE-3 (Smith). It is widely known that the southward turning of the interplanetary field is associated with auroral and magnetospheric substorms. However the timing of this response has been a subject of vigorous debate. The extended viewing times from the DE-1 spacecraft provide unambiguous determinations of the relative timings. It is found that the onset of an auroral substorm follows the southward turning of the interplanetary field at the dayside subsolar point of the magnetopause by periods of 30-60 minutes, i.e., the response is <u>not</u> instantaneous. These delay times correspond to propagation distances down the magnetotail for the interplanetary disturbance of 300 to 600 R_E (geocentric radial distance). These findings imply that the principal acceleration region of the magnetotail is positioned at these relatively large distances. One exception to the above delay in magnetospheric responses occurs for a large increase in total interplanetary magnetic field strength. In this case the delay in increased auroral luminosities is small, < 10 minutes. The increased luminosity is believed to be associated with immediate perturbations in the atmospheric loss cone angles due to the impressed external interplanetary field.

The newly found spatial distribution of auroral luminosities known as a Θ-aurora comprises the auroral oval and a bright polar arc which extends contiguously from the dayside auroral oval to the nightside oval. The presence of a Θ-aurora implies that the two magnetotail lobes are each split into two convection cells separated by a zone of convecting plasma. The Θ-aurora has been shown to occur simultaneously over the northern and southern polar caps during periods of northward-directed interplanetary magnetic fields. At the onset of a Θ-aurora event the polar arc is seen as a small arc near the evening or morning sectors of the auroral oval, or as a small jet of luminosities extending poleward from the midnight sector. Initial brightenings near local noon have not been yet observed at the onset of a Θ-aurora. If the interplanetary magnetic field is directed from dusk to dawn the polar arc develops at local evening and moves toward higher latitudes. A reversal of the magnetic field finds the polar arc developing in the morning sector. These initial observations of the temporal evolution of the Θ-aurora suggest that the earth's magnetosphere is responding to a torque directed about the earth-sun line. Currently there is no magnetospheric model or theory that is able to predict or account for the appearance of this major auroral luminosity distribution.

The computer software necessary to provide global maps of total columnar ozone from simultaneous images of earth at 317.5 and 360.0 nm is in the verification phase that employs ground-based observations and low-altitude satellite determinations from the Nimbus-7 total ozone mapping spectrometer. Several initial maps for columnar ozone over the United States have been produced and the results are very encouraging. After verification, the time evolution of ozone distributions will be studied and correlated with meteorological data. Of high priority for immediate studies is the temporal evolution of the volcanic gas clouds from the El Chichón eruptions.

A spherically symmetric model for the atomic hydrogen densities in the geocorona has been developed from observations of resonantly scattered solar Lα in the vicinity of earth. We have completed the software for the radiation transfer of Lα in the geocorona using the standard Holstein functions and spatial partitioning of the geocorona. A spherically symmetric Chamberlain model is accurate to radial distances of $\sim 4\ R_E$ beyond which the atomic hydrogen densities decline more rapidly than predicted due to charge-exchange, photoionization, and/or radiation pressure. At present, observations of enhanced hydrogen densities in the anti-solar direction are being analyzed.

We are currently attempting to apply the technique of computer tomography (CT) for analysis of a particular operating mode of the imaging instrument when the spacecraft is at perigee over the North or South Poles. The instrument scanning mirrors are commanded to a fixed position such that the atmosphere is scanned in the orbital plane. The angular responses of the imaging instrument as functions of position along the orbit can be deconvolved into atmospheric emisssion rates as functions of altitude and ground distance, i.e., a cross-section of the atmospheric emissions. This simultaneous deconvolution of ~ 50,000 line integrals is sensitive to the type of window, e.g., generalized Hamming and bandlimiting. Present progress in our software efforts and choice of windows suggests that we will be at least partially successful in applying tomographic techniques to optically thin emissions in the earth's upper atmosphere.

[Frank, Craven, Ackerson, Rairden, Edwards, Sigwarth, Eather/Boston College, Carovillano/Boston College, Keating/Langley-NASA, and Garrod/Scripps-UCSD]

(Support by Goddard Space Flight Center/NASA, NASA Headquarters, and the Office of Naval Research)

2.9 Dynamics Explorer (DE-1) (Plasma Waves)

The Plasma Wave Instrument (PWI) on the Dynamics Explorer-1 spacecraft continues to operate without any problems. Digital spectrogram and DC electric field data are collected at the spacecraft duty cycle of 60% to 80%. Wideband analog data are transmitted and collected at a duty cycle which has been increased from the baseline 20% to nearly 40%.

Analysis of the AC wave data has concentrated on the production of color-coded correlation spectrograms. Correlation of the two electric sensors EX and EZ provides wave polarization; correlation of EZ and the magnetic sensors provides one component of the Poynting vector which specifies the wave propagation direction. Software has now been developed so that the correlation is carried out as part of the production data analysis. Auroral Kilometric Radiation consistently exhibits both right-hand and left-hand polarization features with the RH being associated with the higher intensity emissions concentrated closer to the auroral zone latitudes. AKR has also been found to be propagating outward from the earth at radial distances greater than 2 R_E. Auroral hiss tends to be predominantly electrostatic with a consistently low correlation in the auroral zone. Plasmaspheric hiss and chorus exhibit the right-hand polarization expected for whistler mode waves. At typical DE ranges of 2 to 4 R_E, the hiss is found to be propagating away from the earth from the lower altitude source regions, whereas the chorus is found to be propagating toward the earth from equatorial source regions > 5 R_E. This work is being carried out by Shawhan and Huff and by a graduate student, Dan Schultz.

Ann Persoon, Gurnett, and Shawhan are submitting a paper to J. Geophys. Res. which reports values for the electron density over the northern polar cap region between 2 and 4.7 R_E. Hundreds of DE spectrograms were measured to determine the upper cutoff frequency of auroral hiss which occurs at the electron plasma frequency when the plasma frequency is below the electron gyrofrequency. The

The electron density is derived from the electron plasma frequency F_p as follows:

$$N(\text{electrons/cm}^3) = [F_p(\text{kHz})/9]^2 \quad .$$

The electron density is found to fit an $R^{-3.85 \pm 0.32}$ dependence with a value of 1.0 ± 0.5 electrons/cm at 4.6 R_E. These density measurements are the first reported over the polar cap in this altitude range. This work is part of an M.S. thesis by Ann Persoon.

Progress has been made on the analysis and interpretation of the PWI DC electric field measurements by Dan Weimer, Shawhan, and Gurnett. This work is part of an M.S. thesis by Dan Weimer. Portions of about 25 orbits have been processed to provide electric field amplitudes from the 200 meter wire antenna. (The spin axis tubular antenna does not typically give reliable results because of spacecraft charging.) Successive orbits over the polar caps indicate significant changes in the plasma convection patterns over time scales of hours with the patterns typically more complicated than the two-cell structure usually assumed. Auroral zone fields at times exhibit the "electrostatic shock" structure reported by S3-3 but the largest fields observed are less than 300 mV/m -- significantly less than the 800 mV/m reported by S3-3. Differences between DE and S3-3 may be attributed to differences in the altitude ranges surveyed or to differences in performance of the sensor systems. A systemmatic statistical survey of DE data is commencing. Other electric field phenomena which are being investigated include pulsation events with associated magnetometer and RIMS plasma features, SAR arcs, electrostatic AC wave emission and electric field features observed with the DE-2 VEFI experiment on the same field lines.

Other collaborative work includes the following:

(a) Comparison of electron density values derived from the PWI with value derived from the RIMS plasma measurements.

(b) Association of PWI ion cyclotron waves with RIMS plasma heating at the magnetic equator.

(c) Calculation of wave growth rates from HAPI-observed electron beams in comparison with PWI-observed electrostatic wave emissions in the cusp and polar cap regions.

(d) Comparison of PWI-derived plasma convection velocities to ion convection velocities derived from the HAPI measurements.

[Shawhan, Gurnett, Weimer, Persoon, Huff, and Baumback]

(Support by Goddard Space Flight Center/NASA, NASA Headquarters, and the Office of Naval Research)

2.10 Helios 1 and 2

Data from the plasma wave instrument on Helios 1 (launched on 10 December 1974) are still being received and processed. This processing consists mainly of production of 24-hour survey plots which can be used for identifying solar radio bursts, interplanetary shocks and events of interest for correlation with other spacecraft in the interplanetary medium. No data are being processed from Helios 2 which ceased operation in July 1980.

[Gurnett and Anderson]

(Support by Goddard Space Flight Center/NASA
and the Office of Naval Research)

2.11 Space Shuttle (OSS-1 on STS-3 and Spacelab-2) Plasma Diagnostics Package (PDP)

The University of Iowa's Plasma Diagnostics Package (PDP) was flown on the third flight of the Space Shuttle (STS-3) in March 1982 as part of the OSS-1 payload. Measurements of the orbiter environment, of the ionosphere, and of electron beam-generated effects were made with the PDP on the pallet and on the end of the Remote Manipulator System (RMS) 50-foot arm. This same PDP unit is being refurbished and upgraded for flight on the Spacelab-2 mission in March 1985.

Instrumentation on the PDP measured temperature, pressure, DC electric fields, magnetic fields, plasma waves, energetic ions and electrons, ion composition, electron density and temperature, ion beam direction and energy distribution, and orbiter-generated Electromagnetic Interference (EMI).

Some of the findings from the STS-3 mission are as follows:

(a) Pressure measured at the OSS-1 pallet varied from ambient level of $\sim 10^{-7}$ torr to 10^{-5} torr when the atmosphere was being rammed into the payload bay. The increased pressure is thought to be due to a gas sheath near all surfaces possibly due to O^+ reactions. During thruster firings, the pressure rose to $> 10^{-4}$ torr.

(b) Orbiter-generated EMI levels were below the predicted worst case values. At times the levels dropped to the PDP receiver noise levels. Chorus, hiss, whistlers, and emissions from the electron beam were detected.

(c) Within the payload bay, the electron density was found to vary with Orbiter attitude from nearly ambient values of 10^6 cm^{-3} to < 10^3 cm^{-3}. Plasma is excluded from the payload bay when the bay is in the Orbiter wake. Ambient O^+ is typically found but H_2O^+ and NO^+ are also observed in the wake apparently due to Orbiter sources such as the flash evaporators and thrusters.

(d) When the Orbiter thrusters are operated, electron density perturbations, electrostatic waves, energized ions and electrons, changes in electric field and Orbiter potential and H_2O^+/NO^+ ions are observed.

(e) With the PDP on the RMS, 14 cases of directed ion beams (sometimes double beams) were observed and were found to appear and disappear as the Orbiter's attitude changed. Beams are expected as one of the Orbiter wake phenomena.

(f) Broadband electrostatic noise with intensity up to 0.5 V/m at ~ 0.5 kHz is observed. Because of the orbital periodicity and associated RAM/WAKE modulation, it is assumed to be generated by the Orbiter motion though the ionosphere. Observations seem to be consistent with a theory by K. Papadopoulos which predicts a lower-hybrid drift wave generated at the Orbiter surfaces.

(g) By moving the PDP with the RMS, it was possible to scan the PDP through the electron beam column. A 1 keV, 50 ma electron beam was emitted by the Fast Pulse Electron Generator FPEG). The column was found to be 6 meters in diameter--a gyrodiameter--and to contain electrons up to 1 keV and ions up to 250 eV in energy. Waves at the plasma and gyrofrequencies were observed with ~ 1 V/m amplitudes and DC electric fields in excess of 10 V/m were measured. When the electron beam was modulated in the kHz range, VLF emissions were clearly detected.

(h) With and without the FPEG operation, energized plasma is observed in and near the payload bay. Ions up to 30 eV and electrons up to 100 eV are observed; these may be locally accelerated. During the FPEG operations, return fluxes of electrons up to the 1 keV gun energy and of ions up to 300 eV are observed.

Continued data analysis will emphasize understanding of the thruster effects, the origin of the electrostatic noise, the electron wake depletion, and the energized plasma surrounding the Orbiter.

Hardware changes to the PDP for the Spacelab-2 mission include addition of batteries for the free-flying subsatellite operations, addition of booms for the electric field, searchcoil and Langmuir probe sensors and addition of a receiver to measure the field strengths of the Ku-band transmitter. NASA/HQ is considering possible changes to the PDP to make it recoverable on Spacelab-2 so that it can be utilized to support the Chemical Release and Radiation Effects Satellite, the Tether and the Space Plasma Lab-1 missions.

[Shawhan, Frank, Gurnett, D'Angelo, Grebowsky/GSFC, Fortna/GSFC, Reasoner/MSFC, and Stone/MSFC]

(Hardware support by Marshall Space Flight Center/NASA)

(NLRO support by the Office of Naval Research)

2.12 Shuttle-Spacelab/Recoverable Plasma Diagnostics Package (RPDP)

Over the past year, a design study of a Recoverable Plasma Diagnostics Package (RPDP) has been conducted. The RPDP is to be a fully instrumented spacecraft (more sophisticated than the Plasma Diagnostics Package for OSS-1 and Spacelab-2) that is to be carried into orbit and recovered from orbit by the Shuttle. When deployed into orbit, the RPDP measures the ambient plasma conditions and the perturbations caused by the injection of energetic particles (via SEPAC), the emission of waves (WISP), the release of chemical tracers by Shuttle-borne equipment such as CRRES, and perturbations caused by an electrodynamic tether. The Orbiter establishes the experimental geometry with respect to the magnetic field. RPDP data are to be transmitted back to the Orbiter for display to the crew to allow interactive adjustment of experimental parameters.

Because of NASA funding constraints, the RPDP has been descoped to a minimum configuration to support a wave-emphasis Space Plasma Lab-1 mission in 1988 and a particle-emphasis Space Plasma Lab-2 mission in 1990 or 1991.

Study has been concentrated on the complement of scientific instruments and on the performance characteristics to carry out these missions. Some spacecraft design has proceeded on the microprocessor-based controller/encoder, the extendable booms and antennas, the structure design, and the recovery mechanisms.

[Shawhan, Ackerson, Anderson, Craven, D'Angelo, Frank, Gurnett, Shaw, Block/Sweden, Fälthammar/Sweden, Sugiura/GSFC, Hoffman/UTD, Taylor/TRW, Obayashi/Tokyo, Banks/Stanford, Stone/MSFC, and Samir/Michigan]

(Support by Marshall Space Flight Center/NASA)

Shawhan is the co-investigator for the following related programs; the RPDP is designed to support these investigations.

(a) Waves in Space Plasmas (WISP)

Principal Investigator: Robert Fredricks, TRW.
Other U. of Iowa Co-Investigator:
Wynne Calvert.
Responsibility: Accommodate WISP instrumentation on the RPDP; provide VLF instruments on RPDP.

(b) Shuttle Experiments with Particle Accelerators (SEPAC)

Principal Investigator: Tats Obayashi, U. of Tokyo.
Responsibility: Accommodate SEPAC instrumentation on the RPDP; provide VLF and particle detector instruments on RPDP.

(c) Magnetospheric Multiprobes

Principal Investigator: James L. Burch, Southwest Research Institute.
Responsibility: Provide RF antennas, telescoping booms, wire antennas, DC electric field instruments, and plasma wave instruments.

2.13 Galileo/Status of Development of Plasma Instrument

Construction of the plasma instrument (PLS) for the Galileo orbiter was completed in early May 1983. This instrument includes capabilities for measuring the three-dimensional velocity distributions of ions and electrons, simultaneously and separately, over the energy-per-unit-charge range 1 eV $\leq$ E/Q $\leq$ 50 keV and for determining ion composition, M/Q, over this energy range. Significant advances in our knowledge of the Jovian plasma environment are expected because this is the first plasma instrument specially designed for such studies. The dual-microprocessor data system was successfully implemented and allows continued instrument operation even in the event of total fault of one microprocessor or its RAM or ROM memories. The instrument software is sufficiently flexible to allow decisive measurements of a host of plasmas, e.g., solar wind, cool ions and electrons in the Io torus, hot corotating plasmas in the Jovian plasma sheet, and field-aligned electron and ion beams, the latter through an electronic 'search and capture' mode. Currently the PLS instrument is being calibrated and is undergoing qualification testing. Delivery of the instrument for initial integration on the Galileo spacecraft is expected to occur in late July 1983. The Shuttle/Centaur launch of the Galileo spacecraft is scheduled for May 1986. Extensive periods of instrument calibrations and flight sensor installation will occur during the next year.

[Frank, Coroniti/UCLA, and Vasyliunas/MPI Lindau]

(Support by the Jet Propulsion Laboratory)

2.14 Galileo/Status of Plasma Wave Instrument Development

The engineering model and flight unit of the Galileo plasma wave instrument have been delivered to the Jet Propulsion Laboratory and are presently undergoing acceptance level testing.

[Gurnett, Shaw, Shawhan, Gendrin/CNET, and Kennel/UCLA]

(Support by the Jet Propulsion Laboratory)

2.15 Origin of Plasmas in the Earth's Neighborhood (OPEN)/Status of Plasma Instrumentation

The comprehensive plasma instrument for the Geomagnetic Tail Laboratory (GTL) of the OPEN mission is currently being subjected to a sophisticated computer analysis during the definition phase. This plasma instrument is capable of fully three-dimensional measurements of all types of positive ion and electron velocity distributions that are anticipated in the magnetotail and its environs, including the mass (M/Q) composition of the ions. Specifically the individual analyzers that have been combined in this single instrument are (a) a solar wind ion analyzer, (b) an electrostatic analyzer for measurements of the three-dimensional velocity distributions of hot positive ions and electrons over the energy range 1 eV to 50 keV, and (c) imaging mass spectrometers for sensitive determinations of the M/Q composition of ions over most of the 4π steradian solid angle for ion velocity vectors at the spacecraft. The mass range of the mass spectrometers is $1 \lesssim M/Q \lesssim 200$ with a resolution $(M/Q)/(\Delta(M/Q)) \gtrsim 15$ in 330 simultaneously sampled channels. The performance characteristics of the mass spectrometers as proposed for this mission have been verified by laboratory calibrations of an engineering model. Current work is directed toward improving the mass spectrometer performance beyond that stated in the proposal. The equation of motion for charged particles in a spherical-plate electrostatic analyzer has been solved now in closed form. (All previously reported solutions in the literature are based upon time-consuming numerical integra-tion of the trajectories through the analyzer.) Hence we have derived the trigonometric equations for the 21 fundamental quantities of analyzer design, e.g., acceptance angles, energy resolutions, and exit angles. This achievement has allowed us to perform the most comprehensive analyses of electrostatic analyzers to date. Using these equations we have shown that the electrostatic analyzers meet or exceed the performance requirements as stated in the original proposal. Currently we are further improving instrument characteristics, in particular the sampling of phase space segments, by computer codes simulating the existence of 'fencing' collimators at the entrance apertures of the analyzers.

[Frank, Ackerson, Coroniti/UCLA, and Siscoe/UCLA]

(Definition phase work supported by Goddard Space Flight Center/NASA and the Office of Naval Research)

2.16 Origin of Plasmas in the Earth's Neighborhood (OPEN)/Status of Imaging Instrument

The advanced auroral imaging instrumentation for visible wavelengths as proposed by the University of Iowa for the Polar Plasma Laboratory (PPL) of the OPEN mission was funded for definition phase studies in January 1983. The instrument design guidelines include significant improvements in sensitivity, spatial resolution, and temporal resolution relative to those for the DE imaging instruments. A catoptric primary optics system with an off-axis section of a parabolic mirror as the focussing element is used in the OPEN imaging instrument. The angular resolution is planned currently to be 526 μrad/pixel, or a ground resolution from 10 R_E altitude of 60 km/lp. A higher resolution mode for 15 km/lp at 10 R_E is included in the instrument design. Maximum frame rate that can be supported by the spacecraft telemetry system is one frame each 20 seconds. Filters include those for N_2^+ (1st negative 0-0 band) at 391.4 nm, OI ($^1D-^1S$) at 557.7 nm, OI ($^3P-^1D$) at 630.0 nm, and N_2 (1st positive 5,2 band) at 668.0 nm.

The imaging investigators for visible and ultraviolet wavelengths for the OPEN mission were requested by Dr. Burt Edelson of NASA Headquarters to combine the two instruments for these two wavelength ranges into a common instrument in order to minimize the resources required for imaging. The University of Iowa and Utah State University groups have accordingly reached an agreement to design such a comprehensive imaging system. L. A. Frank of the University of Iowa will remain as Principal Investigator for the imaging at visible wavelengths and M. R. Torr of Utah State University will be the Principal Investigator for ultraviolet imaging. The formal agreement outlines the specific portions of the combined instrument that will be designed and constructed at each institution. Current design activity is directed toward optimization of optical performance with respect to limited weight, cost, and power.

[Frank, Craven, Hays/U. of Michigan, and Sharp/U. of Michigan]

(Definition phase work supported by Goddard Space Flight Center/NASA and the Office of Naval Research)

2.17 Origin of Plasmas in the Earth's Neighborhood (OPEN)/Plasma Wave Analyzers for GTL and PPL

Proposals for Plasma Wave Analyzers for the Geomagnetic Tail Laboratory (GTL) satellite (Gurnett) and for the Polar Plasma

Laboratory (PPL) satellite (Shawhan) have been selected for a definition phase study. At present, effort is being expended on a fifteen-month Definition Phase at both the project and the instrument level. As members of the Science Working Team, Gurnett and Shawhan are also making recommendations as to satellite orbits, performance characteristics, management practices, and the capabilities of the science data facility. All four plasma wave instrument groups are meeting to specify the necessary instrument performance characteristics and the management methods. The goal is to design instrument components that can be used on all four OPEN spacecraft to save development cost and to maximize commonality of measurements. With similar instruments, the data analysis and display software can also be similar.

[GTL: Gurnett, Shaw, Anderson, Shawhan, Goertz, Alexander/GSFC, Tsurutani/JPL, Matsumoto/Kyoto, Kaiser/GSFC, and Scarf/TRW]

[PPL: Shawhan, Anderson, Goertz, Gurnett, Kurth, Alexander/GSFC, Kaiser/GSFC, Fredricks/TRW, Kelley/Cornell, Kintner/Cornell, Park/Stanford, Tsurutani/JPL, Temerin/Berkeley, and Matsumoto/Kyoto]

(Definition phase work supported by Goddard Space Flight Center/NASA)

2.18 Active Magnetospheric Particle Tracer Experiment (AMPTE)

A proposal has been accepted by the Office of Naval Research for support of a plasma wave electric and magnetic field instrument for the Active Magnetospheric Particle Tracer Experiment. The basic scientific objective of the AMPTE mission is to use a series of large lithium and barium ion releases in the solar wind, magnetosheath, and distant magnetotail to study the diffusion and transport of charged particles in the earth's magnetosphere. The investigation consists of three spacecraft: the Charge Composition Explorer (CCE) which is to be provided by Johns Hopkins Applied Physics Laboratory (S. M. Krimigis, principal investigator), the Ion Release Module (IRM) which is to be provided by the Max-Planck-Institut für Extraterrestrische Physik (G. Haerendel, principal investigator), and the United Kingdom Subsatellite (UKS) which is being provided by the Rutherford-Appleton Laboratory (D. Bryant, principal investigator). The IRM and UKS will be placed in a highly eccentric near-equatorial orbit with an apogee geocentric radial distance of about 20 R_E and the CCE will be placed in a similar orbit with an apogee geocentric radial distance of 8.5 R_E. The AMPTE launch is scheduled for August 1984.

The University of Iowa has been invited by Dr. Haerendel to provide a plasma wave instrument on the German IRM for the purpose of studying plasma instabilities that develop in the barium and lithium ion clouds after their release near the IRM. The basic instrumentation for this investigation is to consist of a spare electric antenna and a spectrum analyzer from the Helios projects, plus certain instrumentation that is being constructed specifically for the IRM application. At the present time all instrument interfaces have been established and the electronics construction is nearly complete. The instrument is scheduled to be completed by the summer of 1983.

[Gurnett and Anderson]

(Support by the Office of Naval Research)

2.19 RADSAT (CRESS) Plasma Wave Investigation

The radiation satellite RADSAT will use the CRM (Chemical Release Module) spacecraft structure and will be launched by a NASA Shuttle. Instrument delivery is scheduled for September 1984 and launch is expected to be in April 1985. RADSAT will remain in a 300 km altitude circular orbit for about 45 days during which the chemical releases will take place. It will then be boosted into a 6 R_E by 300 km orbit at an inclination of 18°. Mission duration is expected to be three years.

The objective of RADSAT is to determine the energetic particle fluxes throughout the earth's radiation belts and to determine the effect of energetic particles on microelectronics. To achieve these objectives RADSAT will be instrumented (a) to measure the particles' characteristics near the geomagnetic equator, (b) to measure simultaneously the effects upon the microelectronics, and (c) to measure those factors which cause changes in the energetic particle populations. Since plasma waves can play a major role in changing the energetic particle population through pitch angle scattering, ion heating, and other wave-particle interaction processes which exchange energy and/or momentum between the waves and particles, a plasma wave experiment proposed by the University of Iowa has been included on RADSAT.

The plasma wave instrumentation will provide measurements of electric fields from 5.6 Hz to 400 kHz and magnetic fields from 5.6 Hz to 10 kHz with a dynamic range of at least 100 dB. The sensors consist of an extendible 100 m tip-to-tip long electric dipole antenna (to be provided by the spacecraft contractor) and a boom-mounted search coil magnetometer which the University of Iowa will provide. The basic instrumentation that the University of Iowa will build includes (a) a sweep frequency receiver for high frequency resolution spectrum measurements of the electric field from 100 Hz to 400 kHz and (b) a spectrum analyzer to provide high time resolution electric and magnetic field spectra from 5.6 Hz to 10 kHz. The experiment is in the design phase and interface specifications have been negotiated with AFGL. Some critical parts with the longest anticipated delivery times have been ordered.

[Anderson and Gurnett]

(Support by Air Force Geophysical Laboratory)

2.20 Very Long Baseline Radio-Interferometry (VLBI)

The ONR 60-ft parabolic antenna at the North Liberty Radio Observatory has been converted from a spacecraft telemetry facility to a VLBI receiving station operating at a wavelength of 18 cm (OH line). It has been adopted as an element of the national VLBI network at this frequency. A substantial program of observations is underway, in collaboration with other VLBI observatories in the United States, Puerto Rico, and Germany.

[Mutel, Fix, Spangler et al., and observers from other laboratories]

(Principal current support by the National Science Foundation)

2.21 Theory

Theoretical studies are continuing on the propagation and acceleration of solar protons, alpha particles, and electrons in the interplanetary medium; on the emission of X rays and radio noise by the sun; on the generation and propagation of very low frequency radio waves in the magnetosphere and the relationship of such waves to particle acceleration, diffusion, and precipitation; on shock waves in the interplanetary medium; and on the physical dynamics of the magnetospheres of Jupiter and Saturn. This work has been substantially expanded recently by NASA funding of Iowa's innovative research proposal in the area of space plasma physics. A specific objective under this program is to develop a comprehensive understanding of the role of plasma phenomena in the sun and in other astrophysical systems.

[Gurnett, Goertz, Frank, Calvert, Spangler et al.]

(Support by Office of Naval Research, the National Science Foundation, and NASA Headquarters)

3.0 Senior Academic Staff in Space Physics [31 December 1982]

Van Allen, James A.	Carver Professor of Physics and Head of Department of Physics and Astronomy
D'Angelo, Nicola	Professor of Physics
Frank, Louis A.	Professor of Physics
Gurnett, Donald A.	Professor of Physics
Shawhan, Stanley D.	Professor of Physics
Goertz, Christoph K.	Professor of Physics
Shapiro, Maurice M.	Visiting Professor of Physics
Calvert, Wynne	Research Scientist [Research Associate]
Craven, John D.	Research Scientist [Research Associate]
Ackerson, Kent L.	Associate Research Scientist [Research Associate]
Anderson, Roger R.	Associate Research Scientist [Research Associate]
Eastman, Timothy E.	Associate Research Scientist [Research Associate]
Grabbe, Crockett L.	Associate Research Scientist [Research Associate]
Kurth, William S.	Associate Research Scientist [Research Associate]
Randall, Bruce A.	Associate Research Scientist [Research Associate]
Shaw, Robert R.	Associate Research Scientist [Research Associate]
Reinleitner, Lee A.	Research Investigator [Research Associate]

Also in Closely Related Work
(Astronomy and Plasma Physics)

Fix, John D.	Professor of Astronomy
Knorr, Georg E.	Professor of Physics
Neff, John S.	Professor of Astronomy
Payne, Gerald L.	Professor of Physics
Carpenter, Raymon T.	Associate Professor of Physics
Mutel, Robert L.	Associate Professor of Astronomy
Nicholson, Dwight R.	Associate Professor of Physics
Merlino, Robert L.	Assistant Professor of Physics
Spangler, Steven R.	Assistant Professor of Astronomy
Sheerin, James P.	Assistant Research Scientist [Research Associate]

4.0 Senior Engineering and Administrative Staff [31 December 1982]

Enemark, Donald C.	Adjunct Associate Professor of Physics
Brechwald, Robert L.	Manager, Systems and Programming Services
Randall, Roger F.	Senior Engineer
Robertson, Thomas D.	Administrative Associate
Anderson, Roger D.	Engineer IV
Clausen, Terry L.	Engineer IV
English, Michael R.	Engineer IV
Lee, James A.	Engineer IV
Odem, Daniel L.	Engineer IV
Owens, Harry D.	Engineer IV
Bailey, Miles H.	Engineer III
Berry, Martin B.	Engineer III
Kirchner, Donald L.	Engineer III
Knowlton, James R.	Engineer III
Kruse, Elwood A.	Engineer III [R & QA]
Markee, Robert	Engineer III [Departmental Machine Shop]
Phillips, James R.	Engineer III
Remington, Steve L.	Engineer III
Williams, R. Everett	Engineer III [Departmental Graphic Services]
Huff, Richard L.	Research Assistant III
Murphy, Gerald B.	Research Assistant III
Robison, Evelyn D.	Program Assistant [Supervisor, Publications]

5.0 Junior Academic Staff in Space Physics [31 December 1982]

All of those listed below are graduate students, engaged in research in space physics.

	Appointment	Principal Research Project
Adnan, Johari B.	Research Assistant	Hawkeye I
Baumback, Mark M.	Research Assistant	ISEE / Interferometer, DE Plasma Waves
Dresselhaus, Ann	Teaching Assistant	Shuttle PDP / Electron Density
Edwards, Patrick A.	Research Assistant	Dynamics Explorer, Imaging
Fuselier, Stephen A.	Research Assistant	ISEE
Grosskreutz-Hyman, Cynthia	Research Assistant	Pioneer 10/11
Hudek, Dean G.	Research Assistant	Waves in Plasmas
Omidi, Nojan	Research Assistant	ISEE / Plasma Waves
Persoon, Ann M.	Research Assistant	Dynamics Explorer, Plasma Waves
Rairden, Richard L.	Research Assistant	Dynamics Explorer, Imaging
Seery, Joan R.	Research Assistant	Waves in Plasmas
Tokar, Robert L.	Research Assistant	Voyager, JDAP, Plasma Waves
Weimer, Daniel R.	Research Assistant	Dynamics Explorer, Electric Fields

6.0 Advanced Degrees Awarded in Space Physics at U. of Iowa 1 January 1982 -- 31 December 1982

Ph.D. Degrees

Dennis Lee Gallagher (July 1982): "Short Wavelength Electrostatic Waves in the Earth's Magnetosheath"

Lee Allen Reinleitner (July 1982): "Whistler Mode Chorus Generation of Beam Driven Electrostatic Bursts"

M.S. Degree

Cynthia Lee Grosskreutz (July 1982): "Distribution of Energetic Electrons ($E_e > 0.040$ MeV) in Saturn's Inner Magnetosphere"

7.0 Publications in Space Physics 1 January 1982 -- 31 December 1982

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