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PLASMA AND MAGNETOSPHERIC RESEARCH

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by

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and

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ANALYSIS TECHNIQUES AND SOFTWARE DEVELOPMENT

Several programs and variations have been developed to determine statistical means of different plasma parameters when binned in different variables. These parameters include temperatures, densities and spacecraft potentials for any of the ion species, as well as ratios of these variables for any other ion species to the corresponding variable for H^+. The variables for binning include L, radial distance, and geomagnetic latitude; and separate statistics are automatically run for local morning and local evening data. These programs all run from output files from the plasma parameter thin sheath analysis program. A variant program also bins for magnetic activity, using either Kp or Dst, which requires an additional magnetic activity input file. These programs can be run either interactively or in batch mode, using a file listing generated by a "DIRECTORY" command. In addition to printed output, these programs generate output files which can be used to plot the results. Programs to plot these averaged data are under development.

DATA ANALYSIS AND MODELLING

Semi-empirical models of flux vs spin angle have been established for the RIMS Z heads, analogous to those for the radial head, by fitting the same empirical model to the numerical results from parametric calculations with the SHEATH program. Although the Z heads do not spin, these curves are needed to specify the relationship between the flux at 90 degrees and that in the ram direction. This will later be used to try to improve the determination of density from the Z head data.

Considerable progress has been made in the study of the ionosphere of Uranus. A standard neutral atmosphere has been developed as the basis for comparisons of the effects of electron precipitation, as well as new chemical processes such as the influx of water or methane, on the upper atmosphere. Eight separate cases for the ionosphere have been modelled, consisting of different energies and flux levels for precipitating electrons. These auroral simulations are being used to determine the dependence of the Lyman alpha emissions on the energy flux of the precipitating electrons. This will, in turn, provide information on the energy deposition necessary in the Uranian atmosphere to produce the observed levels of Lyman alpha emissions.

In the process of developing the standard neutral atmosphere, the importance of vibrationally excited H3+ has been studied. This work includes some recently determined reaction rates for reactions of excited H3+ with neutrals. The effects of an influx of methane have been included in the most recent versions of the neutral atmosphere. An influx of methane or perhaps water is possible from the Uranian rings and could have significant impact on the ionosphere.

In response to the referees' comments on the O++ paper (Ref. 1), simulations have been performed to study the effect on the ion and electron temperature of the strength and location of ion and electron heat sources in the high altitude plasmasphere (L=3). These results suggest that while the high altitude temperatures are highly sensitive to the magnitude of the source, the spatial width (centered about the equatorial plane) is of minor importance in determining the temperature structure along the field line. Additional simulations of the O++ and N+ populations in the plamasphere have been initiated to answer further comments by the referees on this paper.

SPACECRAFT SHEATH EFFECTS

The analysis of the charging event on ISEE-1 has been largely completed, with the tentative conclusion that the fundamental cause was relatively low conductivity on the solar arrays. Although the solar arrays were coated with indium oxide to provide a conducting surface, it is apparent that the surface characteristics of the ISEE-1 satellite were poorly determined, and varied between ground tests. Charging studies of indium oxide coated surfaces show that they can easily maintain differential potentials of many volts per meter, and that they will charge with respect to the ambient plasma when irradiated by electron beams. These conclusions suggest that future scientific satellites, with conductive coatings, should be treated in such a way as to insure (as much as possible) that the level of conductivity is higher than that of ISEE-1 at launch.

Analysis of electron gun operations on the SCATHA satellite shows evidence for beam-plasma interactions, resulting in the heating of the ambient plasma around the satellite. These results bear a strong resemblence to the SEPAC operations on Spacelab 1. Preliminary results will be presented to the Fall AGU meeting (Ref. 2)

Analysis of the spin modulation of the SCATHA satellite potential has been completed. A manuscript (Ref. 3) has been prepared, reviewed by coauthors, and revised in accordance with their comments; it should be submitted shortly.

An empirical relationship between the mean spacecraft potential and the mean H^+ density has been determined, using a variant of one of the statistical programs discussed above. Based on data from about 60 plasmaspheric passes, this relationship shows a monotonic decrease in spacecraft potential, saturating at about -0.4 volt deep in the plasmasphere. The potential becomes positive for densities below about 1000 cm^{-3}; also, the standard deviation increases substantially for these lower densities. This is probably associated with both increased uncertainties in the analysis and effects of increasing temperatures. Small, but significant, differences were found between results from the morning and evening data sets. These may be effects of systematic temperature differences, compositional differences, or a result of an insufficient data sample.

LABORATORY PLASMA FLOW STUDIES

The Differential Ion Flux Probe (DIFP) for the Centaur IIa payload has been delivered to Southwest Research Institute fo integration. The functional calibration, vibration, and post-vibration tests were completed in September. Analysis of the laboratory calibration data will take place during the next reporting period. Launch of the Centaur IIa will take place in January 1986.

Fabricated parts for the dual ion source have been received from the machine shop, and it is now being assembled. Testing will begin in the next reporting period.

INSTRUMENT DEVELOPMENT

The following tasks were carried out during this reporting period:

- Parts for a mass spectrometer were completed
- Fabrication of parts for a collimator were completed
- Parts were completed for the dual ion source

- Modifications and parts for the gimbal system of the vacuum tank were completed
- Fabrication of parts for 5 detector heads is 90% complete
- A number of miscellaneous parts were manufactured and modifications to instruments and systems were made.

PERSONNEL

We are pleased to have Dr. Roy Torbert join the UAH Physics Department from the University of California at San Diego; he will be carrying out research under this contract.

PUBLICATIONS

In addition to the papers noted above, the following papers are at the indicated stage of the publication cycle.

- Papers published during this reporting period:

  those on ISEE-1 measurements of plasmapause structure (Ref. 4), the cleft ion fountain (Ref. 5, 6), RIMS observations of molecular ions (Ref. 7), and the geomagnetic mass spectrometer (Ref.8).

- Papers accepted for publication and in press are those on:

  differential ion flux measurements on Spacelab 2 (Ref. 9), comparing plasma disturbances caused by the space shuttle with those caused by small ionospheric satellites (Ref. 10), DE-1 eclipse observations (Ref. 11), supersonic outflows in the polar magnetosphere (Ref. 12), and solar wind control of the geomagnetic mass spectrometer (Ref. 13).

o Papers submitted and in review are those on:

ions observed in the wake of DE 1 by RIMS (Ref. 14), ion acceleration associated with plasma expansion into a vacuum (Ref. 15), the expansion of a collisionless plasma into the wake of a moving body (Ref. 16), the electrodynamic effects of the space shuttle on the environmental plasma from OSS-1/STS-3 (Ref. 17), velocity filter mechanism producing bowl-shaped distribution functions (Ref. 18), destiny of earthward streaming plasma sheet boundary layer plasma (Ref. 19), plasma boundaries in the inner magnetosphere (Ref. 20), equality of H^+ and O^+ velocities (Ref. 21), transport of accelerated ions in the polar magnetosphere (Ref. 22), SCATHA eclipse observations of electric fields (Ref. 23), record charging events on ATS-6 (Ref. 24), RIMS obsevations with the aperture bias (Ref. 25), Pc 5 wave observations (Ref. 26), and latitudinal distribution of plasma in the dusk bulge region (Ref. 27).

o Papers in preparation are those on:

equatorial ion observations (Ref. 28), ion velocities in the plasmasphere (Ref. 29), and extensive comparisons between DE-1 and DE-2 observations of plasmasphere-ionosphere coupling (Ref. 30).

In addition to those noted above the following papers have been or will be presented to national or international meetings.

o Paper presented was one on observations relating to the Coulomb excitation mechanism for SAR arcs (Ref. 31).

o Abstracts have been submitted on:

the tail lobe ion mass spectrometer (Ref. 32), the destiny of earthward streaming plasma (Ref. 33), ion bowl distribution (Ref. 34), the construction of a three-dimensional electric potential model for high latitudes (Ref. 35), and calculations of three-dimensional trajectories in the magnetosphere (Ref. 36).

R. H. Comfort

J. L. Horwitz

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FINANCIAL DATA

NAS8-33982

AMOUNT OF CONTRACT	$$1,254,999.00
Expenditures through September 1985	1,147,151.66
Balance September 30, 1985	107 847.34