☆ STAR DUST

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ACUNA TO REVIEW VOYAGER AND PIONEER SATURN DATA


DR. ACUNA

Dr. Mario H. Acuna, Goddard Space Flight Center, will speak on Saturn and its environment at the February 7 meeting of National Capital Astronomers.

The abundance of Pioneer and Voyager data on atmospheres, heat balance, composition, magnetic fields, plasmas, electromagnetic emissions, energetic charged particles, and thousands of images, provides a basis for comparative study of the magnetospheres of those planets now known to have intrinsic magnetic fields — Mercury, Earth, Jupiter, and Saturn.

The subject of widespread active research, these comparisons offer the potential of greatly increased knowledge of the Earth's magnetosphere.

Dr. Acuna will review these recent data and discuss the near alignment of Saturn's magnetic and rotational axes, the absence of a Jupiter-like magnetodisk, planetary radio emissions, the interaction of Titan with its environment, and other related phenomena.

Mario H. Acuna was born in Cordoba, Argentina, where he received his undergraduate degree. He earned the M.S.E.E. in 1967 from the University of Tucuman, and the Ph.D. in Space Science from The Catholic University of America in 1974. He joined Goddard in 1969, where he has been Instrument Engineer, Principal Investigator, or Project Scientist on Explorers 47 and 50, Mariner 10, Pioneer 11, Voyagers 1 and 2, Magsat, the International Solar Polar Mission, Project Firewheel, and Ampte, and has received many awards in recognition of his contributions to NASA programs.

FEBRUARY CALENDAR — *The public is welcome.*

Tuesdays and Fridays — The telescope-making classes will be suspended during February pending Jerry Schnall's recovery from surgery. For further information call Bob McCracken, 229-8321.

Friday, February 6, 13, 27, 8:00 PM — Observing with the NCA 14-inch telescope with Bob Bolster, 6007 Ridgeview Drive, south of Alexandria off Franconia Road between Telegraph Road and Rose Hill Drive. Call Bob at 960-9126.

Saturday, February 7, 6:15 PM — Dinner with the speaker at the Thai Room II, 527 13th Street, NW. Reservations unnecessary.

Saturday, February 7, 8:15 PM — NCA monthly meeting at the Department of Commerce Auditorium, 14th and E Streets, NW. Dr. Acuna will speak.

Friday, February 13, 8:00 PM — Joint NCA-SPSE tour of Naval Observatory. Limited number; see page 23.

JANUARY LECTURE

Dr. Darrell L. Strobel of the U.S. Naval Research Laboratory addressed the January 3 meeting of National Capital Astronomers. He spoke on the synergy among ground-based, earth-orbiting, and deep-space observations, in yielding a better understanding of the universe. With his case in point, the plasma torus in the orbit of Io about Jupiter, he clearly illustrated the importance of coordinating the observational modes for accurate results.

Ground-based observations first disclosed Na D-line emission from a cloud in Io's orbit, with neutral Na near Io. Subsequent observations found neutral K and S ions. Further ground-based observations with an occulting disk showed matter leaving Io with a relative velocity of 10 km per second — too fast for either sputtering or volcanic eruption. The intensity ratios of S II forbidden lines at 6716 and 6731Å and the doublet at 4070Å indicate an effective temperature of 20,000 K and electron density of 10^4 cm^{-3}. At this temperature the intensity ratio varies significantly with electron densities from 10 to 10^4 cm^{-3}. No UV spectrum was expected at this low temperature.

Without observations made in space, this would have been the complete picture. The Voyager I UV spectrometer, however, recorded an extensive UV spectrum with a very strong feature at 685Å and a weaker one at 833Å, indicating the presence of S III, S IV, O II, and O III. The absence of a feature at 539Å limits the amount of O II and thus places a lower bound on the temperature of the plasma. Other features are present at 1020Å (S III), 1070Å (S IV), and one at about 1200Å remaining after subtraction of the interplanetary Lyman α.

Because no UV spectrum was predicted from the ground-based results, the Voyager UV spectrometer was designed primarily to distinguish the 584Å He line and the Lyman-α line at 1256Å; high resolution was not required. Line structure cannot be observed directly with the low (30Å) resolution. Instead, a model was constructed, the resulting spectrum was computed and compared with the observed spectrum and the model was adjusted accordingly. The resulting model temperature was 80,000 K with an electron density of 1850 cm^{-3}. This differs markedly from the model derived from ground-based observations.

Still other results were obtained from the Plasma Science Experiment (PLS) on Voyager. While the EUV computed model predicts an O II density of 49 cm^{-3}, 346 cm^{-3} for O III, and 216 cm^{-3} for S IV, the PLS in-situ measurements yield densities of about 100 cm^{-3} for O III, a larger density of O II, and a density less by a factor of 2 for S IV. These measurements indicate a temperature of 60,000 K, quite different from the EUV indication, though modification of the collision strengths in the EUV model could yield better agreement.

The PLS only measures charge-to-mass ratio; S III and O II, having the same charge-to-mass ratio, are therefore indistinguishable by this method. This deficiency can be overcome, however, leaving three apparently different pictures of the plasma torus.

The Voyager results prompted a program to monitor the O II, O III, S III, and S IV from the ground, during which neutral O was detected. The earth-orbiting IUE detected S III lines at 1198Å and 1256Å and an O III line at 1664Å, which indicate an O III density of 100 cm^{-3}, in better agreement with the PLS than with the EUV or the ground-based measurements.

The way to obtain a coherent picture of the plasma torus that incorporates features of all three models is to examine its structure. This was done by slowly scanning the torus east to west, then north to south through the polar caps of Jupiter. These scans show the torus to be aligned with the magnetic field along the centrifugal equator. The torus exhibits a two-tiered structure; the inner surface is cooler (20,000 K) and well defined, the outer surface much hotter and extended outward, falling off slowly in density. The expected fan-shaped cross-section was observed in S II from the ground, which leads to the conclusion that ions diffusing inward radiate and cool, producing the sharp density discontinuity observed both in situ and from the ground. The maximum plasma density is at 5.7 Jupiter radii (R_J) or 70,000 km, with strong concentrations of S^+ at 5.3 and 5 R_J. Most of the S^+ is inside the Io orbit. The cross-

OCCULTATION EXPEDITIONS PLANNED

Dr. David Dunham is organizing observers for the following grazing lunar occultations in February. For further information call Dave at 585-0989, or Richard Taibi, 449-7170.

UT Date	Time	Place	Vis Mag	Pcnt Sunlit	Cusp Angle	Min Aper
02-06-81	23:01	Milton, DE	7.3	5	9S	10 cm
02-09-81	00:04	Myersville, MD	7.7	20	7S	5 cm
02-12-81	01:13	Hyattstown, MD	8.9	53	4S	20 cm
02-12-81	21:15	Streetsboro, OH	1.1	63	9S	5 cm
02-13-81	04:57	Largo, MD and DC	8.1	66	4N	20 cm
02-21-81	02:18	Leggett & Creedmr, NC	5.2	95	8S	5 cm

TREASURER'S REPORT FOR SIX MONTHS ENDING 31 DECEMBER 1980

Income	
Membership Dues	3192.74
Gifts to Telescope Fund	00.00
Telescope-making classes	25.00
Sale of Publications	50.00
Total	$3267.74

Expenses	
Sky & Telescope	1595.25
Star Dust incl Pstg	417.74
Administv & Miscel*	734.29
Obs Hdbk, Other Pubs	89.11
Total	$2836.39

Balance on hand 1 July 1980	$2371.77
Excess Income Over Expenses	431.35
Balance on hand 31 December 1980	$2803.12

*Includes $269.82 for new overhead projector.

Daniel G. Lewis
Treasurer

NCA, SPSE TO TOUR NAVAL OBSERVATORY

A group of members of National Capital Astronomers and the Washington Chapter of the Society of Photographic Scientists and Engineers will tour the U. S. Naval Observatory on Friday, February 13 at 8:00 PM. Emphasis will be on astronomical applications of photographic techniques. A very limited number can be accommodated; call Bob McCracken for reservations before February 12 noon, at 229-8321. General tours of the Observatory are offered monthly. For those, call the Observatory at 254-4539.

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section of the torus is about 1 R_j.

The two-tiered structure explains the divergence among the observations and emphasizes the necessity to coordinate the ground and space observational modes to obtain the complete picture.

There are three ways to determine the plasma ionization rate: 1. Co-rotational lag indicates $1\text{-}2 \times 10^{28}$ SO_2^+ ions per second throughout the entire torus; 2. Analysis of the radial ion-density profile yields the order of 10^{29} ions per second; 3. The EUV detected 2×10^{12} Watts of radiated energy, which implies a minimum ionization rate of $1.5\text{-}2.5 \times 10^{28}$ SO_2 ions per second. Knowing the ionization rate, density, source strength, and torus size, one can calculate a typical recombination time of 30 days for 10^{28} and 3 days for 10^{29} ions per second. Ground-based spectrometry of the torus with and without Io places an upper limit on the ionization rate one-tenth of the above values. This indicates that ionization occurs not only near Io, but throughout the torus, which is consistent with the previously mentioned detection of neutral O.

Observations of Jupiter indicate that the torus has a large effect on the planet it encircles. The EUV reveals solar Lyman-α scattering and strong auroral emissions in the polar regions due to H II. An interesting discovery is that the plasma-torus magnetic field lines map into the regions of high auroral activity.

Another observation of interest is the albedo of Jupiter. Pioneer 10 measured 0.03, Copernicus 0.5, and Voyager 0.7. To account for this difference between the observations by Pioneer and Voyager requires an increase by ten times of the amount of atomic hydrogen in Jupiter's atmosphere above the methane to provide the necessary photon scattering.

Again, the combined results of multimodal observations yield clues to the production mechanism whereby the hydrogen increase was generated. Radial plasma density analysis revealed unexpected regions of impounded density. The PLS detected a high-temperature ring current of energetic protons that tend to confine the plasma and cause the impounding. Voyager arrived at a time of high auroral activity. Plasma waves generated by the magnetic gyration of the rapidly revolving torus lead to instabilities which scatter charged particles out of the torus along magnetic field lines. The higher density waves can scatter lower energy particles, making many more available. Under conditions of the Pioneer approach this level was in the megavolt range; for Voyager, a few kilovolts. The scattered particles are guided along field lines into the atmosphere and cause the aurora and disassociate H_2 thus producing the increase of atomic hydrogen and photon scattering. The resulting heat increases chemical production of hydrocarbons. Other effects of the plasma torus on Jupiter have been observed.

Dr. Strobel's talk not only illustrated the need for a coordinated ground-based and spaceborne observation program, but also presented an exciting new picture of the largest planet in the solar system.

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EXCERPTS FROM THE IAU CIRCULARS

1. December — E. Waagen found that the possible nova discovered in Cygnus by Honda appeared on several Harvard patrol plates and is therefore probably a periodic variable.

2. December 17 — W. A. Bradfield, Dernancourt, Australia, discovered a comet (1980t) of 6th magnitude in Scorpio. Comet Bradfield became visible at low altitude in the evening sky in early January.

3. December 25 — Roy W. Panther, Walgrave, Great Britain, discovered a comet (1980u) of 10th magnitude in Lyra.

4. January — Swings and Klutz, Institut d'Astrophysique, Leige, reported that spectroscopic studies of RX Puppis indicate that it is returning to the symbiotic nature it showed 4 decades ago. Strong emission lines of He II, O II, N III, and (O III) are present along with TiO absorption bands.

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