sequently, while the figure indicates the correct range of fluctuations, the apparent fluctuation rates are much higher than those shown. During the ionosphere portions of the occultation, the values given may be contaminated by the limited capability of the automatic receivers to discriminate strong multipath signals occurring in the vicinity of ray caustics. More complete reduction and analysis must be based on broadband linear sampling of the received signals. Additionally, the automatic system depends on linearized calibration procedures for accurate intensity results. This procedure was evidently in error and resulted in a compression of the 3.6-cm data by about 5 dB. This effect has been verified by preliminary examination of the broadband data. Use of the broadband data samples will correct this problem.

4. One of the two redundant Voyager 2 radio receivers has failed, and the remaining unit, now in use, has suffered a partial failure. As a result, no coherent radio tracking data were collected for a period of several days surrounding the closest approach of the spacecraft to Jupiter. In addition, a trajectory correction maneuver, executed near perijove, further increased the uncertainties in spacecraft trajectory state during the occultation period. For long-distance occultations the effects of trajectory uncertainties can be multiplied by large factors (*5, 6*), in this case of the order of 10^2 to 10^3.
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11. S. K. Atreya (personal communication) suggests how the Voyager 2 ionosphere profiles can be interpreted as being consistent with those obtained with Voyager 1. At the higher plasma temperature observed at the Voyager 2 entry point, the population of vibrationally excited H_2 is sufficient to reduce the ionization by the same reaction employed in (*9*) to explain the Voyager 1 day-to-night differences. Also, the Voyager 2 entry latitude is within the range of invariant latitudes for which the plasma torus associated with Io maps onto the southern hemisphere of Jupiter, thus providing a potential source of energy to produce the elevated temperatures.
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13. We thank the members of the Voyager flight team and the Deep Space Network, particularly the operations personnel at the Jet Propulsion Laboratory and the Goldstone Tracking Station, for their help and contributions to the observations. We especially thank B. J. Buckles, D. P. Holmes, and P. E. Doms for their efforts in the implementation of this experiment; D. N. Sweetnam and H. B. Hotz for their help in profile computations; D. E. Kline for his help in data production; and H. B. Royden, D. W. Green, and D. L. Nixon for their efforts in reduction of the torus observations. Supported by the National Aeronautics and Space Administration.

28 September 1979

Extreme Ultraviolet Observations from Voyager 2 Encounter with Jupiter

Abstract. *Extreme ultraviolet spectral observations of the Jovian planetary system made during the Voyager 2 encounter have extended our knowledge of many of the phenomena and physical processes discovered by the Voyager 1 ultraviolet spectrometer. In the 4 months between encounters, the radiation from Io's plasma torus has increased in intensity by a factor of about 2. This change was accompanied by a decrease in plasma temperature of about 30 percent. The high-latitude auroral zones have been positively associated with the magnetic projection of the plasma torus onto the planet. Emission in molecular hydrogen bands has been detected from the equatorial regions of Jupiter, indicating planetwide electron precipitation. Hydrogen Lyman α from the dark side of the planet has been measured at an intensity of about 1 kilorayleigh. An observation of the occultation of α Leonis by Jupiter was carried out successfully and the data are being analyzed in detail.*

During the Voyager 1 encounter with Jupiter, the ultraviolet spectrometer (UVS) made a series of significant discoveries, including a hot plasma torus near the orbit of Io and localized auroral zones at high latitudes on the planet (*1*). Now, with the Voyager 2 observation sequences modified to take advantage of our new knowledge of the planet and its environs, many details of the phenomena discovered by Voyager 1 have been elucidated. The measurement sequences recently made have allowed advances of particular interest in the study of the plasma torus and in the morphology and energy budget of particles exciting the atmosphere of Jupiter. Satellite observations by Voyager 2, as by Voyager 1, were somewhat compromised by the intense radiation environment. The question of satellite atmospheres is not emphasized here; more data analysis is required.

A number of the important features of Jupiter and its magnetosphere are displayed in Fig. 1.

Io plasma torus. The extreme ultraviolet (EUV) emission of the Io plasma torus observed by Voyager 2 shows the same major characteristics of spatial distribution and spectral content as the Voyager 1 observations described by Broadfoot *et al.* (*1*). The dominant emitting species are S III, S IV, and O III, as reported earlier, and a number of other persistent unidentified lines remain with roughly the same relative intensities. The spatial distribution of the plasma also remains as a full continuous torus with a radius of symmetry of 5.9 ± 0.3 Jupiter radii (R_J) and a cross-sectional radius of 1 ± 0.3 R_J, both in the magnetic plane and perpendicular to the plane. Figure 1 shows the distribution of emitting species graphically. The sharp peaks at ± 6 R_J are due to the torus emissions at the points at which the path length through the plasma reaches its maximum value of about 9 R_J. The bright emission at 685 Å, composed mostly of three strong multiplets of S III, dominates the spectrum at all times in spite of short-term variations in spectral content.

Although spectral content and spatial distribution did not change systematically between the two encounters, apparent systematic variations in intensity and electron temperature have been recorded with the Voyager 2 spectrometer. Figure 2 shows plots of measured intensity of the S III multiplet at 685 Å and estimated electron temperatures between day 60 and day 192, 1979. The available data indicate an increase in intensity by a factor of approximately 2 after day 158 and a reduced electron temperature as measured by the relative intensities of the S III features at 685 and 1020 Å. The intensities shown in Fig. 2 refer to the location of torus elongation on the sunward side of the planet, and a path length in the plasma of 9 R_J. The Voyager I measurement on day 60, indicated in Fig. 2, is the same datum discussed by Broadfoot *et al.* (*1*) and is on the high side of average brightness during that time. The combined increase in brightness and reduced electron temperature suggests an increase by a factor of 2 in ion density after day 158.

Model calculations in the analysis of the plasma torus emissions have been based on an assumed thin plasma in collisional ionization equilibrium (*1, 2*). Although the EUV observations are consistent with the model from the point of view that excitation of states within a particular species is reasonably explained by a thermalized electron energy source, the observations show signs of disequilibrium between species such as S III and S IV. An example of this type of disequilibrium is shown in Fig. 3, which compares spectra obtained on days 171 and 192. Spectrum a (day 192) indicates a lower electron temperature (see Fig. 2) than spectrum b, based on the relative intensities of the S III multiplets at 685 and 1020 Å. However, spectrum b—in spite of its higher electron temperature—indicates a barely measurable S IV abundance, as deduced from the intensity of

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the allowed S IV line at 1070 Å, compared to the easily measured feature in spectrum a. Other differences in the spectra of Fig. 3 are at least partly due to the doublet transitions and possibly some quartet transitions of S IV.

It is clear that the plasma torus is much more complex than the simple model assumptions that have been introduced to explain the energy budget of the torus. Apart from the strong indications of disequilibrium pointed out above, ground-based observations of the near-infrared S II lines (*3, 4*) and the S III line at 9532 Å (*4*) suggest that the S II emission arises from a cooler region that is displaced radially inward from the orbit of Io (*5*). Emission from O II, recently observed from the ground, may arise in the same spatial region (*6*). This tends to complicate the explanation of energy injection through ionization of neutral particles entering the torus from Io (*1, 2*). In theory, neutral particles entering the plasma torus supply energy through ionization and acceleration in the corotating magnetic field of Jupiter. The calculated radiative cooling rate in this regime, $> 2.5 \times 10^{12}$ W (*2*), is great enough to require that ions be lost to the torus by diffusion rather than recombination. The existence of a dual temperature plasma torus at ion temperatures as different as 2×10^4 and 3×10^5 K (*4*) introduces a considerable complication in the description of the diffusive loss process. Additional evidence for complexity in the torus loss processes has been described briefly by Vogt *et al.* (*7*).

Other significant aspects of the EUV torus spectra include emission features that remain unidentified. The blend of emissions in the 700- to 800-Å region, the emission feature at ~ 900 Å, and lines blended with the hydrogen Lyman α (H Ly α) interstellar emission at 1216 Å all fall in this category. The shape of the feature near 1200 Å appears to be distorted to varying degrees by blended emissions on both sides of 1216 Å, as indicated by the difference between the spectra shown in Fig. 3. No features longward of 1260 Å have been identified as torus emissions. The feature at ~ 1570 Å shown in Fig. 3b appears sporadically in the Jupiter magnetosphere and is a strong emission in spectra of the dayside of the planet.

Aurora. Among the most exciting discoveries of Voyager 1 was the localized sources of bright EUV radiation near both polar regions of Jupiter (*1*). The emission was identified as auroral excitation of H Ly α and the Lyman and Werner bands of H_2. The location of the observed auroral zones indicates that they are magnetically linked to the plasma torus at Io's orbit. As an alternative model (*8*) it has been proposed that, in analogy with the earth, auroral activity be located at the equatorward edge of the area defined by mapping the magnetic tail to the atmosphere of the planet. The latter region thus defined is considerably smaller and is contained entirely within the mapped torus. It is possible to distinguish between these two models by using UVS observations.

We have concluded that the equatorward boundary of the observed auroral zones corresponds to the magnetic mapping of the torus on the atmosphere. Using extrapolated locations of the mapping of the plasma torus and tail region to the atmosphere (*8*), we compared a large number of observations to predictions based on these two models. An example of the analysis leading to the association of the aurora with the torus magnetic projection is shown in Fig. 4. During this observation, which extended over a complete rotation of the planet, the UVS slit was scanned from north to south five times per hour and located on the planet with the use of interspersed support images. To locate the emitting region, we took advantage of two motions: (i) the north-to-south motion of the slit and (ii) the rotation of the planet, which moves the auroral zone in and out of the area scanned by the slit. Both these motions are shown in Fig. 4. The scan in Fig. 4a shows no auroral emission, as would be expected if the aurora were magnetically linked to the torus. In Fig. 4b, the planet has rotated so that the mapped torus lies in the slit, and the aurora is detected strongly at slit position 1. At slit position 2, the portion of the slit filled by the torus magnetic projection is reduced, as is the auroral emission. Finally, at position 3 the slit has moved off the region of the torus projection and no aurora is recorded. On this basis, the aurora must extend as far south as the torus projection, significantly below the theoretical location of a magnetotail aurora. Many other similar cases in both hemispheres confirm this analysis.

The extent of the auroral zone in latitude is an important question. Because of the generally unfavorable observing geometry and the large size of the slit on the planet, it is not possible to rule out

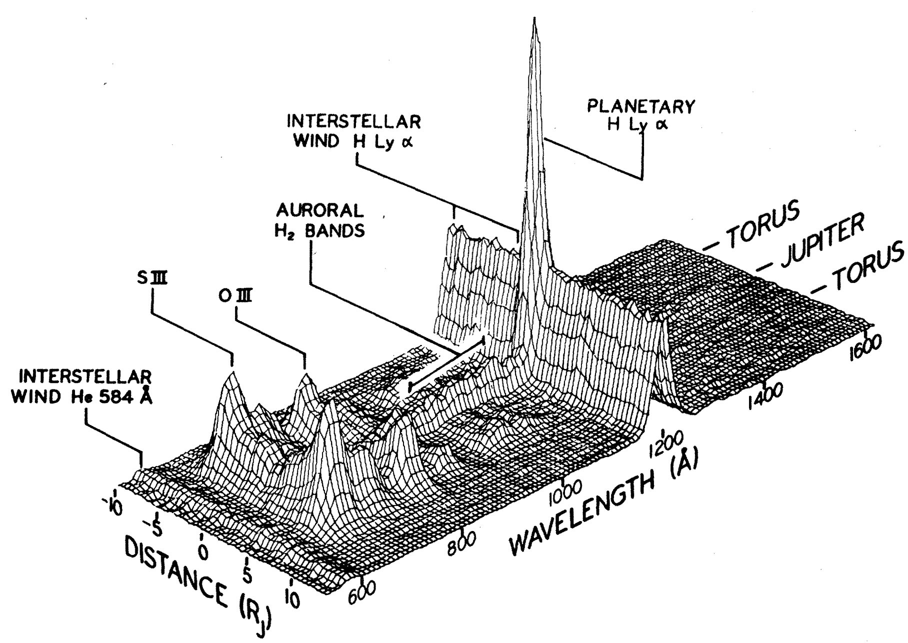


Fig. 1. Ultraviolet spectral-spatial signature of the Jovian system displayed as count rate plotted against space and wavelength. Data acquired over many days were grouped to produce a one-spatial-dimension image of the system. The spatial coordinate has its origin at the planet and is measured in the plane of the rotation equator. The spectrometer slit was oriented roughly perpendicular to this plane. The spatial resolution is 0.5 R_J. Prominent spectral features in the range of 680 to 1000 Å arise from Io's plasma torus; the intensities of these features peak at about ± 6 R_J, the radius of the torus. A weak obscuration by Jupiter of a portion of the torus (averaged over many rotations of the torus) is visible near 0 R_J. Radiation from the planet itself is present in the central spike at H Ly α (1216 Å) and in the aurorally excited H_2 Lyman and Werner bands forming the ridge that extends toward shorter wavelengths from the H Ly α peak. Solar H Ly α and He 584-Å radiation resonantly scattered by the interstellar medium form the two ridges running parallel to the space axis. The planetary H Ly α brightness is not shown in its true relationship to the interstellar wind scattering because the planet was much smaller than the UVS slit during these observations, whereas the slit was filled by H Ly α from the interstellar medium. The true brightness ratio of the planet to the interstellar wind background is a factor of about 30, rather than 2.5 as shown here.

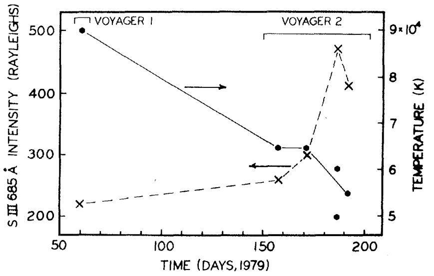


Fig. 2. Io plasma torus electron temperature and brightness variation as a function of time between days 60 and 192, 1979. Electron temperatures were obtained from the relative emission rates of the allowed S III transitions at 685 and 1020 Å. The intensities refer to the sum of three strong S III multiplets in the region of 685 Å observed through an estimated plasma path length of 9 R_J in the elongation of the torus.

auroral excitation poleward of the torus projection. Although there may be emission from the mapping of the magnetotail, the torus-associated aurora is dominant in these observations.

The apparent intensity of the auroral emission is best measured with the slit aligned parallel to the auroral band. This favorable geometry occurred once during the encounter for each spacecraft. Voyager 2 found the southern aurora about 40 percent brighter than the northern aurora, although geometric effects should have been roughly the same in both hemispheres. This is in contrast to the measurement by Voyager 1 of a brighter aurora in the north. Intensities at the two encounters were comparable in view of the observed north-south asymmetries.

The absolute surface brightness of the aurora could be calculated if the width (in latitude) of the auroral zone were accurately known. This width has not yet been determined from the UVS data, but we proceed with the reasonable assumption that the latitudinal extent corresponds to the outer and inner edges of the torus at about 4.9 and 6.9 R_J mapped along the magnetic field onto the surface. This width of about 6000 km is consistent with the UVS observations, and implies a typical surface brightness of about 60 kR at H Ly α and about 80 kR in the H_2 Lyman and Werner band emissions. If the auroral zone extends over 10° invariant latitude, as suggested by a theoretical treatment (*9*), these intensities are reduced by a factor of about 2. A surface brightness of 140 kR in H and H_2 emission corresponds to a radiated power of about 2 erg cm^{-2} sec^{-1}. Our calculation of the efficiency for electron collisional excitation, based on measured ion-pair production efficiencies and excitation cross sections, shows that an input flux of 70 erg cm^{-2} sec^{-1} is required to produce the observed emission.

The total power measured from the auroral zones is independent of the assumed width of the zone and the attendant surface brightness as long as the width of the zone is contained within the slit—a condition satisfied at the time of the intensity measurements. The power does depend on the circumference of the auroral zone, because in this geometric configuration (the slit is aligned parallel to the auroral zone), the UVS measures power per unit length. For an average auroral zone latitude of 65°, the power radiated from both hemispheres in H Ly α and H_2 bands is 5×10^{12} W. Using the conversion efficiency given above, the required electron energy input is 1.7×10^{14} W. This power input exceeds the EUV power radiated directly from the plasma torus by two orders of magnitude.

Dayside emissions. Although the ultraviolet (UV) radiation from the portion of the planet between the auroral zones is dominated by an intense H Ly α emission (*1*), other radiation is present as well. Spectrum b in Fig. 5 was obtained near the equator. The H_2 bands are present at an intensity (integrated over the Lyman and Werner bands) of about 5.5 kR. This emission, which is probably excited by weak, planetwide electron precipitation, is less bright than the same

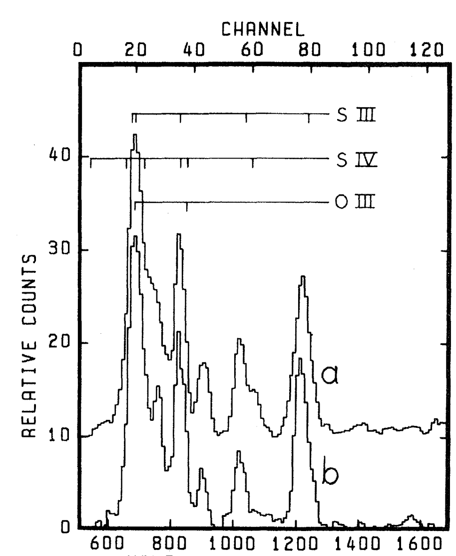


Fig. 3. Voyager 2 EUV spectra of the Io plasma torus showing differences in spectral content indicating interspecies disequilibrium. The spectra have been corrected for internal instrumental photon scattering. A large fraction of the feature near 1200 Å arises in interstellar H Ly α emission at 1216 Å. Spectrum a has been displaced upward by ten units.

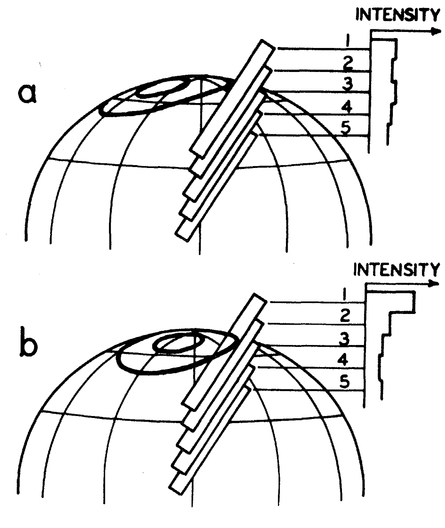
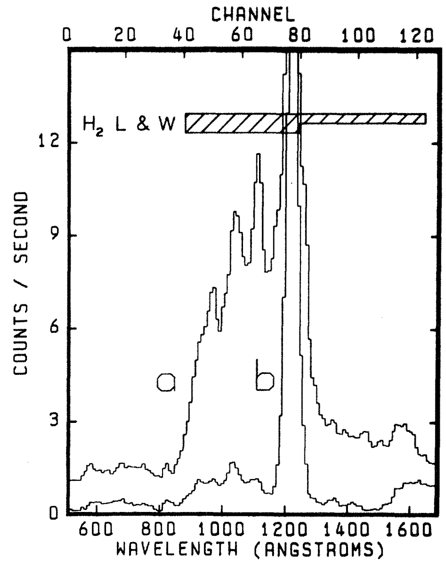


Fig. 4. An example of one type of observation which has led to the association of the auroral zone with the mapped torus. In (a) and (b), two views of Jupiter's northern hemisphere differing by 30° in rotational phase are shown. The small oval represents the boundary of the intersection of the magnetic-tail field lines with the atmosphere. The larger oval shows the magnetic mapping of the orbit of Io onto the atmosphere. At five sequential positions of the UVS slit in its north-to-south motion, the histograms show the relative intensity in the auroral wavelength range 875 to 1150 Å. The measured intensities are consistent with an emitting region linked to the torus, but not with an auroral zone confined to the mapped tail.

bands in the auroral zones by a factor of about 15. A precipitating electron energy flux of about 5 erg cm^{-2} sec^{-1} deposited in the exosphere is implied. Only a small fraction of this energy is radiated in the UV range. The remainder is available for heating the atmosphere, and could be sufficient to maintain the hot exosphere (*10*) observed by Voyager 1 (*1*, *11*). The energy flux associated with inertia gravity waves is comparable (*12*).

Also present in both spectra shown in Fig. 5 is a feature near 1570 Å. This feature is usually found on the disk of Jupiter, but the detailed shape of the spectrum in this wavelength range is variable. The variability is apparent when spectra a and b are compared with each other and with figure 4 of Broadfoot *et al.* (*1*). The brightness for a continuum emission at 1570 Å is about 30 R/Å in the Jovian-disk observation. Figure 5 illustrates the important fact that the brightness of the 1570-Å feature does not follow the intensity of the electron-excited H_2 bands. The 1570-Å feature has roughly the same intensity in both spectra, but the H_2 bands of spectrum a are brighter than the same bands in spectrum b by a factor of 8. Therefore it is unlikely that the 1570-Å radiation is due to electron excitation.



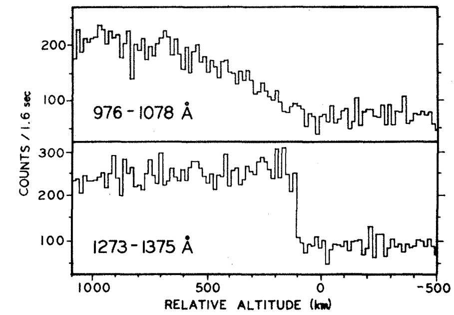


Fig. 5 (left). Airglow spectra from Jupiter. A portion of the northern auroral zone lay within the slit for spectrum a. Spectrum b was recorded near the equator and contains no radiation from the sharply localized auroral zones at high latitudes. The zero for spectrum a is shifted upward by 1 count per second. Noise and scattering within the instrument have been removed from these spectra. Both spectra include emission in the Lyman and Werner bands of H_2 in the indicated wavelength regions as well as H Ly α. The equatorial brightness in the Lyman and Werner bands is about 5.5 kR. An additional feature not due to H or H_2 emission is present in slightly different forms near 1570 Å in both spectra. The origin of this radiation is unknown. Fig. 6 (right). Occultation of α Leo (Regulus) by Jupiter. The stellar light recorded in two wavelength intervals is represented as a function of relative altitude. Gradual absorption at 976 to 1078 Å is attributed to H_2, whereas the abrupt onset of absorption at 1273 to 1375 Å is attributed to hydrocarbons. The residual signal after the hydrocarbon occultation is a combination of high-energy particle background and Jupiter's dayglow.

Emissions of similar wavelength and spectral shape have been recorded sporadically in Jupiter's magnetosphere, well away from the planet and the plasma torus (see Fig. 3, spectrum b). Although the possibility that the emission is atomic in origin cannot be ruled out, there are few and unlikely candidates. There are a number of ground state-connected transitions of Si I between 1545 and 1700 Å that could produce resonance-scattered radiation from the solar continuum, but the brightness of the observed feature would be very difficult to account for with a source of this kind. The possibility that the emission is molecular in origin is being investigated.

Nightside emissions. Hydrogen Ly α emission of about 1 kR has been identified from the nightside mid-latitudes of Jupiter. An upper limit (700 R) of H Ly α was inferred from Voyager 1 data (*1*); this measurement may have been influenced by the severe radiation environment in which the analyzed data were obtained. We do not interpret the measurement of 1 kR as evidence for a change in the nightside H Ly α intensity between the Voyager encounters. This emission is probably excited by a combination of precipitating electrons and resonant scattering of interstellar-wind H Ly α.

No molecular hydrogen band emissions from the nightside mid-latitudes have been identified. However, the data examined to date have not been ideally suited for detecting weak H_2 bands because they contain plasma torus emissions in the same wavelength range. An upper limit on the integrated intensity of the nightside Lyman and Werner band emission of 1 kR is compatible with the data. Since the dayside emission in these bands amounts to 5.5 kR, there is a significant day-to-night variation.

Stellar occultation. As seen from Voyager 2, the bright early-type star Regulus (α Leonis, B7, visual magnitude = 1.3) was occulted by Jupiter when the spacecraft was 21 R_J from the planet. The stellar spectrum was measured by the UVS every 0.32 second as the line of sight approached the planet at a velocity of 9.9 km sec^{-1}. The stellar emission is modified as a result of absorption by atmospheric constituents, yielding information about the chemical composition, temperature profile, and structure of Jupiter's atmosphere.

Both ingress on the dayside and egress on the nightside were observed. Egress observations were somewhat hampered by slow limit-cycle motions of the spacecraft, resulting in a reduction of the UVS signal by about 50 percent, whereas for ingress observations, the star was well centered in the field of view and did not move appreciably. The latitude of the ingress point was +16°.

The stellar spectrum in the UVS wavelength range was completely absorbed before differential refraction would have been significant, which means that all of the decrease in signal can be attributed to molecular absorption. Figure 6 shows the light curves for two bandwidths, 976 to 1078 Å and 1273 to 1375 Å. Each point is the average of five consecutive measurements, and represents 1.6 seconds in time and a change in the line of sight 15.5 km in altitude. The very abrupt disappearance of the star at the long wavelengths is attributed to absorption by hydrocarbons, and occurs at an altitude which can be accurately determined from knowledge of the trajectory. The gradual decrease at the short wavelengths is attributed to H_2 absorption in the Lyman and Werner bands by ground-state molecules in $v'' = 0$ vibrational level. It starts approximately 570 km above the hydrocarbon absorption level. Owing to the complex nature of absorption in the band structure as compared to continuum absorption, the determination of the H_2 column density profile from this light curve is not straightforward and will require further analysis. More thorough data analysis is expected to lead to a positive identification of the absorbing hydrocarbons and their vertical distribution about the point of ingress. The egress measurements showed the same qualitative behavior.

Discussion. The startling nature of the Voyager EUV observations during the first encounter was a result of variability in the Jovian system of a magnitude considerably surpassing expectations. The very bright EUV emissions from the Io plasma torus and from the dayside of Jupiter were not predictable on the basis of earlier measurements and theory. In the torus, the increase in intensity and the decrease in mean electron temperature between encounters is a crude measure of the time constant and capacity for change in the plasma. The time base of the analyzed data is currently too short to define a trend. Without a doubt, our present understanding of the plasma torus is much oversimplified. The observations of interspecies disequilibrium and two distinctly different ion temperatures in associated regions of the plasma are strong indications of a complex dynamic system.

The extensive Voyager 2 observations of Jupiter have produced a number of significant results. The positions of the auroral zones have been defined with the use of support imaging to the extent that the aurora is now known to correspond to the location of the planetary magnetic field lines intersecting the Io plasma torus. The observations do not remove the possibility of a simultaneous magnetotail aurora, but if present it must not be a dominant component. The power required to drive the aurora by precipitated electrons stopped in the atmosphere is 1.7×10^{14} W, and the energy flux is comparable to that in an IBC (international brightness coefficient) III aurora on Earth (*13*). The continuous deposition of this amount of energy must have a measurable global effect on the atmosphere of Jupiter. The auroral activity may in fact be indirectly related to the discovery (reported here) of a general deposition of particle energy on the dayside hemisphere, most plausibly in electrons, of 5 erg cm^{-2} sec^{-1}. Much of this energy flux must end in atmospheric heating.

Finally, successful solar and stellar occultation observations have been obtained, and we expect the measurements to yield significant results on atmospheric structure pending extensive analysis with the aid of atmospheric models.

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14. We acknowledge the untiring effort of Susan Hanson, our assistant experiment representative at the Jet Propulsion Laboratory. She was responsible for most of the detailed sequencing of our experimental observations. We also acknowledge the efforts and operations of all Voyager project personnel, who have made this mission a success. The research described in this report was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under NASA contract NAS 7-100.

28 September 1979

Magnetic Field Studies at Jupiter by Voyager 2: Preliminary Results

Abstract. *Data from the Goddard Space Flight Center magnetometers on Voyager 2 have yielded on inbound trajectory observations of multiple crossings of the bow shock and magnetosphere near the Jupiter-sun line at radial distances of 99 to 66 Jupiter radii* (R_J) *and 72 to 62* R_J, *respectively. While outbound at a local hour angle of 0300, these distances increase appreciably so that at the time of writing only the magnetopause has been observed between 160 and 185* R_J. *These results and the magnetic field geometry confirm the earlier conclusion from Voyager 1 studies that Jupiter has an enormous magnetic tail, approximately 300 to 400* R_J *in diameter, trailing behind the planet with respect to the supersonic flow of the solar wind. Additional observations of the distortion of the inner magnetosphere by a concentrated plasma show a spatial merging of the equatorial magnetodisk current with the current sheet in the magnetic tail. The spacecraft passed within 62,000 kilometers of Ganymede (radius = 2,635 kilometers) and observed characteristic fluctuations interpreted tentatively as being due to disturbances arising from the interaction of the Jovian magnetosphere with Ganymede.*

The Voyager 2 magnetic field experiment, for which the instrumentation is identical to that on Voyager 1 (*1, 2*), operated flawlessly throughout the second Jupiter encounter. Here we present a brief overview of the results obtained to date on the Jovian magnetosphere, the bow shock, the magnetopause, and the extended magnetic tail. The magnetic tail was first identified during studies of Voyager 1 data (*3*). Because the radius of the tail on the dawnside of the magnetosphere is so large [150 to 200 Jupiter radii (R_J)] and the postperiapsis trajectory was at a sun-planet-spacecraft angle of 140°, Voyager 2 was immersed in the tail for approximately 2 weeks. Two crossings of the near-equatorial current sheet (plasma sheet) were observed in the magnetosphere and its tail almost every 10-hour rotation period of the planet. Hence, a definitive mapping of the geometry and character of these enhanced plasma and depressed magnetic field regions has been possible far into the nightside tail region. At periapsis the observed field is 335 nT (nanotesla), 20 percent less than the expected 425 nT; this is because of the immersion of Voyager 2 in the current sheet.

In addition, there is evidence for an interaction of the satellite Ganymede with the Jovian magnetosphere that leads to disturbances observed forward of this satellite as the Jovian magnetosphere corotates with the planet past the satellite. The character of these disturbances is complex. Their spatial location suggests that the magnetosphere may be in motion with respect to the planet at the satellite distance of 15 R_J.

In obtaining the data presented here we used averages of the basic vector field measurements (at $16^2/_3$ Hz) over intervals of 1.92 seconds, 9.6 seconds, 16 minutes, and 1 hour. As in the 30-day report on the Voyager 1 results, these data and interpretations are preliminary and based on "quick-look" data tapes and ephemerides.

Bow shock and magnetopause. Voyager 2 crossed the bow shock of Jupiter inbound at least 11 times from day 183 (2 July 1979) at 1621 universal time (UT) to

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