the data show that, as expected, the illuminated and nonilluminated sides have the same brightness temperatures. The South Equatorial Belt (SEB) shows the highest brightness temperatures and appears separated from the North Equatorial Belt by the incipiently resolved equatorial zone. The South Tropical Zone (STZ) is clearly noticeable because of its low brightness temperature and large degree of limb darkening. Further south, the increase of temperature associated with the South Temperate Belt is also shown. A more detailed comparison with the visual images will be carried out when definitive geometry has been established.

In this preliminary discussion we shall characterize the thermal emission of the two most prominent features, the SEB and STZ, by a mean intensity at normal emergency b_1 and a coefficient of linear limb darkening d. The surface brightness at an emission angle e is then related to these two parameters by

$$b(e) = b_1 (1 - d + d \cos e)$$

The values of the mean peak brightness temperatures, corresponding to b_1, and the best-fit darkening coefficients for each region and each channel are given in Table 1. In order to compare these parameters with predicted values, we have calculated values of b_1 and d for a family of model atmospheres as calculated by Trafton (*3*), characterized by an effective temperature T_e and an abundance ratio a, which essentially determines the opacity. A NH_3 equilibrium concentration has been included to evaluate its contribution to the opacity, although it is of secondary importance. On the basis of these models, we infer the effective temperatures and nominal He abundances given in Table 1. The comparison of the calculated darkening coefficients, fixed by the model, with the measured ones, however, shows a conspicuous disagreement in the 20-μm channel, especially for the SEB. This implies that the calculated temperature gradient, with respect to optical depth in the 20-μm channel, is too high. Since darkening in the 40-μm channel is approximately as predicted, the lapse rate calculated on the assumption of radiative-convective equilibrium should be approximately correct, and the disagreement found implies that the opacity in the 20-μm channel has been underestimated.

The values of the effective temperatures derived for the SEB and the STZ will not be affected significantly by a more realistic evaluation of the opacity in the 20-μm channel. If we take into consideration the fact that the fraction of the planet covered by zones and polar regions is larger than that covered by the SEB and other belts, generally of lower net thermal flux than the SEB, it is estimated that the whole planet has an effective temperature close to $T_e = 128°K$. If we adopt a Bond albedo of 0.42, the effective temperature Jupiter would attain if heated only by insolation is $T_e = 107° \pm 3°K$. We thus derive a net energy output between 2.0 and 2.5 times larger than the solar energy input. This value is somewhat smaller than that inferred from aircraft-based measurements of the planet as a whole (*4*). The main uncertainty remaining in this important characteristic of the Jupiter interior arises from the estimates of the planetary Bond albedo.

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Pioneer 10 Observations of the Ultraviolet Glow in the Vicinity of Jupiter

Abstract. *A two-channel ultraviolet photometer aboard Pioneer 10 has made several observations of the ultraviolet glow in the wavelength range from 170 to 1400 angstroms in the vicinity of Jupiter. Preliminary results indicate a Jovian hydrogen (1216 angstrom) glow with a brightness of about 1000 rayleighs and a helium (584 angstrom) glow with a brightness of about 10 to 20 rayleighs. In addition, Jupiter appears to have an extensive hydrogen torus surrounding it in the orbital plane of Io. The mean diameter of the torus is about equal to the diameter of the orbit of Io. Several observations of the Galilean satellites have also occurred but only a rather striking Io observation has been analyzed to date. If the observed Io glow is predominantly that of Lyman-α, the surface brightness is about 10,000 rayleighs.*

The ultraviolet instrument (*1*) on Pioneer 10 is a two-channel photometer designed to observe the resonance emissions from atomic hydrogen and helium at 1216 Å (the H Lyman-α line) and 584 Å, respectively. The instrument uses a filter and photocathodes to isolate these two emission features.

Detailed calculations (*2*) show that the hydrogen and helium resonance lines are the strongest features to be expected from the outer atmosphere of Jupiter, and arise from resonance scattering of the incident solar hydrogen and helium lines; thus, only broadband isolation of these lines is required. The He channel uses a thin aluminum film as a filter and LiF as a photocathode, resulting in a spectral band pass of approximately 200 to 800 Å. The hydrogen channel uses the front surface of the Al film as a photocathode for which the photoelectric response extends up to about 1400 Å. This channel is sensitive to both hydrogen and helium emissions, but the former is more intense by more than an order of magnitude, so the recorded signals accurately represent the Lyman-α intensity.

The optical axis of the photometer is oriented at 20° to the spacecraft spin axis while the instantaneous field of view is approximately 1° by 20° with the longer dimension tangential to the 20° arc swept out by the spacecraft rotation.

This orientation was chosen to give two views of Jupiter, the first occurring at approximately 50 Jovian radii (R_J), and outside the predicted radiation belts, while the second observation period occurred at about 10 R_J. In addition, several observations of the Galilean satellites were possible during the 5 days before closest approach.

During the first Jupiter viewing period emissions from the planet were observed in both the hydrogen and helium channels but the data obtained during the second viewing period suffered degradation due to the energetic radiation belt particles. The preliminary estimate of the hydrogen Lyman-α intensity is somewhat less than 1000 rayleighs (*3*) while that of the He emission is approximately 10 to 20 rayleighs. Helium emissions have not previously been observed from Jupiter although the presence of He has been speculated on for many years.

The present Lyman-α measurements are lower than the sounding rocket observations of Rottman *et al.* (*4*). This discrepancy may be partially due to variations in the solar Lyman-α flux, differences in atmospheric properties which depend on solar activity, and calibration uncertainties.

Ultraviolet emissions were also observed in the hydrogen channel from the innermost Galilean satellite Io (JI). It is reasonable to assume that these emissions correspond to Lyman-α since the surface of Io is thought to consist of hydrogen-bearing ices of NH_3 and H_2O (*5*). The atomic hydrogen could result from photolysis and particle bombardment of the atmosphere and surface. If H Lyman-α is the main contributor, the source brightness is approximately 10,000 rayleighs. Such an intensity would seem to require an excitation mechanism in addition to resonance scattering. Aurora-like activity, as produced by energetic electrons accelerated toward Io by its motional electromotive force (*6*), seems an attractive possibility.

Finally, hydrogen channel signals were observed from the equatorial plane of Jupiter during periods when neither the planet nor its satellites were in the field of view. These emissions of several hundred rayleighs in intensity are tentatively interpreted as due to a toroidal cloud of neutral hydrogen in orbit around Jupiter, similar to the hydrogen torus proposed by McDonough and Brice (*7*) for Saturn and Jupiter (*8*). Preliminary analysis indicates that this gas cloud occurs at approximately the orbit of Io, suggesting that this satellite is the source.

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The Imaging Photopolarimeter Experiment on Pioneer 10

Abstract. *A 2.5-centimeter telescope aboard Pioneer 10 is capable of making two-dimensional spin-scan maps of intensity and polarization in red and blue light at high spatial resolution. During the recent flyby of Jupiter, a large quantity of imaging and polarimetric data was obtained on Jupiter and the Galilean satellites over a wide range of phase angles.*

A prime objective of the encounter phase of our experiment was to gather photometric and polarimetric data on Jupiter over a wide range of phase angles from which the gas abundance above the Jovian clouds and the size, shape, and refractive index of the cloud particles might be derived. In addition, polarimetric observations of the Jovian satellites were sought for comparison with laboratory data. Finally, our intensity data could be displayed as

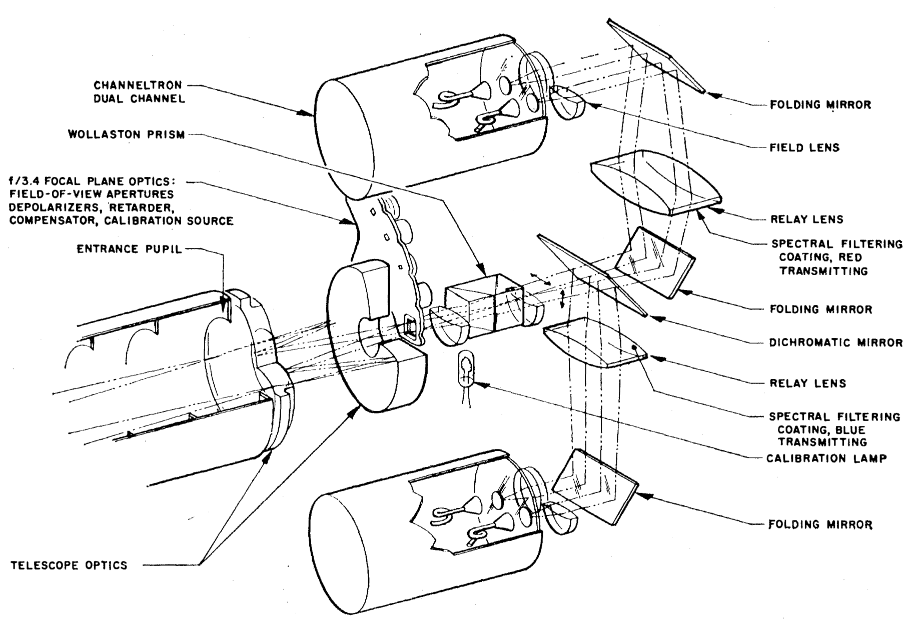
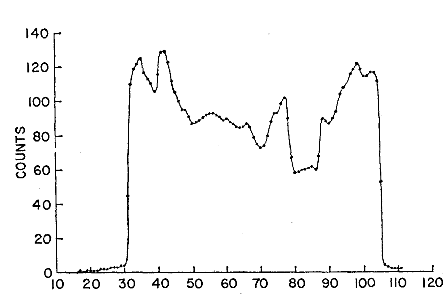


Fig. 1. Optical system of the Pioneer 10 Jupiter imaging photopolarimeter. Light is analyzed into orthogonally polarized beams at two wavelengths (red and blue).



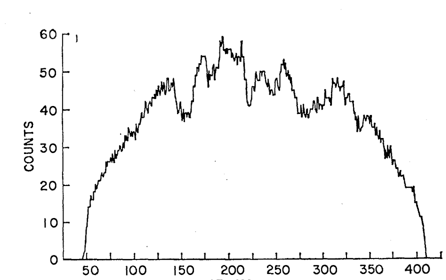


Fig. 2 (left). Scan line on Jupiter taken at 3 R_J in the photopolarimetry mode. The depolarized blue intensity is shown at phase angle ~ 104°. Fig. 3 (right). Scan line on Jupiter taken at 35 R_J in the imaging mode. The depolarized red intensity is shown at phase angle ~ 27°