POLARIMETRY OF ULTRAVIOLET CLOUDS ON VENUS

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ABSTRACT

Differential polarization of ultraviolet light across the disk of Venus is found to be insufficient to support Kuiper's scattering-absorption model for cloud visibility.

As a test of a scattering-absorption model suggestion by Kuiper (1952) to explain the visibility of ultraviolet clouds on Venus, we have attempted to measure differential polarization in ultraviolet light over the disk of Venus. Polarization due to single scattering in the atmosphere of Venus (the bright areas, according to Kuiper) would be strongest near the time of dichotomy, i.e., when the phase angle is approximately 90°. At the time that this observational test was proposed by C. Sagan and J. B. Pollack (late December 1967), Venus was nearly two months past western elongation with a decreasing phase angle.

Numerous efforts were made during January and February 1968 to obtain photographic polarization observations. We used the New Mexico State University 61-cm Cassegrainian reflector with a 45-m all-mirror optical system (4".53/mm). A broad ultraviolet band was isolated on Eastman III-O plates by a Schott UG-2 filter. The effective wavelength of the total source-receptor combination is 365 nm. Polarization was accomplished with a commercial Tiffen polarizing filter. The polarization plane was alined alternately parallel and perpendicular to the

photometric plane (Sun-Venus-Earth); the photographic plates were exposed in corresponding pairs, seldom more than five minutes apart. All plates were photometrically calibrated immediately after exposure at the telescope. The plates were processed in UFG developer (diluted 1:1), with indivudual sets always being processed together.

Observing conditions near morning twilight were unusually bad throughout January and February with very few mornings being free of clouds, wind, or bad seeing. Throughout this interval only a half dozen photographic polarization pairs were obtained and, of these, only one was considered suitable for photometric study. The one useful set was obtained on 5 January 1968 at 1335 U.T. (perpendicular) and 1341 U.T. (parallel); the phase angle was 61° at the time.

Two images on each plate, all of comparable quality, were selected for measuring on a microphotometer. The images were scanned along a diameter perpendicular to the orbital plane with a spot subtending a diameter equal to 0.015 of the planetary disk. The tracings for each of the two images on a given plate were first converted to light intensity, then averaged. The north-south intensity profiles for each of the two polarization planes (E-vector) are shown in Fig. 1. Intensity is normalized to 1.0 at the brightest point for each curve. Two dark clouds are easily seen in the mid-latitudes of the northern and southern hemispheres. One also notes a general decrease in brightness from the southern to northern polar regions. The slight discrepancy in the planetary diameter in Fig. 1 is caused by seeing effects on the two sets of photographic images.

It is immediately evident that differential polarization in ultraviolet light is limited to a few percent at most across the disk of Venus.

Kuiper's proposal would require the bright clouds, in this case the polar and equatorial regions, to be strongly polarized in a direction perpendicular to the photometric plane. We should therefore expect to see a relatively high contrast in the cloud pattern when photographed in light polarized perpendicular to the photometric plane, and correspondingly little or no contrast with parallel orientation. These properties are not observed, thus ruling out the suggested explanation for cloud visibility put forth by Kuiper in 1952.

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References

Kuiper, G. P., 1952. Atmospheres of the Earth and Planets, (p. 371), University of Chicago Press, Chicago.

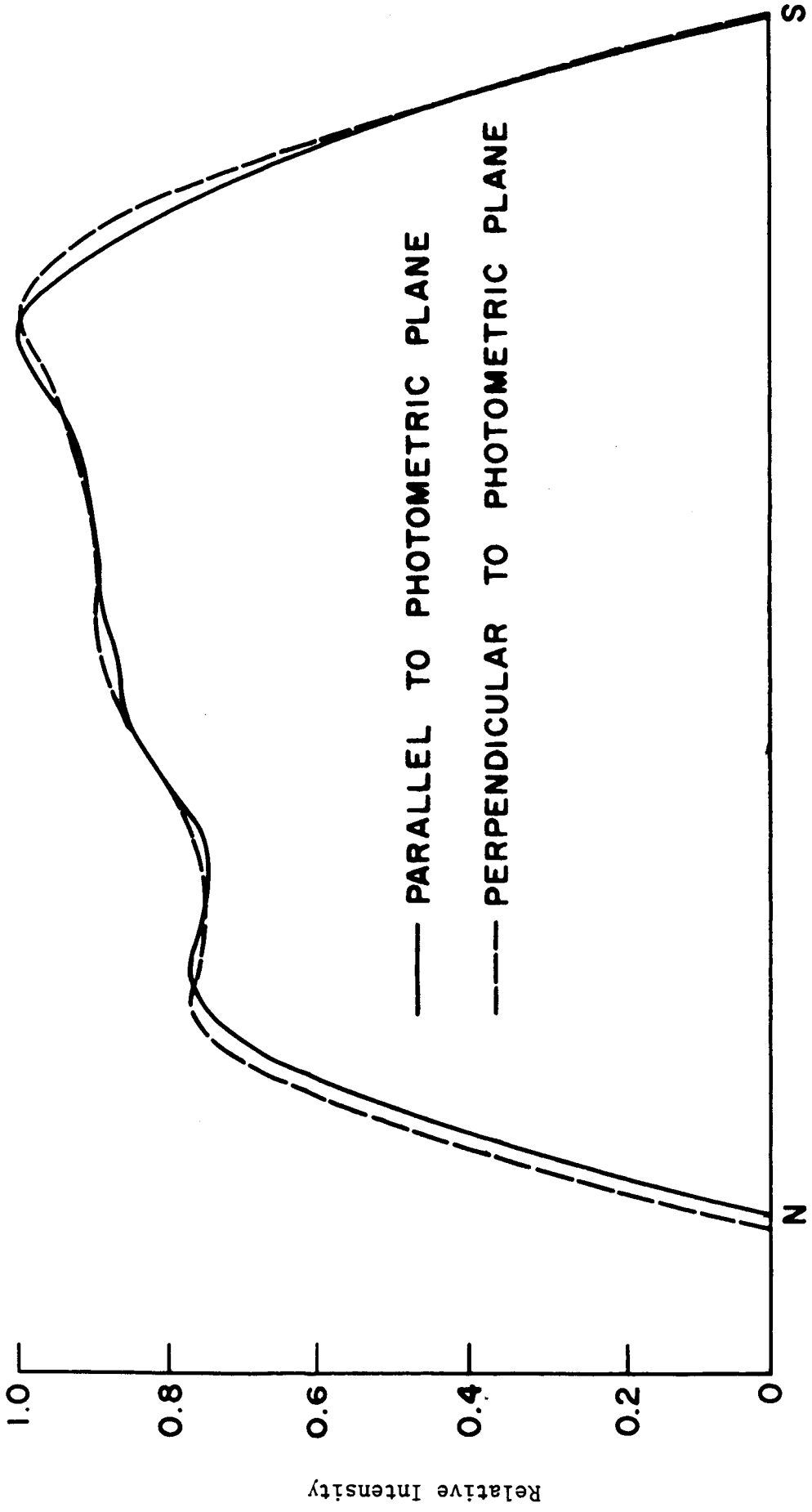

Figure 1. Relative intensity across the disk of Venus in polarized ultraviolet light, with the electric vector alined parallel and perpendicular to the photometric plane. The scans are normal to the photometric plane and were made at a time when the phase angle was 61°.