Scattered Light Correction for the SWP Camera

It is apparent from low resolution IUE spectra of solar system objects that a substantial level of grating-scattered light is present in addition to continuum emission. In IUE spectra of the outer planets, for example, a flat signal level appears around the Ly α peak which is much higher than expected, even from a 100 % reflecting planet. In fact, the emission from Jupiter from 1300-1350 Å has been previously determined to be essentially zero flux (Giles et al. 1976), and the extraneous signal in the IUE spectra is interpreted as longer wavelength radiation scattered along the dispersion direction by the cross disperser grating. In principle, there is no method of data reduction that will distinguish between continuum emission and scattered light in a particular spectrum, other than to deduce the level of scattered light by some other means and perform a subtraction from the net spectrum. A first approximation to correcting for scattered light in these planetary spectra is to subtract a constant level of flux from the whole spectrum equal to the average level between 1300-1350 Å. A more sophisticated modeling of the scattered light function has also been attempted, since an accurate measurement of the continuum emission (and thus of the geometric albedo) requires an accurate subtraction of the scattered light. This section describes the method of modeling and the results obtained along the way.

The model was constructed as a synthetic spectrometer computer program, designed to mimic both the measured sensitivity of the SWP camera and the predicted scattering profile of the grating. A plot of the solar spectrum in 10 Å bins was used as input, combining the measurements of Mount et al. (1980), Broadfoot (1972), and Arveson et al. (1969), as shown in Figure 1. Since the albedos of the giant planets are relatively constant over the range 1500-3000 Å, this was considered to be a good approximation to their spectra. A relative sensitivity curve for the camera from 1100-5500 Å was obtained from the SRC Appleton Laboratories (M. Sandford, personal communication) and normalized to the published camera sensitivity at 1900-1950 Å (Bohlin et al., IUE Newsletter #2). The result of convolving the solar spectrum with the relative sensitivity of the camera is plotted in Figure 2. It is apparent from this graph that the scattered light influencing the SWP spectra comes predominantly from the wavelength region 2100-3500 Å. This sensitivity-corrected solar spectrum was then convolved, in each 10 Å bin, through a model grating scattering profile. The scattering profile was based on measurements of a test grating which was a replica of the same original grating as the flight SWP cross disperser (Mount and Fastie 1978). To duplicate the observed flat level of scattered light around 1100-1500 Å, this profile was made constant more than 500 Å from line center; and since the vertical scale of the scattering profile of Mount and Fastie was plotted for "% Line Center per .1 Å" and the present model employed 10 Å bins, the vertical scale in the model was two orders of magnitude higher than that published by Mount and Fastie. In addition, it was proposed and roughly confirmed using the test grating that the total amount of scattering from these gratings should decrease with the square of the wavelength of the incident radiation (G. Mount, personal communication). The entire

scattering profile was thus adjusted by a factor:

$$S' = S \left(\frac{1236\ \text{Å}}{\lambda_{\text{incident}}} \right)^2$$

where 1236 Å is the wavelength at which the scattering profile was measured in the laboratory. Each 10 Å bin longward of 1500 Å was run through the adjusted scattering profile, and the resultant levels of accumulated scattered light from 1200-1900 Å were summed and are plotted in Figure 3 on a scale of the fraction of the peak Ly α (1216 Å) flux after sensitivity correction. Also shown in the figure for comparison is a sample 5-minute exposure of Jupiter, plotted before conversion to absolute flux units for consistency with the model plot.

The model plotted in Figure 3 predicts a level of scattered light in the vicinity of the Ly α peak of 5 % of the Ly α peak flux, as opposed to a measured level of 8 % in the Jovian spectrum. Considering the crudeness of the model, this is a fairly good result. However, if the modeled level of scattered light is normalized to the observed level around 1300-1350 Å the modeled level at 1600-1700 Å then becomes comparable to the level of planetary emission; this is an unreasonable result, since the albedo of Jupiter is known to be on the order of 20 % in the range 1600-1700 Å (Giles et al. 1976). Not surprisingly, it appears that a measurement of the scattering profile from the actual flight grating would be needed to accurately model the total spectrum of the scattered light. Therefore, the original approximation of a constant level of scattered light normalized to the amount at 1300-1350 Å has been used in the calculation of geometric albedos (Clarke, Moos, and Feldman 1981). Nonetheless, this model has shown that the level of scattered light increases toward longer wavelengths, gradually at first but rather sharply longward of 1750-1800 Å. The existing correction is thus probably accurate up to around 1700 Å and progressively less accurate toward longer wavelengths. In addition, the shape of the modeled scattered light is quite smooth, indicating that any sharp non-solar changes in calculated albedo with wavelength must represent features of the planetary atmosphere rather than artifacts of the scattered light subtraction.

References

Arveson, J.C., Griffen, R.N. and Pearson, B.D. Jr. 1969, Applied Optics, 8,2215.

Broadfoot, A.L. 1972, Astrophys. J.,173,681.

Clarke, J.T., Moos, H.W. and Feldman, P.D. 1981,in preparation.

Giles, J.W., Moos, H.W. and McKinney, W. 1976, J. Geophys. Res., 81, 5797.

Mount, G.H. and Fastie, W.G. 1978, Applied Optics, 17, 3108.

Mount, G.H., Rottman, G.J. and Timothy, J.G. 1980, J. Geophys. Res.,85, 4271.

John T. Clarke

Space Sciences Laboratory
University of California, Berkeley

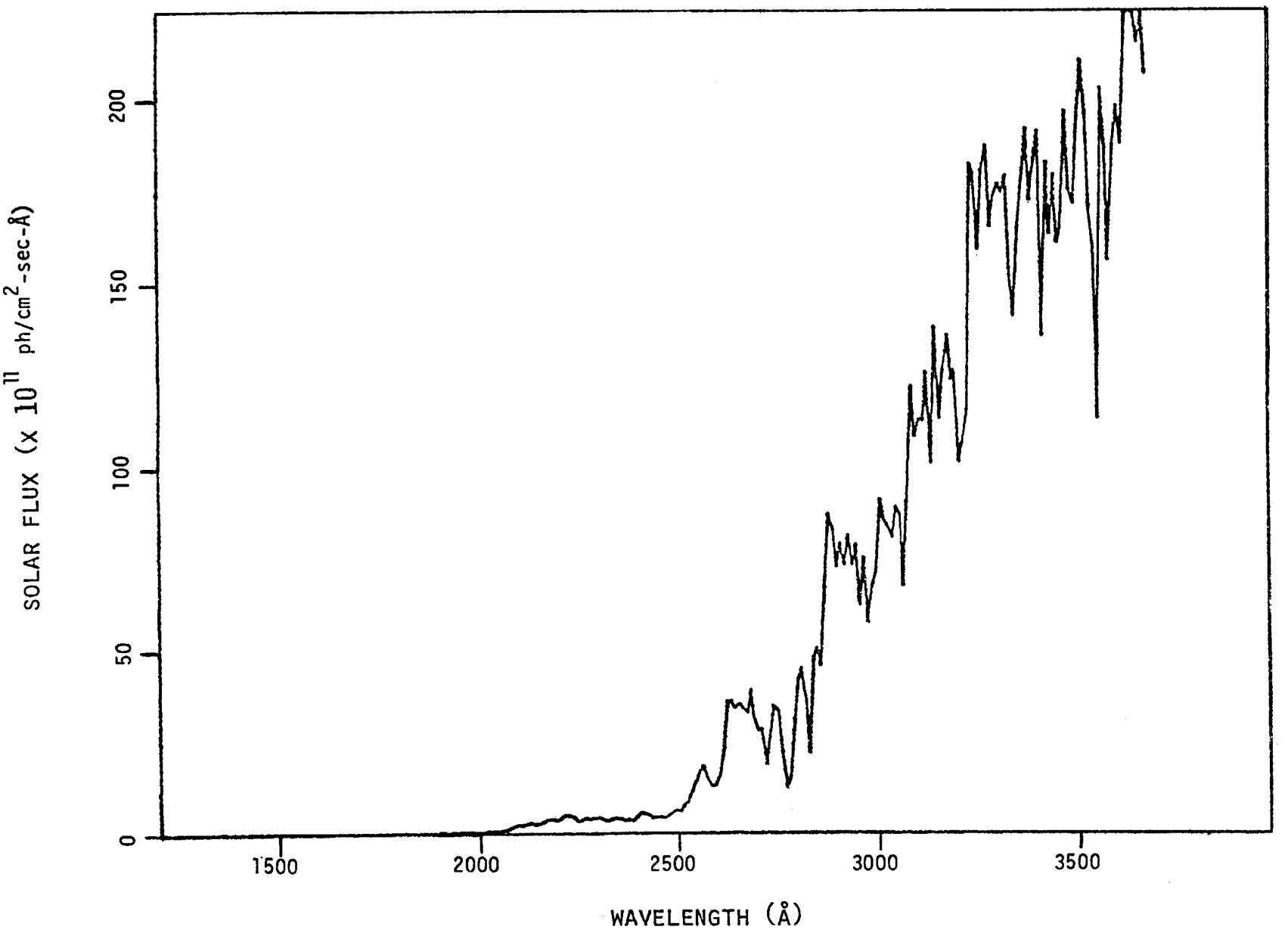

Figure 1 Solar flux at the Earth

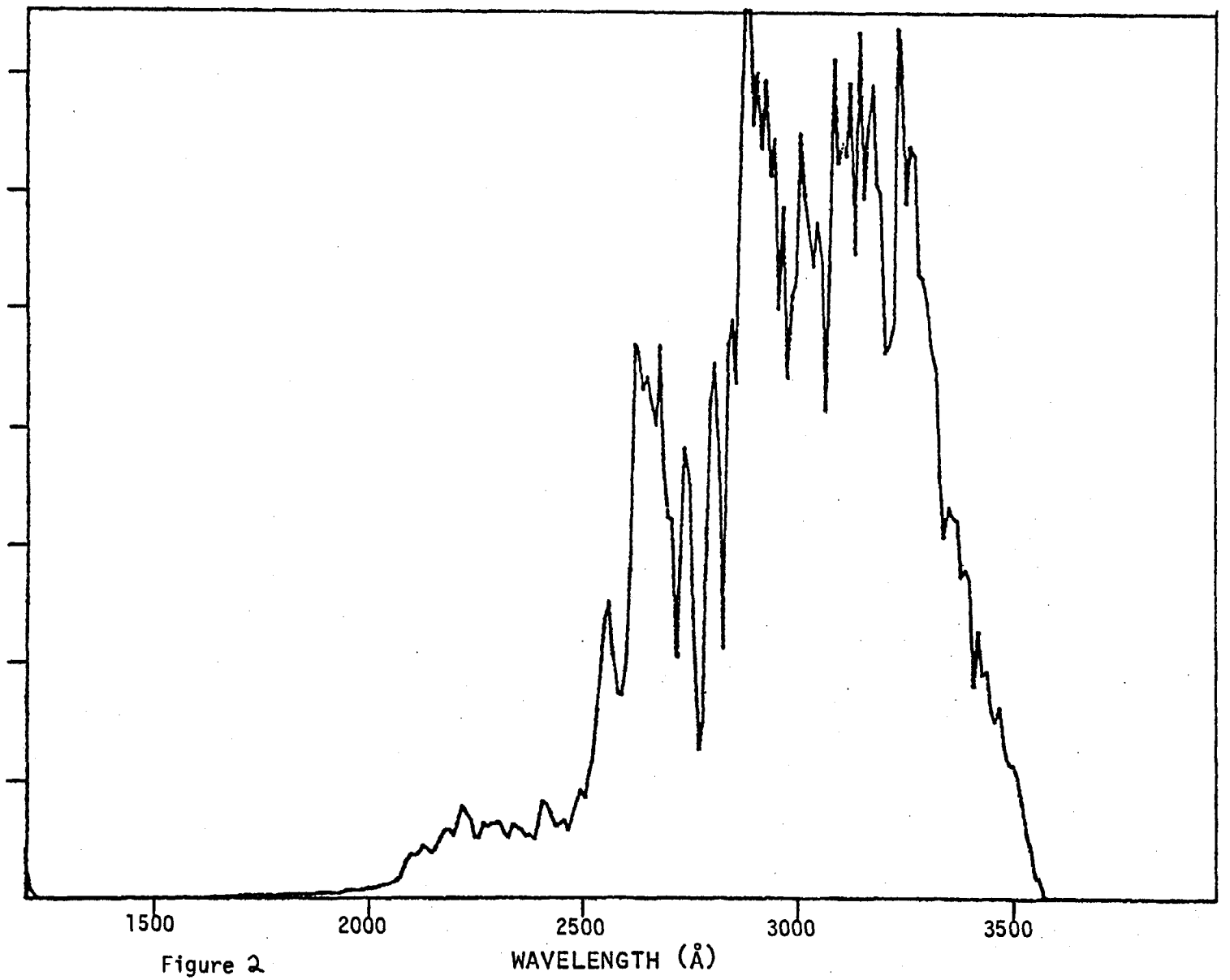
SWP RESPONSE TO SOLAR FLUX
1500
2000
2500
3000
3500
WAVELENGTH (Å)

Figure 2

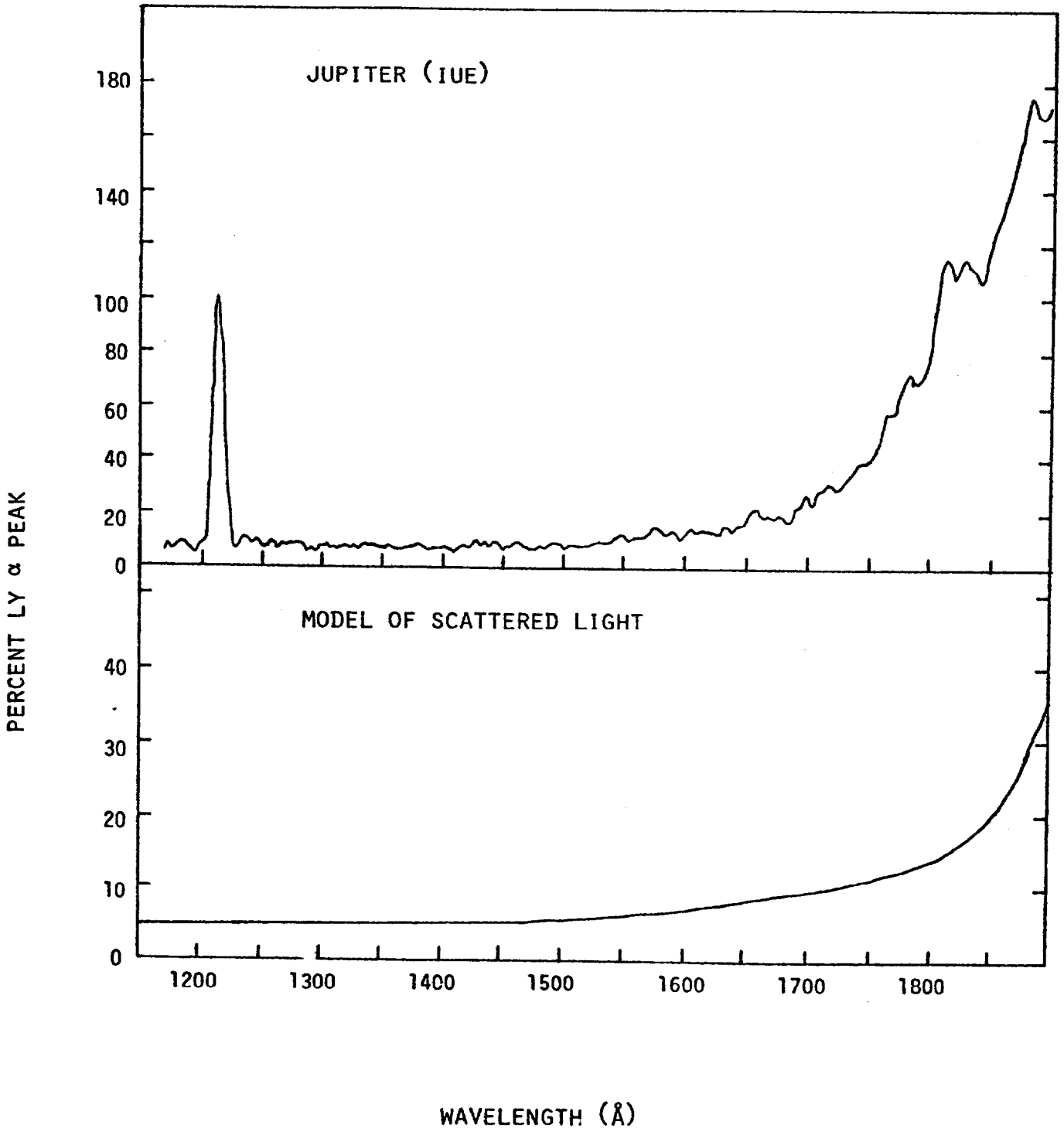

Figure 3 Scattered light model profile