

THE FAR ULTRAVIOLET BACKGROUND: DUST SCATTERING AND THE EXTRAGALACTIC CONTINUUM

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NASA's Ultraviolet Experiment (UVX) payload, which flew aboard space shuttle *Columbia* in January 1986, contained a spectrograph built by the Space Astrophysics Group at the University of California, Berkeley. The wavelength range is 1400–1850 Å with a FWHM resolution of $\sim 15 \pm 2$ Å. A full description of the instrument can be found in Martin and Bowyer (1984). The instrument was pointed at various regions of the sky for 8 nighttime orbits. Targets spanning a wide range of galactic latitudes and neutral hydrogen column densities were observed.

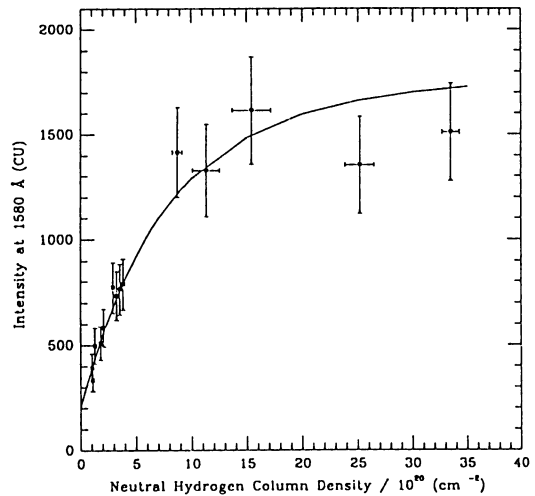
The long-slit imaging capabilities of the Berkeley spectrograph allowed us to delete those areas on the detector that were contaminated by bright stellar sources. A mechanized shutter periodically blocked the light path at the spectrometer entrance slit, allowing accurate determination of the detector dark rate event (which was stable throughout the flight and represents no more than 40% of the total signal for the faintest targets). Remaining sources of contamination are expected to be negligible, based on a detailed analysis.

A full description of the model used to interpret the data can be found in Hurwitz et al. (1989, in preparation). The model predicts the intensity of the ultraviolet (UV) background at any wavelength in the Berkeley spectrograph bandpass for any choice of galactic observables b and N_{HI} and free parameters ω (albedo of the grains), g (scattering asymmetry factor of the grains), E_{B-V_0} (equivalent reddening due to residual dust when $N_{\text{HI}} = 0$), and $I_{EX\lambda_0}$ (intensity of radiation from sources located beyond the scattering dust). We assume that the dust distribution falls off exponentially with height above the galactic plane and that the grains are illuminated by an interstellar radiation field arising from intermixed fluids of emitting stars and absorbing dust, normalized to the TD–1 measurements of the direct starlight at 1550 Å (Gondhalekar, Philips, and Wilson 1980). The model is valid for all values of the dust optical depth.

For this analysis, we have averaged the spectra over bins 30 Å in width. The statistical uncertainties in the data thus averaged are typically less than 5% of the measured intensity in the brightest targets. We estimate that a combination of systematic errors and effects not accounted for in the model represent an additional uncertainty of about 15%. The net uncertainty in the data used to set confidence intervals on the model parameters consists of the statistical uncertainty summed in quadrature with 15% of the measured intensity.

We limit our discussion here to the wavelength bin centered at 1580 Å. This bin is located near the center of the instrument bandpass and excludes line emission features detected in the data (Martin and Bowyer 1990). We have varied the four free parameters to find the values that provide the best fit to the UVX data. These are: $\omega = 0.25$, $g = 0$, $E_{B-V_0} = 0.015^m$. In Figure 1, we plot the intensity at 1580 Å versus N_{HI} and also show the best-fit model prediction versus N_{HI} . The source of the hydrogen column densities is the Bell Labs survey (Stark et al. 1989, in preparation). Between 3 and 11 column densities in the region of each UVX target were averaged; the error bars in N_{HI} represent the 1σ scatter in these values. Although the model predictions for each set of free parameters are generally a function of *two* galactic observables, for the special case of $g = 0$ the model prediction is independent of b (this can

Figure 1. Intensity in a 30 Å band centered at 1580 Å versus N_{HI} . Best-fit model prediction is also shown. Parameters of the model are stated in the text.



be shown analytically as well as via the numerical integration routines used by the model).

The data and our best-fit parameter values at 1580 Å are generally representative of our UVX results at other wavelengths. We find that $I_{EX,\lambda,0}$ has a wavelength-averaged continuum value of ~ 125 CU where 1 CU = 1 photon cm^{-2} s^{-1} sr^{-1} Å^{-1} . A full discussion of the single and joint confidence intervals on these parameters and their wavelength dependence will be published elsewhere (Hurwitz et al. 1989, in preparation).

Our analysis indicates that the correlation of the intensity of the far-ultraviolet background with N_{HI} can be well described with our model. The model indicates that the albedo of the grains is lower than most previous estimates (Witt 1989, this volume) and that the grains scatter nearly isotropically. Scattering from residual dust at $N_{\text{HI}} = 0$ makes up a significant fraction of the UV background in directions of very low column density. Using a standard gas-to-dust ratio, the residual dust corresponds to a hydrogen column density of the order of 10^{20} cm^{-2} , which is consistent with the typical column density of ionized gas detected at high galactic latitudes by Reynolds (1989, this volume). The wavelength-averaged intensity of the radiation arising from sources beyond the dust (~ 125 CU) is consistent with a summation of the ~ 50 CU of true extragalactic background detected by Martin and Bowyer (1989) and of the ~ 60 CU of two-photon emission arising from the ionized gas (Martin, Hurwitz, and Bowyer 1989).

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