MEASUREMENTS OF THE DIFFUSE ULTRAVIOLET RADIATION

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ABSTRACT. We have used the imaging instrumentation on the *Dynamics Explorer 1* (*DE*) satellite to measure the intensity of the diffuse ultraviolet (UV) radiation on two great circles about the sky. We find that the isotropic component of the diffuse UV radiation (possibly of extragalactic origin) has an intensity of 530 ±80 units (a unit is one photon cm^{-2} s^{-1} sr^{-1} $Å^{-1}$) at a wavelength of 150 nm. The galactic component of the diffuse UV radiation has a dependence on galactic latitude, which requires strongly forward-scattering particles if it is produced by dust above the galactic plane.

1. INTRODUCTION

The diffuse UV radiation is the cosmic UV radiation that is not attributable directly to stars in the galaxy. The nature of the diffuse UV radiation is of interest in both galactic and extragalactic contexts. The extragalactic component of the diffuse UV radiation may include contributions from quasars, galaxies, and the intergalactic medium (Paresce and Jakobsen 1980). The extragalactic component is presumed to be isotropic, but detectable only in directions in which the galactic component is very small. The galactic component of the diffuse UV radiation is thought to be primarily starlight from the galactic plane that has been scattered by interstellar dust particles. If so, then the intensity of the galactic component at a given wavelength and in a particular direction should depend on the amount of dust in that direction, the albedo and phase function of the particles, and the amount of UV light emerging from the galactic plane.

2. OBSERVATIONS

We have used the UV imaging instrumentation on *DE* to measure the intensity of diffuse UV radiation. The *DE* was placed in polar orbit in August 1981. The *DE* orbit has a period of about 6.8 h and an apogee of about 4.6 $R_\oplus$. The imaging instrumentation for the *DE* (Frank et al. 1981) was designed primarily to obtain global auroral images at visible and UV wavelengths. The *DE* UV imaging photometer consists of a baffled collimator, a flat stepping mirror, an off-axis parabolic mirror, a pinhole, a collimating lens, one of several transmission filters, and a photomultiplier tube. The effective collecting area of the photometer is 20.3 cm^2. The field of view is 0°.32. The imager scans a strip of sky 0°.32 wide during each spacecraft rotation (6 s), obtaining data for about 1550 pixels at intervals of 0°.23. Each pixel is accumulated for 3.4 ms. Normally, the field of view is rotated 0°.25 after each spacecraft rotation by means of the stepping mirror to produce an image. In order to develop adequate counting statistics, however, we have used repeated measurements of the same scan line in investigating the diffuse UV radiation.

The observations reported here were obtained over a four-day period in July 1984 and over four days in July 1987. During those times, the *DE* apogee was nearly above the north geographic pole. For each year, the scan line was nearly a great circle and nearly perpendicular to the celestial equator. The measurements were made using two filters, each with a peak photometric response of near 150 nm and a full width half maximum (FWHM) of 27 nm. Instrumental sensitivity was determined by comparing count rates for bright stars with flux

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distributions from the *IUE Ultraviolet Spectral Atlas*. After we eliminated pixels contaminated by identified stars, 1325 pixels for 1984 and 1342 pixels for 1987 remained for further analysis. The photometry included a dark count rate due to cosmic rays. We determined the absolute value of the photometer response to cosmic rays by comparing measurements made with the two filters, which differed in sensitivity. The cosmic ray count rate was then subtracted from the data.

3. DISCUSSION

The intensity of the UV radiation shows a definite dependence on galactic latitude, but the precise nature of the relationship between intensity and latitude varies with galactic longitude. At galactic latitudes above 50°, the UV intensity has a typical value of about 500 units. Although there appear to be real differences in the dependence of intensity on latitude for the four cuts through the galactic plane, we explored the general relationship by averaging all data in 2° intervals of absolute value of galactic latitude, b. For $|b| > 10°$, intensity can be reasonably well fit by a linear function of $\csc|b|$. Extrapolation of the $\csc|b|$ relationship results in an estimate of 550 ±80 units for the intensity of diffuse UV radiation at the galactic pole.

We have used the neutral hydrogen column densities of Heiles (1975) (and the zero-point correction of Heiles, Stark, and Kulkarni 1981) to investigate the relationship between UV intensity and hydrogen column density. A linear least squares fit to the relationship between intensity and hydrogen column density has an intercept at 530 ±80 units, which may be the extragalactic component of the diffuse cosmic radiation. However, it is also possible that the isotropic component of the diffuse UV radiation has nothing to do with extragalactic radiation. Paresce (1983) has suggested an alternative explanation in which the galaxy is enveloped in a thin haze of scattering dust.

Our result is in general agreement with most of the recent determinations of the high latitude UV intensity, which are generally less than 1000 units in the spectral region below 250 nm. A background intensity at the level of a few hundred units can be accounted for as the integrated light of galaxies for some models of galactic evolution and some mixtures of galaxy types (Code and Welch 1982). However, more speculative mechanisms for producing a measurable extragalactic component of the diffuse UV radiation have also been proposed. These mechanisms are discussed by Paresce (1983).

When the isotropic component is subtracted from the intensity, the galactic component remains. We have tried to match the latitude dependence of the galactic component using numerical calculations based on a scattering model of Anderson et al. (1982). None of the calculations produced a latitude dependence that was steep enough to match the measured intensity. We conclude that either the model for the galaxy or the Henyey-Greenstein phase function is inappropriate, but that the measurements require strongly forward-scattering particles in any case.

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