ALEXIS Observations of the Diffuse Cosmic Background in the Extreme Ultraviolet

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We present preliminary results of *ALEXIS* satellite observations of the extreme ultraviolet diffuse sky. *ALEXIS* was designed to be a half-sky monitor in three narrow wavelength bands between 13.0 and 19.0 nm. In our band centered at 172 Å we find a clear signal from the diffuse sky that is about 20 counts per second above the signal when looking at the dark earth from the same part of an orbit. This difference corresponds to an upper limit on the true cosmic diffuse background signal in this narrow band. When estimates of the geocoronal contributions, both in and out of band, are removed, our upper limit is reduced.

1. Introduction

The *ALEXIS* satellite was designed to make robust measurements of the diffuse cosmic background in the extreme ultraviolet. For a description of the instrument and its performance, see Bloch et al. 1990, or Bloch, this volume. We have selected a small number of time intervals to examine during which telescope pair 1, which looks out approximately along the satellite spin equator, alternately looks at the dark earth and the sky on each spin. If the earth is truly dark, i.e., no significant airglow or aurora, the difference between sky-looking and earth-looking fluxes should be an absolute upper limit to the diffuse cosmic background flux. As can be seen from Figure 1, our strict upper limit is at the limit of detectability of previous instruments. When all our analysis is done, we should be able to decrease this limit. Here we confine ourselves to telescope 1B which has a bandpass from approximately 171 to 186 Å, with peak sensitivity at 176 Å.

2. Analysis

Data is selected by a nested set of criteria. This was done in order to eliminate data that was contaminated by the anomalous background that is observed when the angle between the ram of the spacecraft orbital motion and the look direction of the telescope falls below 90° to 100° (Bloch et al. 1994). The method used excluded data with a ram angle below 100 or a count rate above 100 counts s^{-1}. This removed the unwanted ram background and also excluded data when the spacecraft passed through the auroral zones or the South Atlantic Anomaly. The ram background can be seen in Figure 2, which shows the smoothed count rate scalers and the horizon angle for a number of *ALEXIS* spins as a function of time.

Figure 3 shows the count rate as a function of angle from the telescope optical axis to the earth's horizon in 5° bins. At 0° on this axis, half the 33° field of view is on the earth and half is on the sky. The data is shown for telescope 1B (176 Å) where a difference of more than 10 counts s^{-1} is observed between the earth-looking and sky-looking count rates. Telescope 1A, with a bandpass at about 133 Å, shows no difference.

We are in the process of compiling a number of long data sets to look for correlations in the sky-ground count rates at different times of the year. These sets of data are being compiled on a spin-by-spin subtraction of the average count rate at 30° above the horizon

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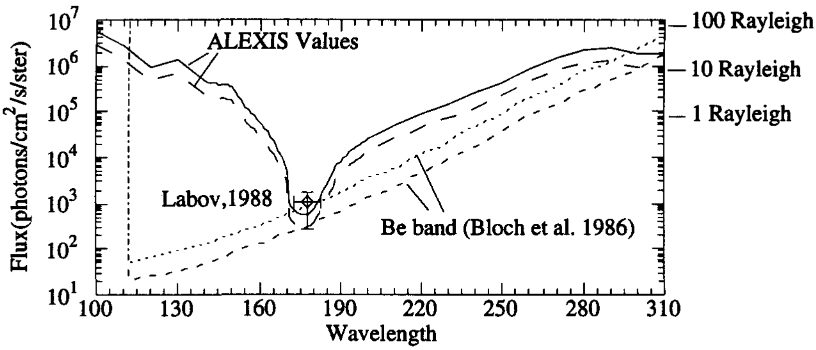

FIGURE 1. A comparison of upper limits on the diffuse cosmic background in the extreme ultraviolet. The sounding rocket results of the Wisconsin group (Bloch et al. 1986) are shown for the "beryllium band." The result of Labov (1988) for a single line is shown. The *ALEXIS* upper limit is shown for excess sky rates of 10 (lower curve) and 20 counts s^{-1}.

from the average count rate at 30° below the horizon. Differences range from −10 to 50 counts s^{-1} as can be seen in the histogram of a data set from January shown in Figure 4. This histogram peaks around a sky-to-ground difference of 10 to 20 counts s^{-1}. The variation might be due to variations in geocoronal or interplanetary contributions to the sky flux, or to true variations in the diffuse soft X-ray cosmic background, which is known to vary by factors of three across the sky.

To derive Figure 1, we assumed that the net sky counts could be converted into flux using an area-solid angle product of 4.22 cm^2-sr and an effective system efficiency of 0.004 counts per incident photon, as measured directly during pre-flight calibration. Our measured flux for HZ43 leads us to believe that our in-flight efficiency is close to the pre-flight calibration.

3. Discussion

The observed flux contains contributions from geocoronal He II 304 Å (0.1 to 1.6 R; e.g., Chakrabarti et al. 1982) and He I 584 Å (0.4 R; e.g., Chakrabarti et al. 1984), as well as interplanetary 584 Å backscatter, which has a seasonal variation when looking-antisun, being largest in December, up to 10 R, and smallest in June, 1 R (R. R. Meier, private communication). The sensitivity of telescope 1B to 304 Å is about 1 count per Rayleigh, while the sensitivity to 584 Å is about 25 times smaller. Therefore, it appears that no more that a few counts per second can be easily attributed to helium line fluxes. Other potential sources of sky flux include scattered solar X-rays and EUV, which we estimate to be smaller than 304 Å contributions. Local particle flux is not variable in a repeatable way over time scales of less than 1 minute, and we believe our subtraction technique should eliminate them as an explanation for the observed sky-earth difference. Auroras in the field of view, when we are earth-pointed, would decrease the observed net flux, and indeed one can see spins then this seems to be happening.

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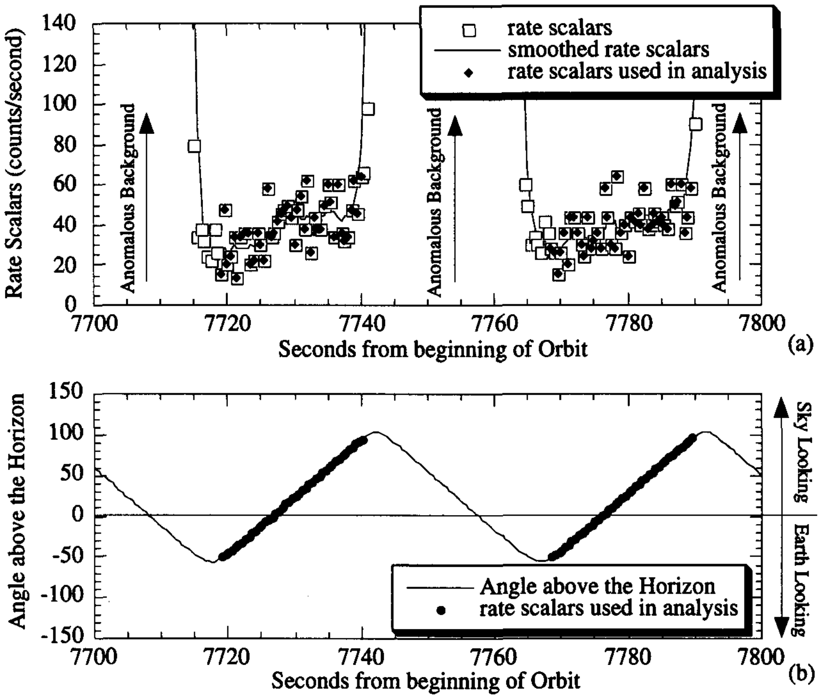

FIGURE 2. The count rate scalers (a) and the horizon angle (b) for two rotations of telescope 1B. Times dominated by the anomolous background (a) and our selected data intervals (b) are shown.

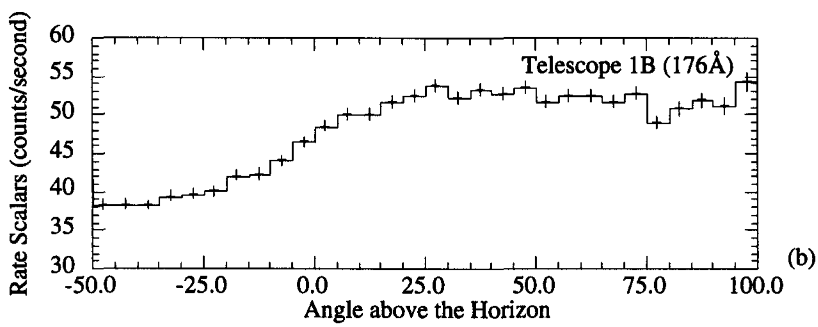

FIGURE 3. Count rates for telescope 1B as a function of the angle between the telescope's optical axis and the earth's horizon, in 5° bins.

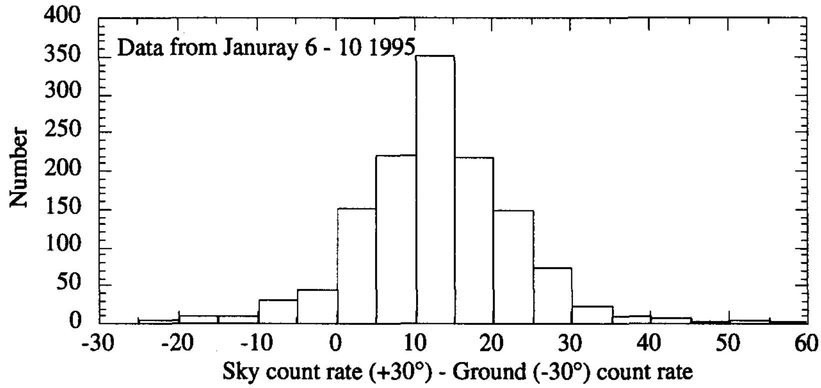

FIGURE 4. Histogram of the count rate differences between 30° above and 30° below the horizon for a data set in January.

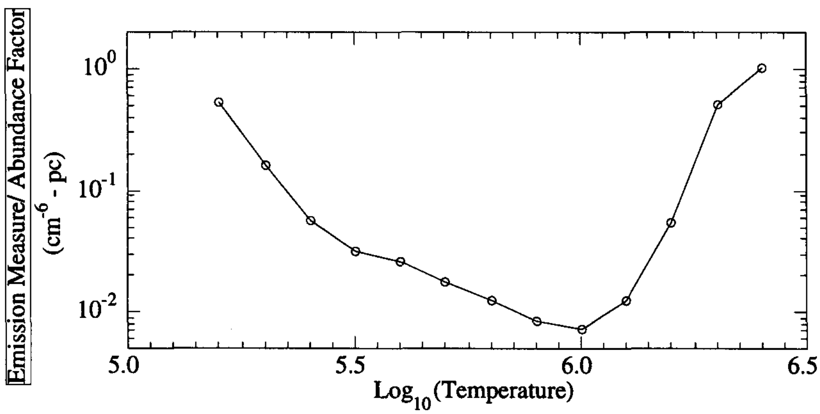

FIGURE 5. Upper limit on the emission measure of a hypothetical hot interstellar plasma with cosmic abundances and no absorption, as a function of the logarithm of the plasma temperature in kelvin. The spectrum is from Brickhouse et al. 1995.

In Figure 5 we use the latest plasma spectrum model of Brickhouse, Raymond, & Smith (1995) with the response curve of *ALEXIS* telescope 1B, to derive upper limits on the emission measure required to make up the observed net sky flux without interstellar absorption. When absorption is added, these limits will rise. Therefore these are preliminary upper limits to the possible emission measure assuming normal cosmic abundances.

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