ULTRASOFT X-RAY BACKGROUND OBSERVATIONS OF THE LOCAL INTERSTELLAR MEDIUM

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ABSTRACT

Preliminary results from a May 8, 1984 sounding rocket survey of the soft X-ray background are presented. The X-ray detectors are sensitive to X-rays in three soft X-ray bandpasses: 80-110 eV, 90-188 eV, and 284-532 eV (at 20% of peak response). The lowest energy X-rays in this range have a mean free path of order 10^{19} cm^{-2} and provide information about the local interstellar medium. The count rate in the 80-110 eV energy band (the Be band) tracks the 90-188 eV band (the B band) very well, indicating that the same ~1 million degree gas that is responsible for the B band emission may be responsible for the bulk of the Be band X-rays as well. We estimate for the flux in the Be band ~1 photon cm^{-2}s^{-1}sr^{-1}eV^{-1}, about a factor of four lower than that found by Stern and Bowyer (1979) and Paresce and Stern (1981) over a similar energy band.

INTRODUCTION

The soft X-ray background appears in all directions of the sky and is thought to be emitted by hot (~1 million degree) interstellar gas surrounding the Sun (e.g., see Edgar and Cox, this colloquium). The mean free path for Be band X-rays against interstellar absorption is 10^{19}cm^{-2}. Thus the bulk of the X-rays detected in the 80-110 eV band originate closer to the Sun than the closest few times 10^{19} cm^{-2} of neutral material.

EXPERIMENTAL DETAILS

Figure 1 shows the scan path of the experiment superimposed on a map of the soft X-ray B band (130-188 eV) intensity (McCammon et al. 1983). The instrument covered a swath of sky, ~ 15° x 140° degrees, stretching from the inside of Loop I, across the northern extreme of the North Polar Spur, passing within 15° of the North Galactic Pole, skirting the edge of the Hercules soft X-ray enhancement, heading towards the galactic plane along l = 150°. The detectors were proportional counters filled with 100 torr of methane, 1 cm thick, collimated to a 14° circular field of view. Detector "Y" had a 24 microgram cm^{-2} Formvar window behind a 5500 Angstrom beryllium filter, thus defining the Be band, 80-110 eV. Detector "Z" had a 30 microgram cm^{-2} Formvar window with a ~200 microgram cm^{-2} boron coating, defining a soft B band, 90-188 eV. The area-solid angle curves as a function of energy are shown in Figure 2.

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SPATIAL STRUCTURE

Figure 3 shows the count rate in both the Be band (circles) and B band (squares) as a function of angle along the scan path. They clearly are highly correlated as shown in Figure 4. This suggests that the source of the Be band X-rays is the same 1 million degree gas that is thought to produce the B band X-rays (and most of the C band X-rays, 160-284 eV). Because the Be band X-rays must originate closer than the closest ~2×10^{19} cm^{-2} of neutral material, the implication is that the B band and C band X-rays also originate in the local interstellar medium.

SPECTRAL FITS

Figure 5 shows the pulse height distribution from both the Be band and B band detectors accumulated over the times when the experiment scanned angles 0 to +25 degrees (see Figure 1). The solid line shows the calculated detector response to a three-component model of the soft X-ray background (McCammon et al. 1983). It assumes an $11E^{-1.4}$ extragalactic spectrum absorbed by $N_H = 2\times10^{20}$, an equilibrium hot plasma of T = 3 million degrees absorbed by 2×10^{20}, and an equilibrium hot plasma of 1 million degrees with no absorption. We find no need for an additional softer component. The 80-110 eV flux that we measure is ~1 photon $cm^{-2}s^{-1}sr^{-1}eV^{-1}$, which is a factor of 4 lower than that found by Stern and Bowyer (1979) over a similar energy band. Figure 5 also shows the pulse height distribution that we would expect in our detectors for a thermal emission component of log T = 5.6, n_e^2d = 0.01 and N_H = 0 (Paresce and Stern 1981).

REFERENCES

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Paresce, F., and Stern, R. 1981, Ap. J., 247, 89.

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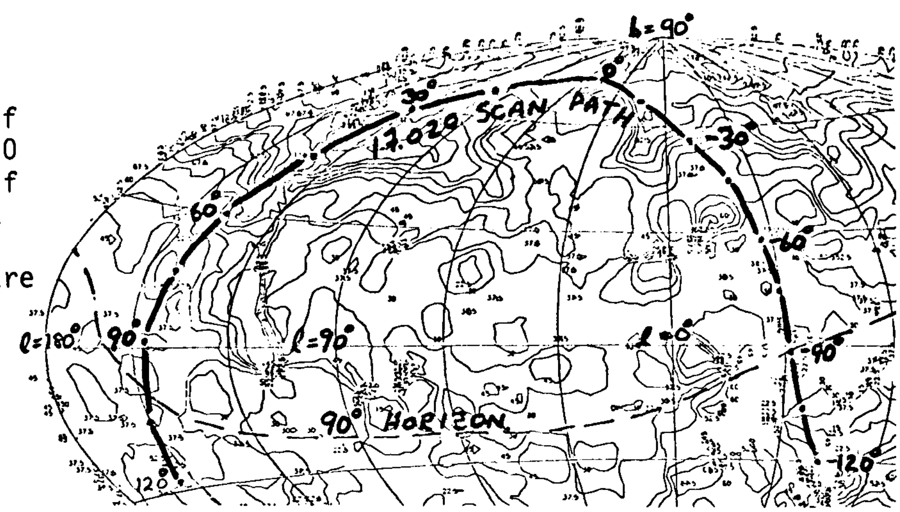


FIG. 1 - Scan path of sounding rocket 17.020 superposed on a map of the soft X-ray B-band intensity. Degrees along the scan path are indicated.

FIG. 2 - Area-solid angle product as a function of energy
a) for the beryllium filter detector (Y), and
b) for the boron window detector (Z).

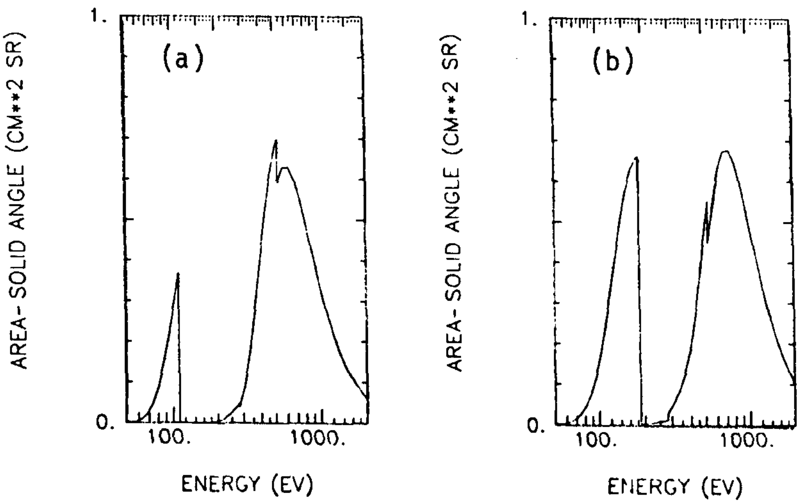


FIG. 3 - Count rate in the Be band (circles) and in the B band (squares) as a function of angle along the scan path (see Fig. 1) of flight 17.020.

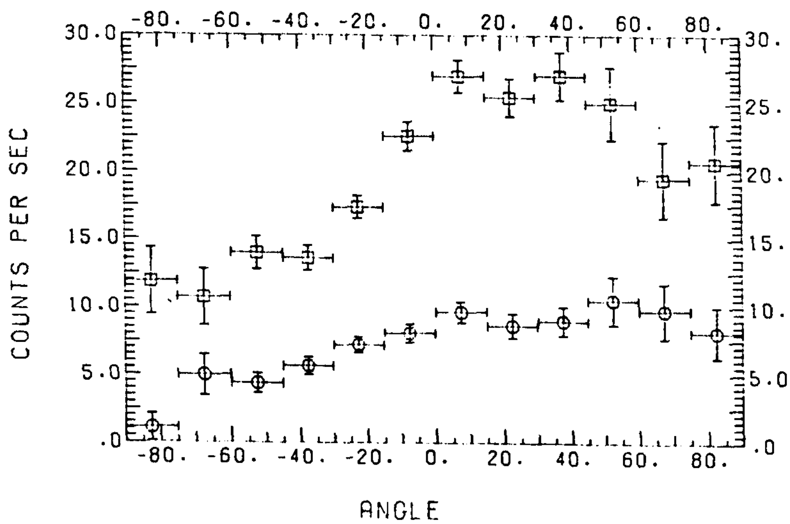
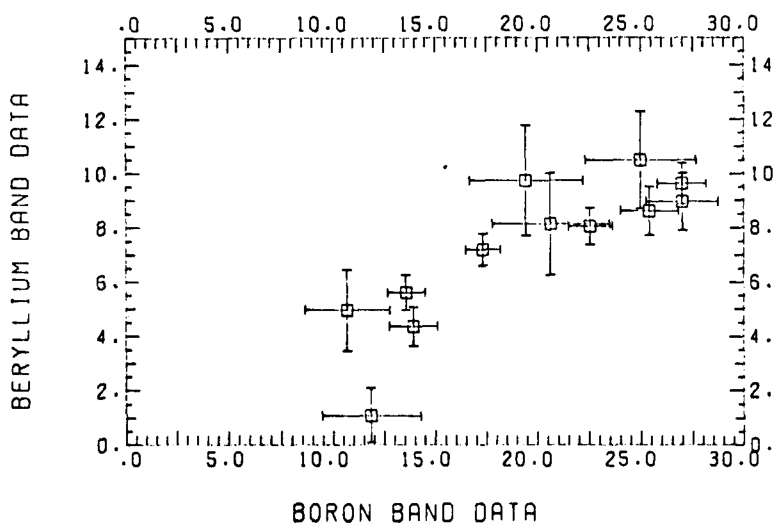


FIG. 4 - Be band count rate (counts s^{-1}) plotted versus B band count rate (counts s^{-1}) for the data of Fig. 3.



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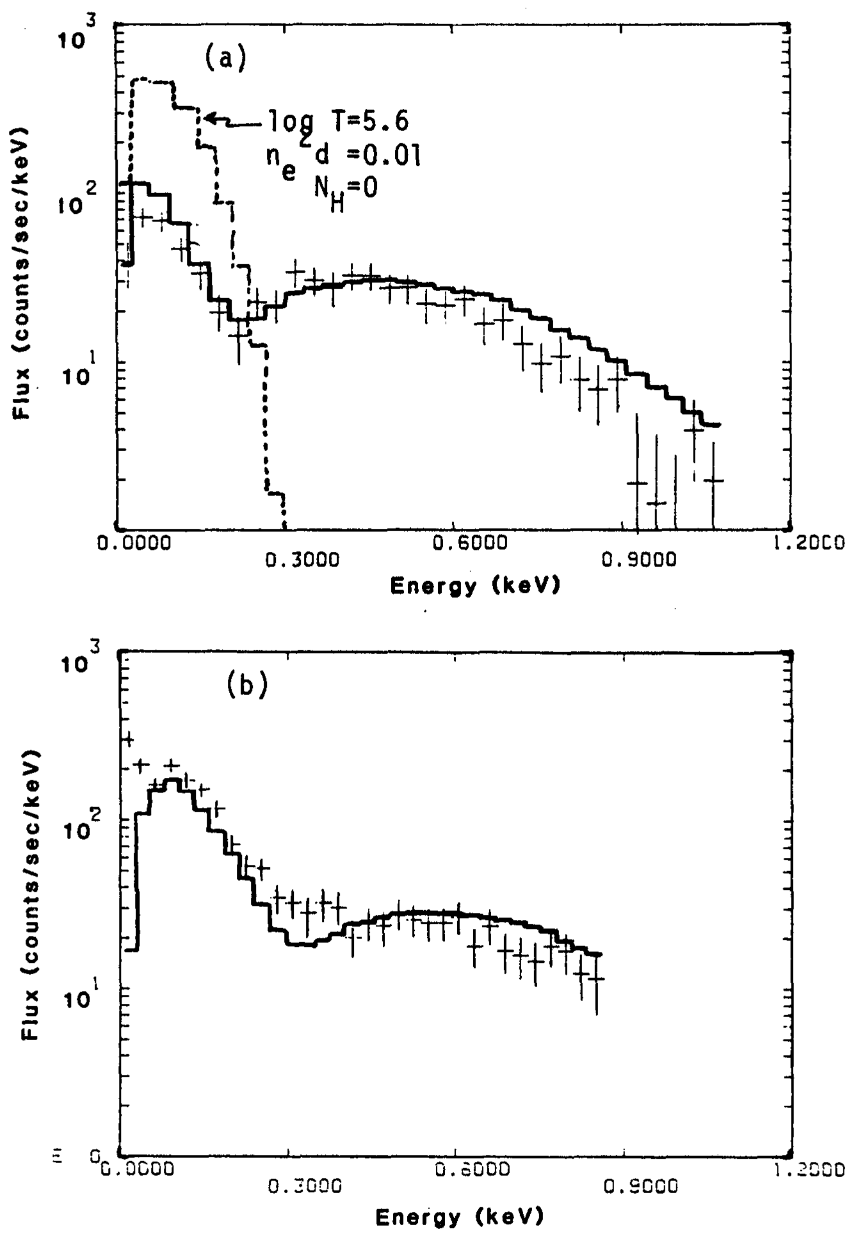

FIG. 5 - Pulse height distributions measured when experiment scanned from 0° to +25° along the scan path (see Fig. 1). The solid line shows the flux expected from a "typical" spectrum that fits (on the average) the B and C band pulse height distributions. The dashed line shows the flux expected from the log T = 5.6 spectrum of Paresce and Stern (1981), a) For the beryllium filter detector, and b) for the boron window detector.

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