Fe VIII, IX, AND X LINE EMISSION FROM THE SOFT X-RAY BACKGROUND: PREVIOUS LIMITS AND A FUTURE MEASUREMENT

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ABSTRACT. We discuss pulse height analysis of Be band data in relation to the important 72 eV Fe line cluster emission from the soft X-ray background (SXRB). Pulse height fits to the Be band data suggest that the Fe lines must be suppressed by a factor of ~10 with respect to the rest of the X-ray spectrum. The broad band rates and the mean energy of the pulse height data for the Be band can be brought into agreement by using depleted elemental abundance emission models. A planned measurement of the SXRB Fe lines using the Array of Low Energy X-ray Imaging Sensors (ALEXIS) experiment could resolve this issue.

1. THE Fe LINE EMISSION FROM THE SOFT X-RAY BACKGROUND

The soft X-ray background (SXRB) emission (0.07-0.25 keV) is thought to originate in a $\sim 10^6$ K plasma that exists in the local interstellar medium. The SXRB flux has been measured in the Be (0.07-0.111 keV), B (0.130-0.188 keV), and C (0.16-0.284 keV) bands (McCammon *et al.* 1983, Marshall and Clark 1984, Bloch *et al.* 1986, Juda 1988). The relatively constant ratio (see Figure 1) between the Be band and the B band flux from the SXRB has been used as an argument that the SXRB emission source is within 100 pc of the sun and closer than the first $\sim 1 \times 10^{19}$ cm^{-2} of HI column density (Bloch *et al.* 1986, Juda 1988).

Emission models of a $\sim 10^6$ K plasma (Raymond and Smith 1977,1987) with normal cosmic elemental abundances predict that 34% of the atomic cooling power comes from a set of closely-spaced lines around 72 eV from Fe VIII, Fe IX and Fe X (see Figures 2 and 3). These lines should have dominated the observed counts in the Be Band (Bloch *et al.* 1986), but pulse height analysis of these data yields a mean energy which is incompatible with 72 eV (see Figures 4a and 4b, Bloch 1988). The flux from the Fe lines must be reduced by ~10 with respect to the rest of the SXRB spectrum within the Be band to make the model spectra compatible with the observed pulse height distribution. One way that the broad band Be, B and C band rates can be reconciled with the Be band pulse height distribution is to assume an equilibrium plasma emission using standard depleted abundances (Bloch 1988) as observed in higher density regions of the ISM. (see Figures 4c and 4d). Such a situation might arise if the hot plasma was formed by heating cool gas containing dust that has not yet been destroyed by the hot component.

2. THE ALEXIS PROJECT

A direct measurement of the flux in the 72 eV Fe lines would provide an important diagnostic of the hot local interstellar medium. The Earth and Space Sciences division at Los Alamos National laboratory is planning the Array of Low Energy X-ray Imaging Sensors (ALEXIS) experiment (Priedhorsky *et al.* 1988). It consists of 6 normal incidence ultrasoft X-ray telescopes with microchannel plate detectors flown on a mini-satellite. Each telescope will have a 40 degree field of view with one degree resolution and an effective collecting area of 0.56 cm^2 at the peak of the multilayer response. FWHM spectral resolution of the mirrors will be ~5%. The telescopes will utilize spherical multilayer mirrors with three or four narrow passbands distributed among the six telescopes. One passband will be centered at 72 eV to include the Fe line emission. The flux from these lines in the SXRB could produce a signal of as much as 100 counts per second for ALEXIS telescopes with this passband. With the narrow spectral response of ALEXIS, an unambiguous measurement of the flux from the lines will be possible. ALEXIS' spatial resolution and estimated year-long operating lifetime will allow the generation of all-sky maps of the SXRB in the 72 eV Fe lines with one degree resolution and considerable sensitivity. Comparison of such maps with those at other energies could help resolve remaining questions about the origin of the SXRB.

Several other upcoming missions with capabilities within the EUV regime (e.g., EUVE, ROSAT XUV wide field camera) should provide limits for the flux from these Fe lines. However due to their wider spectral responses or poorer area-solid angle products they will not easily provide true measurements.

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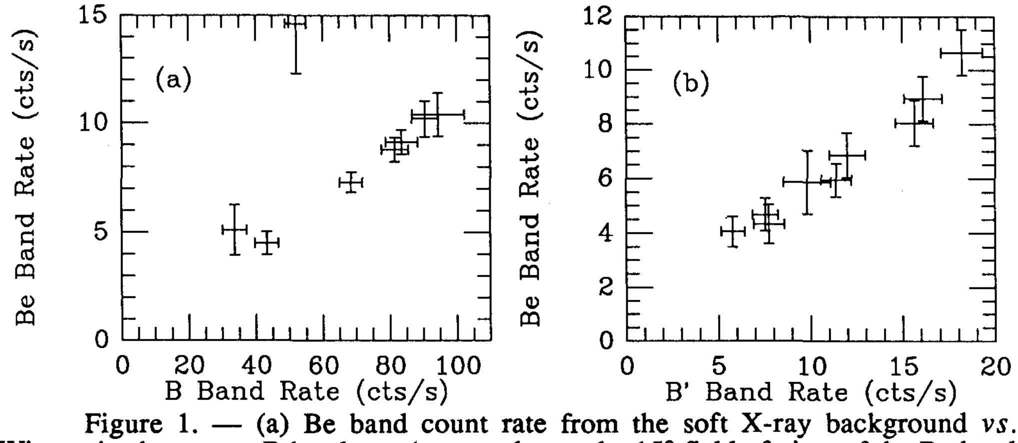

Figure 1. — (a) Be band count rate from the soft X-ray background *vs.* Wisconsin sky survey B band rate (averaged over the 15° field of view of the Be band detector). These results are from the first Be band detector flight reported in Bloch *et al.* 1986. (b) Be band rate vs. B' band rate observed on the second flight of the Be band detector (Juda 1988). The B' band rate was measured with a B band detector on the same rocket flight with the same field of view as the Be Band detector. An optical depth in the Be Band is ~1×10^{19} cm^{-2} HI while in the B band it is ~6×10^{19} cm^{-2} HI.

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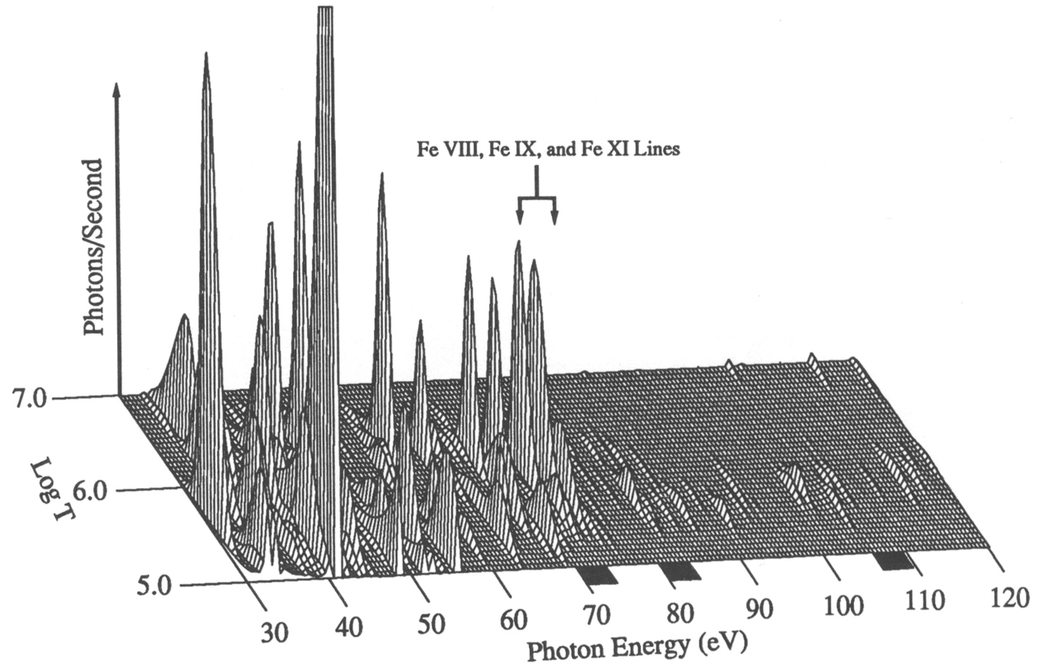

Figure 2.— Surface plot showing the photon spectrum from an optically thin plasma with temperatures ranging from Log T 5.0 to 7.0. The black boxes indicate the three ALEXIS bandpasses.

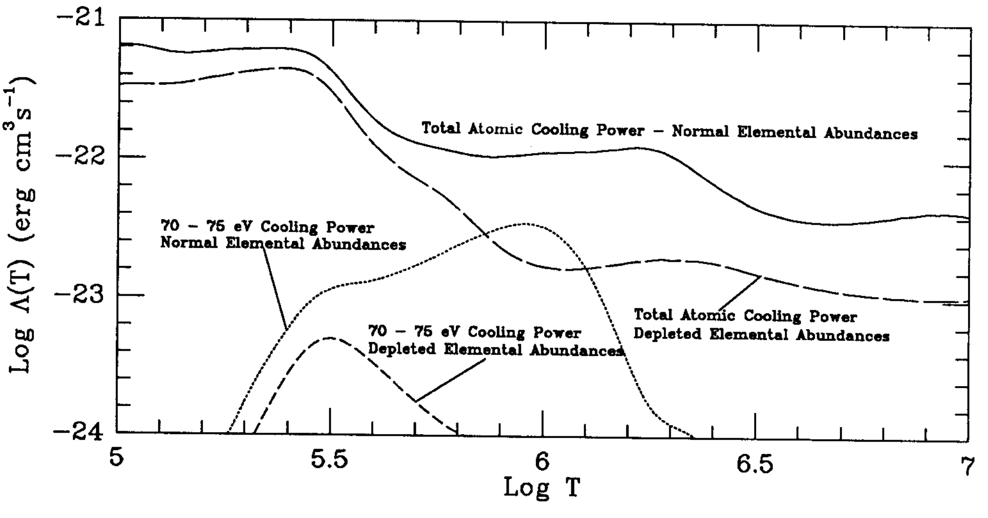

Figure 3.— Atomic cooling power radiated by an optically thin plasma in thermal equilibrium as a function of temperature. Normal and depleted abundance cooling curves are shown for the total power and the power radiated by lines between 70 and 75 eV.

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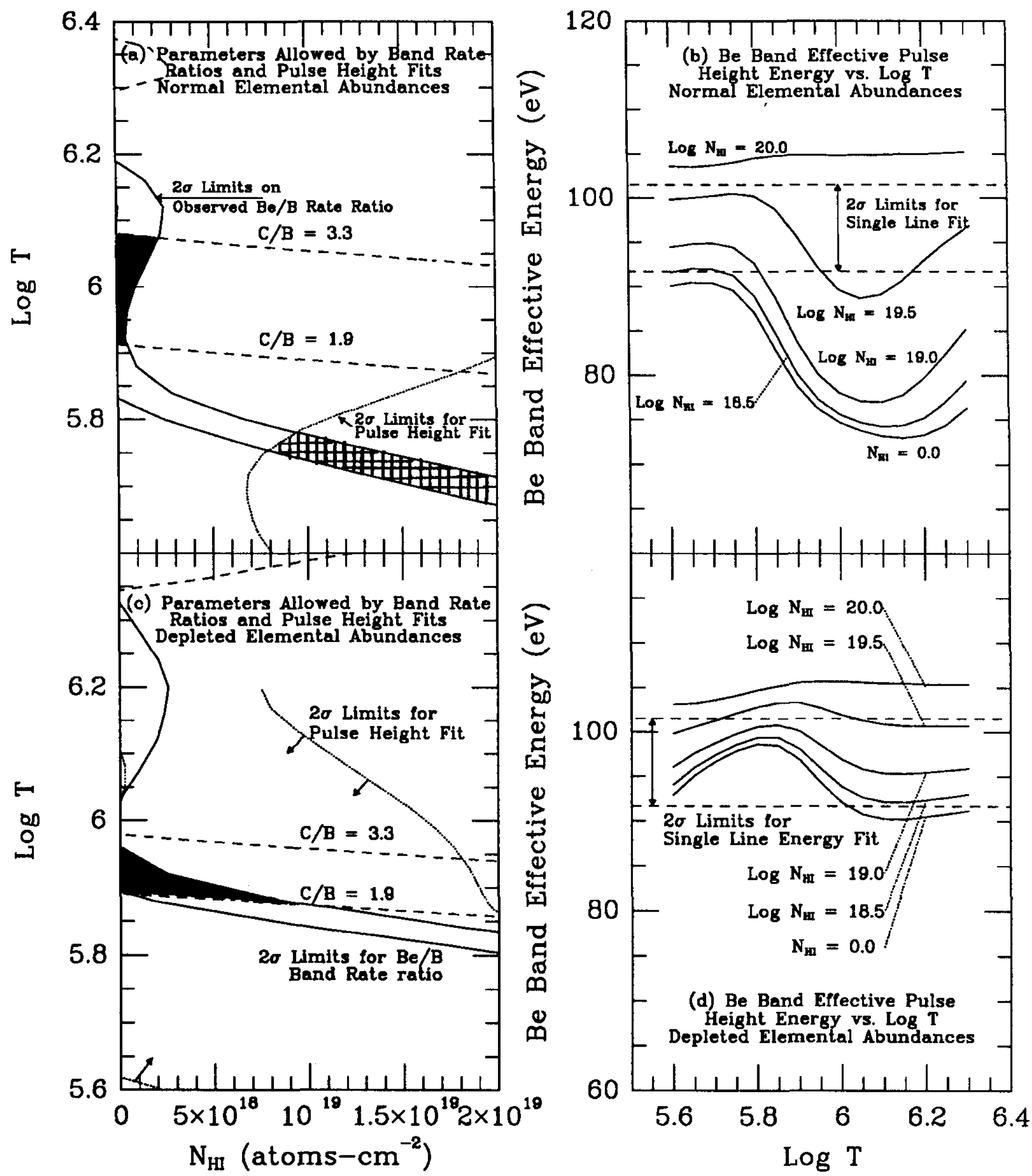

Figure 4. — (a) Temperature *vs.* intervening gas parameter for optically thin plasma emission. The black region is consistent with the 2σ limits on the observed Be/B ratio and the fluctuations in the C/B ratio for the observed regions of the SXRB. The hatched region is consistent with the Be/B ratio and the Be pulse height distribution. This region cannot generate enough C band X-rays and requires more than an optical depth of absorption for the Be band X-rays. (b) Be band effective energy vs. temperature for the same model as (a). (c) Same as (a) except using depleted abundances. The black region is consistent with the pulse height distribution and the Be/B ratio and generates most of the C band emission. (d) Same as (b) except using depleted abundances.

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