USING IRAS CIRRUS TO LOOK FOR X-RAY SHADOWING WITH ROSAT

Helen J. Walker and Alan W. Harris
Rutherford Appleton Laboratory
Chilton, Oxfordshire
OX11 0QX, UK

Timothy J. Sumner
Imperial College of Science
Technology and Medicine
London, SW7 2BZ, UK

The ROSAT X-ray satellite mission and its X-ray telescope (XRT) are described by Trümper (1984). The characteristics of the Wide Field Camera (WFC) on ROSAT and its potential for studies of the soft X-ray background (SXRB) are discussed by Harris, Sumner, and Walker (1989, this volume). The energy range covered by the WFC is 0.06 keV to 0.21 keV (60 Å to 200 Å), whilst the XRT covers the higher energy range from 0.2 keV to 2 keV. Observations performed to date in this field have given rise to conflicting evidence on the location and nature of the 10^6 K gas, which is presumed to be the origin of the observed emission (see references in Harris, Sumner, and Walker, 1989, this volume).

A direct way of establishing the location of the emitting gas is to look for absorption of the diffuse emission by nearby, small, interstellar clouds with known distances (e.g., Fried et al. 1980), but previous attempts have been constrained by poor angular resolution (typically ~5°) and lack of capability in the extreme ultraviolet (EUV) beyond 100 Å. The 2′ resolution of the WFC and the < 1′ resolution of the XRT offer the unprecedented possibility of imaging silhouettes of *individual* small cirrus clouds, such as the high galactic latitude molecular clouds discovered in CO emission by Magnani, Blitz, and Mundy (1985), which are the *nearest molecular clouds to the sun.* In particular, the MBM clouds listed in Table 1 have well-determined distances (or upper limits), from either NaI absorption line studies (Hobbs et al., 1986, 1988) or from star count data (Magnani and de Vries, 1986). MBM12, with a distance of 65 pc, is the nearest known molecular cloud. The clouds are visible in the IRAS Skyflux 100 μm maps (IRAS Explanatory Supplement, 1985), and their outlines are similar to those inferred from the CO maps. The larger IRAS maps confirm that these clouds are isolated compact features in the general background cirrus. The estimates of N(H) in Table 1 are from the CO data of Magnani, Blitz, and Mundy (1985), and they include both HI and H_2. These estimates are for the *cores* of the clouds.

TABLE 1. CO/IRAS Clouds

Cloud	RA (2000)	Dec (2000)	b (°)	Size (°)	Dist. (pc)	$N(H)_{CO}$
MBM 12	02 56 50	19 32 03	−34	1 × 2	~65[a]	11×10^{21}
MBM 16	03 19 43	10 40 50	−38	2 × 3	60–90[b]	5×10^{21}
MBM 20	04 35 18	−14 13 53	−37	1.5 × 2	≤125[c]	6×10^{21}
MBM 7	02 22 24	19 53 38	−38	1.5 × 2	125±50[c]	6×10^{21}
MBM 26	08 07 03	60 34 20	33	1 × 1.5	175±50[c]	2×10^{21}
MBM 32	09 32 47	65 51 43	41	1 × 1	≤275[c]	3×10^{21}

[a] Hobbs et al. (1986); [b] Hobbs et al. (1988); [c] Magnani and de Vries (1986)

If we assume that a discrete compact cloud (containing hydrogen which absorbs the SXRB) is embedded in a uniformly distributed medium of hot SXRB–emitting gas mixed with absorbing hydrogen (e.g., Kahn and Jakobsen, 1988), we can estimate the difference in SXRB count rate expected between the image area occupied by the cloud and that around the cloud. The field of view of the XRT is 2.5°, whereas, for the WFC it is either 5° or 2.5°, depending on the filter selected (Harris, Sumner, and Walker, 1989, this volume). We assume the cloud occupies half the field of view (the clouds discovered by Magnani et al. are typically 1–2° in

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diameter). The strong dependence of the count rate difference on both the hydrogen column density to the cloud and within the cloud is revealed in Figure 1. If the foreground hydrogen column density is small (as expected in the local ISM) and the exposure time sufficient, structure within and around the clouds should be observable by virtue of the partial absorption of the SXRB. It should be stressed, however, that these predictions are highly sensitive to the assumed model.

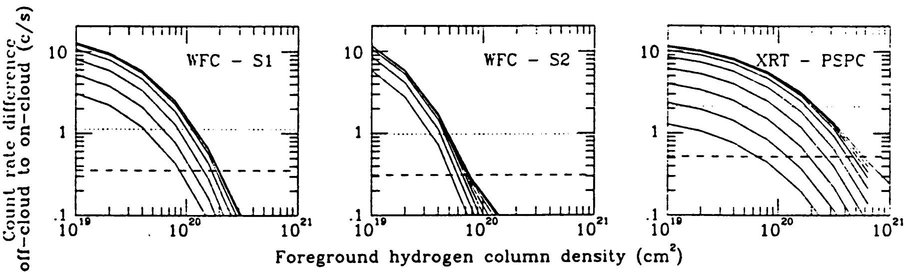

Figure 1. Count rate differences between off-cloud and on-cloud image areas are shown for the combination of the WFC and the two survey filters, and the XRT with the PSPC (Position Sensitive Proportional Counter), as a function of the foreground hydrogen column density. The S1 and S2 filters cover the ranges 0.09–0.21 keV and 0.06–0.11 keV, respectively. The XRT–PSPC covers the range 0.2–2 keV. The curves correspond to different hydrogen column densities in the cloud. The lowest curve in each plot is for a column density of 1×10^{19} cm^{-2}, and each successive curve corresponds to a doubling of the column density. The dotted lines show the minimum detectable (5σ) difference in count rate in the ROSAT survey, assuming the cloud fills 50% of the field of view. The dashed lines show the sensitivity which would be achieved with a 1×10^4 s observation. An SXRB spectrum of $1.2 \times E_{\rm keV}^{-3.4}$ ph cm^{-2} s^{-1} sr^{-1} keV^{-1} has been assumed.

The comparison of results for clouds at different distances will enable important new constraints to be placed on the SXRB. For example, if much of the hot emitting gas is located in front of a cloud, the simple model assumed (Figure 1) would not apply. In this case the contrast between vacant and cloudy image areas would be less than indicated, so that failure to detect the silhouettes of even the nearest clouds would be a highly significant result, implying that the bulk of the SXRB emission originates in the very local interstellar medium, in front of the clouds. Therefore, whether silhouettes are detected or not, such observations with ROSAT will have a crucial impact on our understanding of the distribution and nature of the hot phase of the interstellar gas.

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