X-ray shadowing and the Local Interstellar Medium

We have observed the darkest regions in the soft X-ray sky with XMM-Newton. Among these are the Ophiuchus Molecular Cloud and the Bok globule Barnard 68.

Analysing these deep X-ray shadows we have found clear indications that a significant fraction of the diffuse emission below 650 eV originates in the foreground of the absorbers, closer than 120 pc.

Moreover, a detailed spectral analysis has shown that the X-ray emission towards the opaque objects cannot be reproduced by a plasma in collisional ionization equilibrium with $10^{6.0}$ K; further components to the X-ray background are needed to explain these spectra, and/or the emitting plasma is not in collisional ionization equilibrium. Thus the standard model for the Local Bubble (a region devoid of H I) has to be changed accordingly.

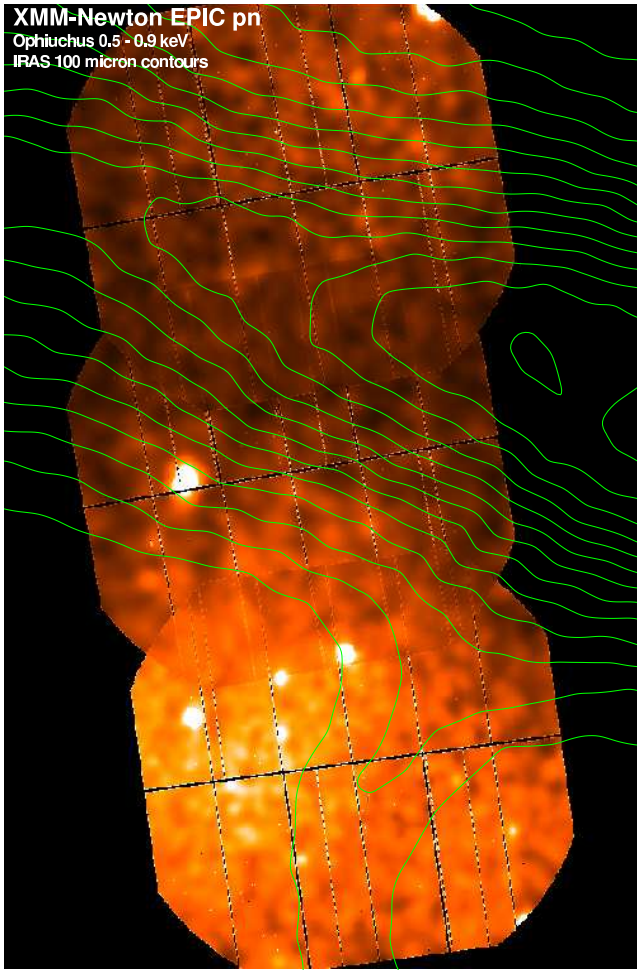
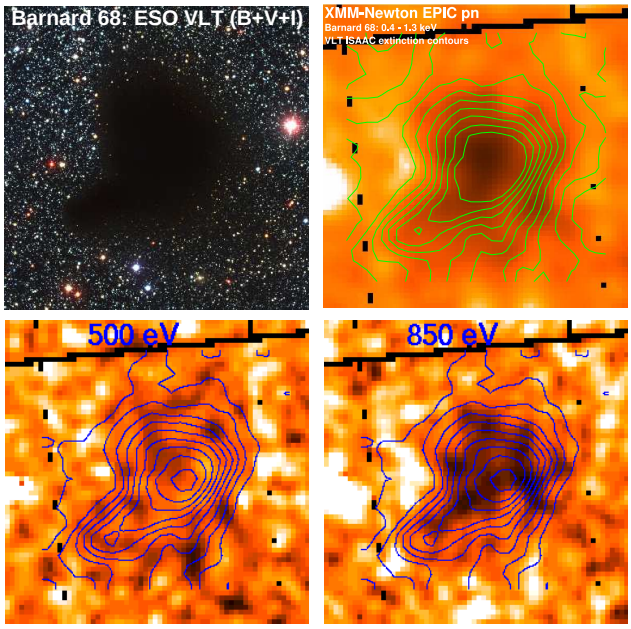


Figure: XMM-Newton EPIC-pn intensity image of the Ophiuchus molecular cloud region in the energy band $0.5-0.9$ keV, green lines show the IRAS 100 μm contours.



Figures: Upper left: 3-colour image (B, V, I) of the Bok globule Barnard 68, obtained at ESO VLT. Upper right: EPIC-pn X-ray image (0.4 – 1.3 keV) with ISAAC extinction contours overlayed. Bottom Left: narrow-band image in 0.40 – 0.60 keV range. Bottom Right: narrow-band image in 0.75 – 0.95 keV range. The X-ray shadow is clearly evident in the 0.5 – 1.0 keV range. Most of the Fe-L emission at $\sim$ 850 eV originates in the background, and the shadow is much weaker at the oxygen line energies.

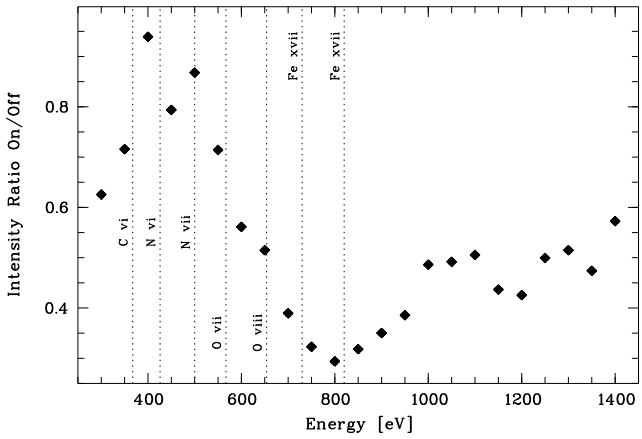


Figure: Depth of the X-ray shadow (ratio of on-cloud to off-cloud intensities) for the Bok globule Barnard 68 as function of energy. This shows that a significant fraction of the emission below 600 eV originates in the foreground of the cloud.

References:
M.J. Freyberg, D. Breitschwerdt & J. Alves, 2004, Mem.Soc.Ast.It. 75, 509
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