# THE SOFT X-RAY EMISSION IN DIRECTION OF HYADES

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## ABSTRACT

It has been known for decades that the Local Bubble (LB) is a very important contributor to the diffuse soft x-ray background. The exact contribution of the LB in different directions of the sky is still unknown. With the advent of the new generation of x-ray satellites, like XMM-Newton and Chandra, we can performed on a systematic study of the spatial structure of the LB. We present a spectral study of the LB contribution to the soft x-ray background emission in the direction of Hyades and Ophiuchus.

Key words: Soft X-ray Diffuse Background; Local Hot Bubble; Galactic Halo :ISM: Hyades.

## 1. INTRODUCTION

For more than 30 years it is known that the solar system is surrounded by a hot and tenuous plasma emitting soft x-ray photons. With the discovery that this x-ray emission anti correlates with the neutral hydrogen density the Local Bubble (LB) model was put forward (Sanders et al., 1977; Tanaka & Bleeker, 1977). Comparing the average density of neutral material, of the normal interstellar medium (ISM), this low neutral density forms a cavity that has an average radius of 100 pc and is elongated in the poles directions. In the past, due to the medium spectral resolution, the LB spectra have been modeled using a plasma in collisional ionization equilibrium. An ongoing study of the 3D structure of the LB is being performed. Both spatial and spectral variations of the LB are investigated. In this study, we make use of the powerful capabilities of the XMM-Newton satellite to study the contribution of the LB in several lines of sight. Of prime importance is the use of x-ray shadows experiments on dense molecular clouds, such as Ophiuchus (Mendes et al., 2005), to disentangle the contribution of the LB, e.g. in direction of the galactic center. The present communication is a report on the contribution of the LB to the diffuse soft x-ray background in direction of the Hyades star cluster. The distance to the Hyades is $\sim 46$ pc and its age is about 625 Myr (Perryman, M. et al., 1998). The galactic column density in this direction is $\sim 2.0 \times 10^{21}$ cm$^{-2}$.

## 2. DATA REDUCTION

For this particular study we have used XMM-Newton data. The data (ID 0094810301) were obtained with the EPIC-PN camera in full frame mode with thin filter. This field was observed for 10.0 ks from which only 6.0 ks, of low background, were used for scientific purposes. All data reduction was performed using the standard tasks in SAS v.6.1.0. Since we are mainly interested in studying the weak diffuse soft x-ray emission, by nature an extended source of x-ray photons, it is important to use all the field of view from the EPIC-PN camera. To avoid the contribution of x-ray emission due to point sources to the diffuse soft x-ray emission spectrum, a source detection was performed. A total of 23 detected point sources were removed for the present analysis. Two of the sources were strong enough to produce significant out of time events. In these cases several columns had to be removed from the events file in order to avoid contamination. From the remaining area ($\sim 456$ arcmin$^2$) a spectrum, to study the diffuse soft x-ray emission, was extracted.

## 3. SPECTRAL ANALYSIS

Besides the extraction of a spectrum, appropriate response and ancillary files were created for spectral analysis. A closed filter observation was used to produce a detector background spectrum for subtraction. The spectral fitting has been performed in XSPEC v.11.3.1. The spectrum was binned to have at least 50 counts per energy channel.

### 3.1. The Model

The first assumption that was made, when fitting the extracted x-ray spectrum, was that this x-ray emission could be successfully explained using two plasmas, one representing the LB and one the hot galactic halo, and the extragalactic power law. However, such a simple model was

*Table 1. Results from the best fit to the model.*

| | Temperature | Abundances | Normalization $\times10^{-2}$ |
|---|---|---|---|
| LB | $0.09 \pm 0.03$ | 1.00 | $0.04 \pm 0.03$ |
| Plasma | $1.10 \pm 0.07$ | $1.24 \pm 3.21$ | $0.01 \pm 0.03$ |
| Halo | $0.17 \pm 0.03$ | $0.02 \pm 0.02$ | $2.21 \pm 1.15$ |

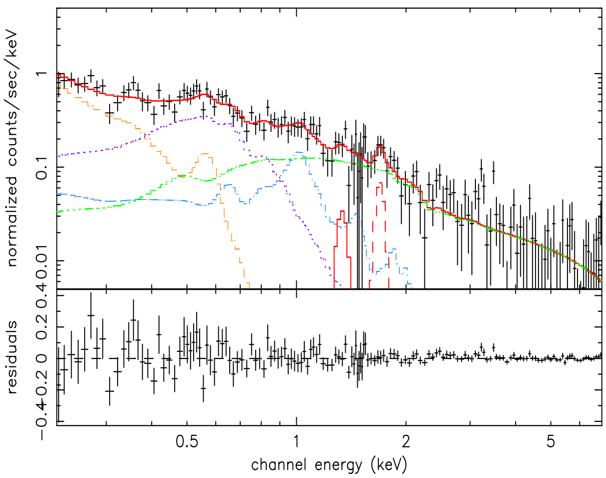


*Figure 1. In this figure the best fit to the data is shown. Also shown are the various model components: the LB, the galactic hot halo, a very hot plasma and the extra-galactic power law.*

not sufficient to explain the observed spectrum. Another plasma had to be added to the previous model in order to account for the unexpected high flux on the energy range of $0.8 - 1.1$ keV. The model used during the fitting procedure consists of three Raymond-Smith plasmas, a power law representing the extragalactic background, presumably due to a population on unresolved AGN's, and two Gaussian lines which were added just for fit purposes. The power law spectral index and the normalization values were fixed to the ones that one should expect from Lumb et al. (2002), $\Gamma = -1.4$ and $\sim 4.0 \times 10^{-4}$ photons cm$^{-2}$ s$^{-1}$ keV$^{-1}$. In Tab. 1 the results from the best fit to the model are presented. In Fig. 1 the plot of the fit is shown. Due to the low statistics the errors from the fit are high. The $\chi^2_{\rm red}$ of the fit is 1.03 with 144 degrees of freedom.

## 4. HYADES VERSUS OPHIUCHUS

In Fig. 2 we compare two spectra, one from the Hyades field and one from the Ophiuchus field (ID 0112480101). To make this comparison we used a Ophiuchus spectrum, extracted from the region with the highest column density. This high column density efficiently blocks the soft x-ray radiation ($< 1$ keV) from the background of the cloud producing a x-ray shadow. The observed soft x-ray emission is produced in the foreground. Both spectra were extracted in a region with a radius of 5.833 arcmin. The spectra were binned to have 50 counts per energy channel. In the case of the Ophiuchus spectrum the emission in the interval of $0.5 - 0.7$ keV is higher than in the Hyades spectrum. The opposite occurs around 1.0 keV and at 1.7 keV, where the emission is lower than in the Hyades spectrum.

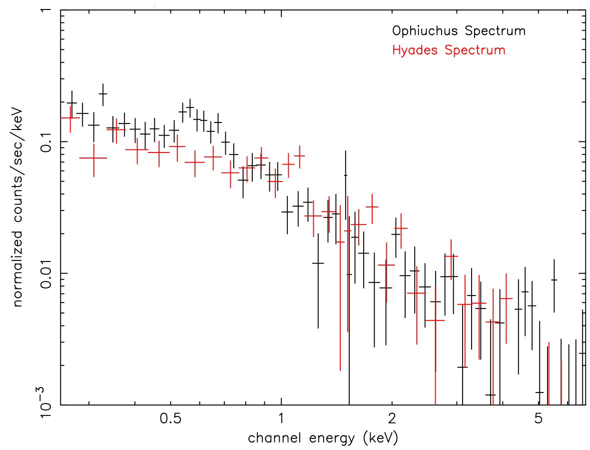


*Figure 2. In this figure we compare two spectra, one from the Hyades field (grey-dotted) and one from the region of Ophiuchus molecular cloud with the highest column density (black-solid). As can be seen there is a significant difference in the 0.5 - 0.7 keV band.*

## 5. CONCLUSIONS

We briefly summarize the preliminary results from this study. The LB, the galactic halo and the extragalactic x-ray background are not enough to explain the observed spectrum. A very hot plasma is needed to account for the flux on the interval of $0.8 - 1.1$ keV. There is an unidentified emission line in the spectrum, that cannot be explained. This is still work in progress, and a more detailed investigation of these discrepancies are underway.

## ACKNOWLEDGMENTS

P.M. acknowledges support from FCT, Portugal.

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