Mem. S.A.It. Vol. 84, 653

Memorie della

Spectrum of the unresolved cosmic X ray background

What is unresolved 50 years after its discovery

A. Moretti[1], S. Vattakunnel[2], P. Tozzi[2], R. Salvaterra[3], P. Severgnini[1], D. Fugazza[1], F. Haardt[4,5], and R. Gilli[6]

[1] INAF, Osservatorio Astronomico di Brera, Via Brera 28, 20121, Milano, Italy
e-mail: alberto.moretti@brera.inaf.it
[2] INAF, Osservatorio Astronomico di Trieste, Via Tiepolo 11, 34143 Trieste, Italy
[3] INAF, Istituto di Astrofisica Spaziale e Fisica Cosmica, Via Bassini 15, 20133 Mi, Italy
[4] DiSAT, Università dellInsubria, via Valleggio 11, 22100 Como, Italy
[5] INFN, Sezione di Milano Bicocca, P.za Della Scienza 3, 20126 Milano
[6] INAF, Osservatorio Astronomico di Bologna, Via via Ranzani 1, 40127, Bologna, Italy

Abstract. We studied the spectral properties of the unresolved cosmic X-ray background (CXRB) in the 1.5-7.0 keV energy band to provide an observational constraint on the statistical properties of those sources that are too faint to be individually probed.

Key words. X-rays: diffuse background – X-rays: general – galaxies: active

1. Introduction

We performed a spectral measure of the X-ray unresolved emission in the 4 Ms observation Chandra deep filed south, the deepest X-ray observation ever performed. The unresolved cosmic X-ray background (CXRB) may be due to an intrinsically diffuse component or to the cumulative contribution of individual sources below the current flux limit. In the latter case, high redshift and Compton-thick (CT) AGN (the ones for which the neutral hydrogen column density is higher than the inverse of the Thomson cross-section, $N_H > 1.5\times10^{24}$), together with star forming galaxies, are expected to be the main contributors.

Send offprint requests to: A. Moretti

2. Our work

We directly measured the unresolved emission on the Swift XRT observation of the CDF-S, subtracting the signal of the sources revealed by Chandra. In this way we exploited, at the same time, the low and predictable instrument background of the Swift X-ray telescope (XRT), which is $\sim$ 40 times lower than Chandra and the unprecedented depth of the Chandra observation.

Besides the instrument background, the unresolved signal on the XRT detector in the 1.5-7.0 energy band is expected to be contributed by the following elements: the sources detected by Chandra and not by XRT, the optically/IR detected (X-ray undetected) sources, the PSF

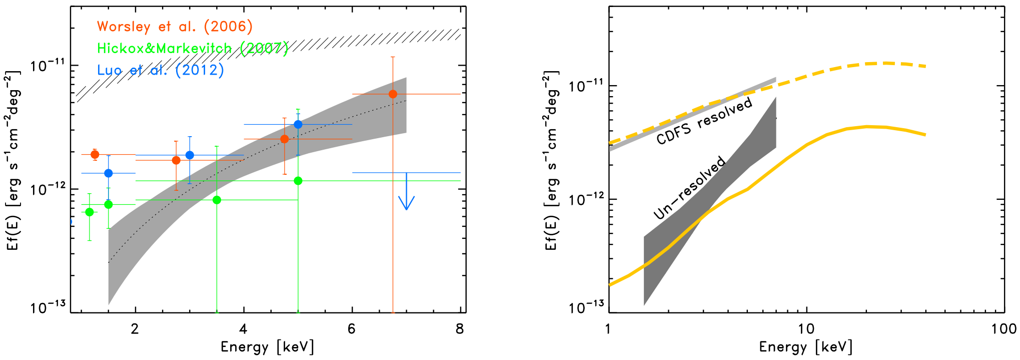

Fig. 1. Left Panel: the spectrum of the unresolved CXRB: comparison with previous measures. The gray area is the result of the present work. The dashed area represents the total CXRB emission as measured by Swift (Moretti et al. 2009). **Right Panel:** the grey areas represent the spectrum of the unresolved and resolved CXRB. The yellow dashed and continuous lines show the expectations of the (Gilli et al. 2007) model for the two components.

residuals from detected sources, the stray-light contamination and the unresolved CXRB that is the goal of the present work.

Accurately modelling all these components, we found that the unresolved emission can be modeled by a hard power law with photon index Γ=0.1±0.7 and a normalization of 7.6 (+10.0,-5.2) $\times 10^{-5}$ photons s^{-1} cm^{-2} deg^{-2} at 1 keV, corresponding to a flux density of 5 $\times 10^{-12}$ erg s^{-1} cm^{-2} deg^{-2} in the 2.0-10. keV band.

Compared to previous works and thanks to the low level of the Swift-XRT instrument background in the hard band (>2 keV) we significantly reduced the uncertainties finding consistent results in terms of absolute flux measurement (left panel of Fig. 1). After reducing the uncertainties our result left room for a small, but significant component still to be resolved. To check whether the unresolved spectrum can be accounted for by current AGN population synthesis models, we compared our results with Gilli et al. (2007) (G07) model, which provides the integrated spectrum for different AGN subpopulations at given luminosity (L), redshift (z) and absorbing column density (N_H).

The G07 model is fully consistent (7% scatter) with the summed spectrum of all the sources in Xue et al. (2011) catalog . We also find that the same model accurately reproduces the soft part ($\lesssim$ 3 keV) of the spectrum of the unresolved emission, whereas it falls short in replicating the 3-7 keV emission, hinting that there are some missing hard sources (right panel of Fig. 1). This discrepancy can be solved assuming that the number of AGN at high redshift ($z > 2$) is much higher (a factor 4) than the local population.

On the other hand, neglecting the CT contribution and conservatively assuming that all the unresolved emission comes from very high redshift AGN (no source at $z > 6$ has been detected in the CDF-S), our measure can be used to probe the SMBH formation models at these early epochs (Salvaterra et al. 2012).

Full details of the work are given in Moretti et al. (2012).

References

Gilli, R., et al., 2007, A&A, 463, 79
Moretti, A., et al. 2009, A&A, 493, 501
Moretti, A., et al. 2012, A&A, 548, 87
Salvaterra, R., et al., 2012, A&A, 545, L6
Xue, Y.Q., et al., 2011, ApjS, 195, 10