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Rest-frame stacking of 2XMM catalog sources
Fe Kα line properties

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Abstract
The aim of this work is to characterize the average iron (Fe K) emission properties of active galactic nuclei (AGNs) in the source rest-frame. We selected a sample of 248 AGNs from the 2XMM catalog. We employed two independent rest-frame stacking procedures to compute the mean Fe K profile. The counting statistics for the integrated spectrum is comparable to the one available for the best studied local Seyferts. To assess the significance of the observed Fe K emission line features and the artifacts possibly introduced by the stacking procedures, we have carried out simulations. We report that average Fe K line profile in our sample is best represented by a combination of a narrow and a broad line. The equivalent widths of the narrow and broad (parametrized with a disklike) components are ~30 eV and ~100 eV, respectively. We also discuss the implications of the adopted continuum modeling on the broad line parameters and its significance.

I. Aims
Fluorescent Fe Kα lines in AGNs are a potentially unique tool to probe the innermost regions around a black hole. The line properties, such as the peak energy, intensity and profile carry important diagnostic information relevant to the physics and structure of the region where the emission originates (Fabian & Miniutti 2002, Miller 2007, Turner & Miller 2007). In this study, we focus on the Fe Kα line properties of a large AGN sample using two independent procedures.

II. Sample
The sample comprises 248 high galactic latitude (B<25 degrees) point sources from the 2XMM catalog (Watson et al. 2009), covering a wide redshift range 0 < z < 5 and with the sum of EPIC-PN net 2-10 keV rest-frame counts greater than 200 and power law photon indices in the range 1.5-2.2. (See Fig. 1 for distributions of the redshifts (left), X-ray luminosities (center) and EPIC-PN net counts in the rest-frame 2-10 keV band (right) of the sources used in our study.)

III. Method
We have developed a procedure for stacking spectra in the rest-frame, which differentiates from the other published methods (Stern et al. 2005; Corral et al. 2008) and involves adaptive grouping in predefined energy bins of equal width (0.25 keV) in the rest-frame 2-10 keV band, XSPEC fitting of each binned spectrum, 3σ clipping on the ratios (saved with respect to the best fit model) in each bin and subsequent averaging of these ratios. The mean ratio profile was converted to a flux spectrum with photon index of 1.8 for performing the spectral analysis.

We also created the "averaged X-ray spectrum" of these sources following the procedure of in 2011. The left panel of Fig. 2 displays the ratio profiles computed from two procedures. To assess the significance of the line features evident in the averaged ratio profile of the sources (red points in Fig. 2 left panel) and the artifacts possibly introduced by the stacking method, we carried out simulations using XSPEC (see Fig. 2 right panel for the results of simulations). The narrow core is significant at ~3σ.

IV. Results
We have carried out a detailed spectral analysis of the averaged spectra (created from two independent procedures) by employing various continuum and line models. Our main results are the following:

1. We find that the average narrow core equivalent width (EW) for the whole sample comprising 248 AGNs is ~30 eV and is stable in various continuum models employed. We also recovered the "Karasawa-Taniuchi effect" (Isiwa, K., & Taniuchi, Y. 1993; see also Bianchi et al. 2007, Chaudhary, et al. 2010).

2. We report that the broad line parameters, e.g. shape, EW and its detection significance are dependent on the assumed continuum and adopted stacking method as illustrated in the left panel of Fig. 3. In particular, despite having a well defined sample with reasonable statistical errors (net counts ~100000) in the "averaged X-ray spectrum", we do not detect a clear extended red-wing, and the measured EW of the broad line is always greater than 150 eV, in good agreement with the recent studies of the average Fe K emission from local AGNs (Gasparri et al. 2006, Nandra et al. 2007, Longinotti et al. 2008). Our results are also consistent with predictions of the relativistic Fe K line intensities from the integrated spectra of AGNs presented by Ballantyne 2010.

Figures adapted from Chaudhary et al. 2011 (submitted to A&A)


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