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Will Simbol-X unravel the high energy emission of the LLAGN M81?

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Abstract. Accretion onto LLAGNs is still poorly understood. In this work we focus on the LINER galaxy M81, for which several different physical models (from standard accretion disks to advection dominated flows) have been invoked to explain its X-ray spectrum. The long (132 ks) XMM-Newton/pn observation of M81 has been analysed to test all the models proposed in literature. The same models are then used to perform simulations in order to evaluate *Simbol-X* capabilities in disentangling the three different physical scenarios of a standard accretion disk, a photoionized model and an ADAF model with a truncated disk, through the characterisation of the Fe K complex and the continuum features (e.g. reflection bump, etc). We find that *Simbol-X* will be able to distinguish between the three different solutions.

Key words. accretion – galaxies: active – galaxies: individual (M81) – galaxies: X-rays

1. Introduction

Low-luminosity AGNs (LLAGNs) show different SED and variability with respect to bright AGNs, possibly because a different mode of accretion onto the central black hole is at work. The Sab galaxy M81 is the closest (d=3.6 Mpc) and best studied example of LLAGN ($L_{2-10keV} = 1.5 - 6 \times 10^{40}$ erg/s). It is also classified as either a LINER or Sy 1.8. The origin of its 2-10 keV spectrum has been argument of debate for thirty years. It shows a complex FeKα feature and the presence of absorption edges, a reflection component or thermal emission are still uncertain. XMM-Newton/pn data are fitted here with the three models discussed in the literature. The same models have then been used to simulate Simbol-X spectra.

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2. Three different models: photoionization, standard disk or ADAF?

Fig.1 shows the residuals from a fit with a power law that emphasizes the FeK complex. The spectrum shows a Gaussian line at 6.4 keV due to fluorescence of distant neutral Fe. However, there is a broader, possibly double peaked, Fe component at ~6.7-6.9 keV, which origin remain uncertain. In the literature the XMM-Newton/pn spectrum of M81 can currently be described under three different scenarios: i) photoionization model; ii) standard

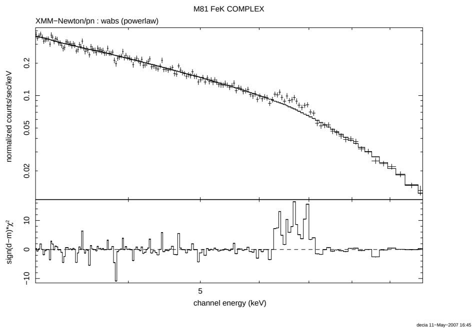

Fig. 1. The XMM-Newton/pn 3-10 keV spectrum of the active nucleus of M81 (power law, $\Gamma = 1.88$). The residuals show the broad FeKα complex between 6 and 7 keV.

accretion disk; iii) advection dominated accretion flow (ADAF, Narayan & Yi, 1995).
i) In the photoionization model the broad component of the FeK complex is fitted with two Gaussian lines due to fluorescence of photoionized FeXXV (6.67 keV) and FeXXVI (6.96 keV). An absorption edge, as seen with BeppoSax ($\tau = 0.15$, Pellegrini et al. 2000), is included at 8.6 keV which may correspond to absorption by FeXXV.
ii) In the standard disk model the broad component of the FeK complex is fitted with a diskline ($r_{in} = 100$ and $r_{out} = 1000 r_g$), reflected from a standard accretion disk. The reflection continuum component, expected from the presence of the disk, has been modeled with pexrav and pexriv models (R=1), that will peak in the 20-30 keV energy range.
iii) In the ADAF model the broad component of the FeK line complex is fitted with a mekal model that reproduces the bremsstrahlung radiation of a hot thermal gas (kT=10 keV). The mekal model is used to describe the emission of the ADAF that lies inside a truncated ($r_{in} = 100 r_s$) disk (Dewangan et al., 2004).

3. Distinguishing among the three models using Simbol-X

We have simulated *Simbol-X* spectra with the above models, using the latest *Simbol-X* response files and compared them to a simple power law model. The spectral resolution of Simbol-X is comparable to XMM-Newton but it allows the continuum to be well characterized up to 80 keV. The FeK line complex assumes different profiles, but the models are statistically undistinguishable; if variability is present, differences might emerge. The distinction can be made when considering the continuum and the spectral features above 7 keV. Fig.2 shows that the $\tau = 0.15$ absorption edge, if present, will be detected with 20% deviation from the power law flux. Moreover, a reflection bump between 20 and 40 keV is clearly detectable in the disk scenario (20% above the power law flux for R=1), while in the ADAF model the high energy tail will be steeper than the power law, the emission going down to 40%-50% of the power law flux at 50 keV. The absorption edge, the reflection component and the high energy cutoff are thus three different signatures of the continuum above 15 keV, which will allow Simbol-X to discriminate between the models.

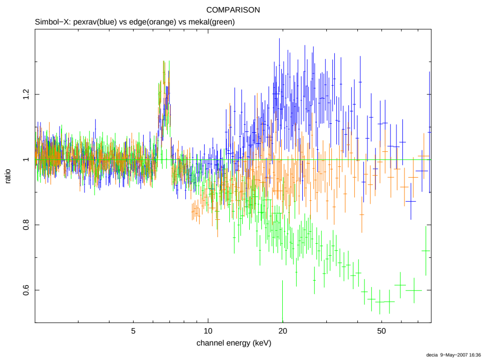

Fig. 2. *Simbol-X* simulated spectral residuals (w.r.t. a power law) for the three different models.

4. Conclusions

To conclude, *Simbol-X* will be able to detect, if present, a thermal cutoff, a reflection component and/or an absorption edge. Therefore, it will be possible to distinguish between photoionization, standard disk and ADAF models.

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