NGC 7314: X-ray properties of a candidate "type II" NLSy1

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Abstract: We present preliminary results from the study of the type II Seyfert galaxy NGC 7314. Archival data by ASCA, BeppoSAX, Suzaku and XMM-Newton were used. We mainly focused on the long term properties of the high energy emission of the source and on its timing characteristics. Our results add further clues to the picture in which NGC 7314 is an absorbed counterpart of a NLSy1.

Introduction: NGC 7314 has been optically classified as a Seyfert 1.9 (Condon et al. 1998). The X-ray behavior of the source is extreme, with high variability (factor 3/5) on all observed time scales, in agreement with what from the estimated mass (M~10^6 $M_{\odot}$ Middleton et al. 2008 and references therein). The source was proposed to be a good NLSy2 candidate (Dewangan & Griffiths 2005).

We analyzed X-ray data taken from all focusing X-ray satellite flown since ASCA (see Table 1). There are clear indications of source variability on long time scales. Moreover, we found a clear correlation between the emitting state and the spectral slope between 2-10 keV (see Fig. 1).

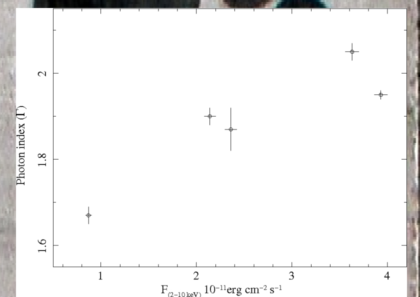


Fig. 1: Hard X-ray power law photon index vs. 2-10 keV flux from all the archival data sets

Table 1. Observation log

Satellite	obs. date	exposure[a]	$F^{b}_{2-10keV}$
ASCA 1	November 20, 1994	47[c]	3.63
ASCA 2	May 18, 1996	3[c]5	2.14
BeppoSAX	June 6, 1996	90[d]	2.36
XMM-Newton	May 2, 2001	30[e]	3.93
Suzaku	April 25, 2007	109[f]	0.87

[a]in ks; [b] in units of 10^{-11} erg s^{-1} cm^{-2}; [c] SIS0 exposure; [d] MECS exposure; [e] pn exposure, [f] XIS0 exposure.

The Fe K lines. Both Suzaku and XMM-Newton detected two iron lines at E~6.4 keV and E~6.9 keV (Fig. 2). The data from older satellites are consistent with these results (see Table 2) even if they do not allow to disentangle between a single broad feature or two different lines. The width of the two lines as detected by Suzaku and XMM-Newton indicates an origin from the same gas. The EW is not consistent with the line being produced by the same matter responsible for continuum absorption.

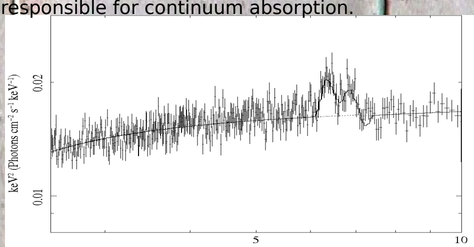
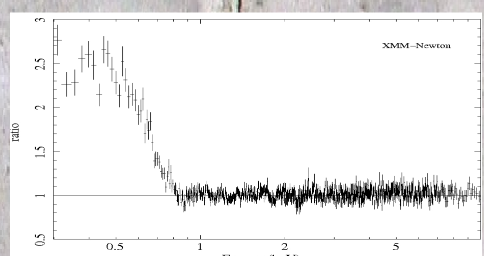


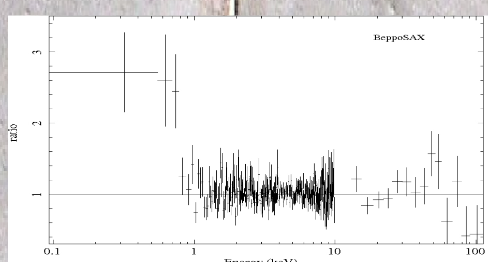
Fig. 2: 2.5-10 keV XMM-Newton data fitted with two Gaussian emission lines.

Model #	N_H	Γ	E_{line1}	σ_{line1}	EW_{line1}	E_{line2}	σ_{line2}	EW_{line2}	χ^2/d.o.f.
	10^{22}cm^{-2}		keV	eV	eV	keV	ev	ev	
ASCA #1	$0.88^{+0.04}_{-0.05}$	$2.05^{+0.07}_{-0.07}$	$6.28^{+0.28}_{-0.32}$	1650^{+734}_{-692}	713^{+713}_{-537}	$6.44^{+0.07}_{-0.07}$	≤94	84^{+29}_{-27}	433.6/386
ASCA #2	$0.82^{+0.03}_{-0.03}$	$1.90^{+0.04}_{-0.03}$	6.39^{f}	250^{+257}_{-138}	260^{+141}_{-92}	6.97^{f}	10^{f}	*leq*5	367.1/400
BeppoSAX	$0.94^{+0.08}_{-0.08}$	$1.87^{+0.04}_{-0.04}$	6.39^{f}	≤620	145^{+50}_{-50}	6.97^{f}	≤730	≤120	242.7/262
XMM-Newton	$0.71^{+0.01}_{-0.01}$	$1.95^{+0.01}_{-0.01}$	$6.40^{+0.01}_{-0.01}$	116^{+66}_{-35}	82^{+23}_{-19}	$6.86^{+0.02}_{-0.02}$	104^{+12}_{-12}	50^{+21}_{-16}	1670.9/1530
Suzaku	$0.76^{+0.03}_{-0.03}$	$1.67^{+0.03}_{-0.03}$	$6.39^{+0.02}_{-0.02}$	72^{+22}_{-26}	150^{+24}_{-28}	$6.97^{+0.07}_{-0.12}$	77^{+11}_{-7}	64^{+50}_{-30}	1864.1/2359

Table 2: Double emission line fits parameters.



Broad band spectrum: the low energy band of the spectrum is absorbed by a column of ~9×10^21 cm^-2 (see Table 3). A soft excess is clearly present below E~1 keV. The intensity of the excess does not depend on the flux state of the source, being always a factor 2/3 above the extrapolated high energy continuum (see Fig. 3). We found only marginal statistical evidence for the presence of a reflection continuum, with an upper limit on the reflection fraction of 0.73 (Suzaku).



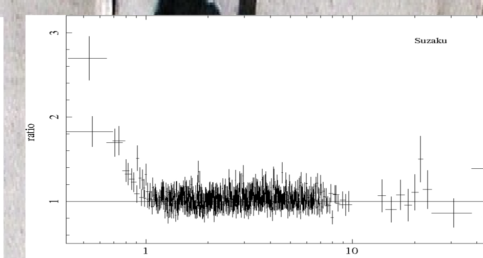


Fig. 3: Broad band data-to-model ratios of XMM-Newton, BeppoSAX, and Suzaku data. The baseline continuum model is the best fit hard X-ray power law.

Timing: Soft and hard X-ray lightcurves show similar variability patterns (Fig. 4). This is confirmed by the measured coherence function between 0.3-1 keV and 1-10 keV XMM-Newton lightcurves (Fig. 5). The coherence is very high and above the 3σ level for zero-coherence even at the highest sampled frequencies (i.e. in the range 9×10^-5 – 3×10^-3 Hz). This means that the soft excess and the hard emission components have an high degree of linear correlation, especially at frequencies below 10^-3 Hz. Fig. 6 shows that in this frequency range the variations in the soft lead the variations in the hard band.

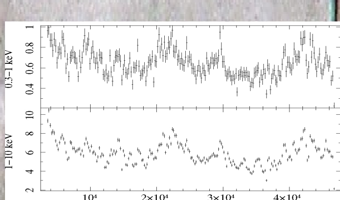


Fig. 4: 0.3-1 keV (top) and 1-10 keV (bottom) XMM-Newton lightcurves.
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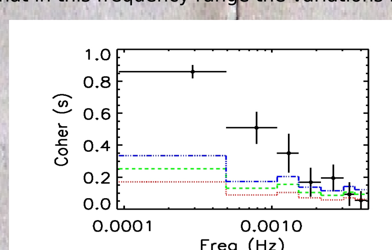

Fig. 5: Measured coherence between 0.3-1 keV and 1-10 keV lightcurves, plus 1σ (red), 2σ (green), and 3σ (blue) contour plots obtained from zero-coherence simulated lightcurves.

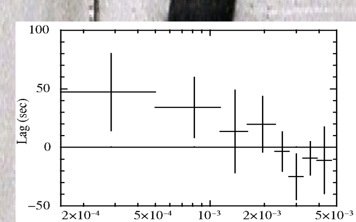

Fig. 6: Time lag between 0.3-1 keV and 1-10 keV lightcurves as a function of frequency.

Conclusions: NGC 7314 shows interesting spectral and timing properties. The soft and hard components seem strictly linked in their temporal behavior. This is true both on long and short time scales. This suggests that emission rather than absorption components dominate the soft excess. However no clear spectral evidences for a strong additional reflection component can be assessed from the data. This is in apparent contradiction with the observed correlation between the photon index and the 2-10 keV flux, which fits in the light bending scenario (Miniutti & Fabian 2004).

References:

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