High-energy monitoring of Seyfert galaxies: the case of NGC 5548 and NGC 4593

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The Extremes of Black Hole Accretion
Madrid, June 8 2015
NGC 5548

- Object of a multiwavelength campaign in 2013
- The nucleus appeared obscured by a clumpy stream of ionized gas - a disc wind? (Kaastra+15; see talk by M. Cappi)
- 7 high-energy observations with XMM, NuSTAR and INTEGRAL (Ursini+15)

The logs of the simultaneous XMM-Newton, NuSTAR and/or INTEGRAL observations of NGC 5548 during our campaign.

<table>
<thead>
<tr>
<th>Obs.</th>
<th>Satellites</th>
<th>Obs. Id.</th>
<th>Start time (UTC) yyyy-mm-dd</th>
<th>Net exp. (ks)</th>
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</table>
NGC 5548: high-energy view

Obs. 2: Broad-band fit, residuals and best-fit model.

Counts s$^{-1}$ keV$^{-1}$

XMM–Newton/pn

NuSTAR/FPMA

NuSTAR/FPMB

INTEGRAL

good constraints on both the primary power law and the reflection component
PEXMON Cut-off energy (keV)

PEXMON Photon Index

PEXMON Norm.

PEXMON Ec (keV)

Reflection component
NGC 4593: XMM/NuSTAR monitoring program

Past observations by BeppoSAX (1998: Guainazzi+98), XMM (2002: Reynolds+04, Brenneman+07), Suzaku (2007: Markowitz&Reeves09) show:

- a strong reflection hump above 10 keV and a prominent, non-relativistic Fe Kα line (truncated disc? distant material?)
- a significant soft X-ray excess below 1 keV (Comptonization?)
- a lower limit for the high-energy cut-off of 150 keV
NGC 4593: XMM/NuSTAR monitoring program

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5 × 20 ks joint observations in early 2015

The logs of the joint XMM-Newton and NuSTAR observations of NGC 4593.

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<tr>
<th>Obs.</th>
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<th>Obs. Id.</th>
<th>Start time (UTC) yyyy-mm-dd</th>
<th>Net exp. (ks)</th>
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Significant flux variability

Significant spectral variability in the soft band (0.5-10 keV)

... not much in the hard band (3-50 keV)
Each spectrum is fitted separately; we divide the first observation into two intervals.
XMM/pn and NuSTAR/FPMA data fitted with a power law
Baseline model:
warm abs.*(soft excess + cut-off power law + reflection)

\[
\text{bbbody} \quad \text{xillver} \quad \AFe \quad \text{free}
\]

Obs. 2: Broad–band fit, residuals and best–fit model

![Graph showing the broad-band fit, residuals, and best-fit model with energy and counts vs. energy.]

- XMM–Newton/pn
- NuSTAR/FPMA
- NuSTAR/FPMB

Weak hump (R ~ 0.2-0.3)
Fe Kα line flux and EW, primary flux (3–10 keV), photon index

- Line flux
  - $A_{Fe} \approx 2-3$

- Line EW

- $F(3-10 \text{ keV})$

- Photon index ($\Gamma$)
Anticorrelation between EW of the Fe Kα line and primary flux

(A)

(B)

\[ \rho = -0.92 \quad p\text{-value} = 0.009 \]
Correlation between soft excess and primary flux

Flux (3–10 keV)

p-value = 0.001

Flux (10–50 keV)

p-value = 0.007
Conclusions

NGC 5548 (see Kaastra+15; Mehdipour+15; Arav+15; Ursini+15; di Gesu+15)

- Distant reflector (~ light months)
- Evidence of variable photon index and high-energy cut-off
- Temperature and optical depth of the hot corona show long-term (~15 yrs) variability
- Next step: detailed test of Comptonization models

NGC 4593

- Strong spectral variability in the soft band on a time-scale of days
- Neutral Fe Kα line:
  - flux ~ constant; equivalent width anticorrelated with primary flux
  - accompanied by a weak reflection hump ⇒ two line components?
- Soft excess below 1 keV correlated with the primary emission
- Work in progress!