High-energy monitoring of NGC 4593 with XMM-Newton and NuSTAR

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AGN 12
A joint XMM+NuSTAR monitoring

| Obs. | Satellites          | Obs. Id.         | Start time (UTC) yyyy-mm-dd | Net exp. (ks) |
|------|---------------------|------------------|-----------------------------|--------------|
| 1    | XMM–Newton          | 0740920201       | 2014-12-29                  | 16           |
|      | NuSTAR              | 60001149002      |                             | 22           |
| 2    | XMM–Newton          | 0740920301       | 2014-12-31                  | 17           |
|      | NuSTAR              | 60001149004      |                             | 22           |
| 3    | XMM–Newton          | 0740920401       | 2015-01-02                  | 17           |
|      | NuSTAR              | 60001149006      |                             | 21           |
| 4    | XMM–Newton          | 0740920501       | 2015-01-04                  | 15           |
|      | NuSTAR              | 60001149008      |                             | 23           |
| 5    | XMM–Newton          | 0740920601       | 2015-01-06                  | 21           |
|      | NuSTAR              | 60001149010      |                             | 21           |
XMM/pn and NuSTAR/FPMA+FPMB light curves and hardness ratios

Counts/s

XMM/pn 0.5–2 keV

XMM/pn 2–10 keV

XMM/pn 2–10 keV/0.5–2 keV

Counts/s

NuSTAR 3–10 keV

NuSTAR 10–50 keV

Counts/s

NuSTAR 10–50 keV/3–10 keV

Hardness ratio

Time (s)
XMM/pn and NuSTAR/FPMA data fitted with a power law

Counts s$^{-1}$ keV$^{-1}$ cm$^{-2}$

Data/model ratio

Energy (keV)

Energy (keV)
The iron line(s)

Counts/(s keV cm$^2$)

Contributions to $\chi^2$

pn data 3–10 keV

narrow line @ 7.056 keV

narrow line + broad line @ 6.4 keV
Narrow Fe Kα line flux and EW versus primary flux

(B) $\rho = -0.82, \ p = 0.045$

| $E$ (keV) | $\sigma$ (eV) | average flux | average EW (eV) |
|----------|--------------|-------------|----------------|
| 6.4 (narrow) | 0            | 2.42        | 106            |
| 6.4 (broad)  | 300$^{+130}_{-70}$ | 2.36        | 102            |
| 7.056       | 0            | 0.6         | 30             |
XMM/pn and NuSTAR data with best-fitting model

Variable primary cut-off power law + 2 reflection components + soft excess

cut-off PL
XILLVER (Rs~0.3-0.6)
RELXILL (Rs~0.2)
(Rin=40 Rg)
Correlation between soft excess and primary emission

Flux(3–10 keV) vs. DISKBB Flux(0.3–2 keV)

- $\rho=0.98$, $p=8 \times 10^{-4}$
- $\rho=0.95$, $p=3.3 \times 10^{-3}$
- $\rho=0.97$, $p=1.8 \times 10^{-3}$
Timing

De Marco et al., in prep.
Main results

- Remarkable variability, both in flux and spectral shape over ~days and down to ~ks

- Significant variations of Gamma (1.6-1.8) and cut-off (~100 keV up to >500 keV): temperature/optical depth variations?

- 2 reflection components, giving rise to a narrow and a broad Fe K alpha lines. One (XILLVER) is from neutral and distant matter, one (RELXILL) from an ionized disc with Rin~40 Rg

- Soft excess correlated with primary emission: warm Comptonization? Link with the UV? (in progress)

- See Ursini et al. 2016, MNRAS, 463, 382