
Not just a beast for Ultra-fast outflows: measuring the long-lasting X-ray reflection in APM 08279+5255 ($z=3.91$)

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Collaborators: Lanzuisi, G., Vignali, C., Cappi, M.,
Dadina, M., Gilli, R., Matzeu, G., Chartas, G.

**What good-quality X-ray spectra
tell us about quasars at $z > 1$**

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AGN feedback: Ultra-fast Outflows (UFOs)

Less than 20 quasars at $z > 1$

~90% are gravitationally lensed

(Chartas+03,+07,+09,+16,accepted; Lanzuisi+12;
Vignali+15; Dadina+16,+18; Bertola+20)

Detection fraction ~80% (Chartas+accepted)

vs. ~40% in local Universe (Tombesi+10, Igo+20)

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2 *Is a $\Gamma = 1.9$ power law really enough?*

High-energy cutoff measured with good accuracy in **two high-z AGN** (+1 tentative)

(Dadina+16, Lanzuisi+16,+19)

→ redshift record: B1422+231

@ $z = 3.62$

APM 08279+5255

Gravitationally lensed BAL quasar $z=3.91$

Well known for UFOs

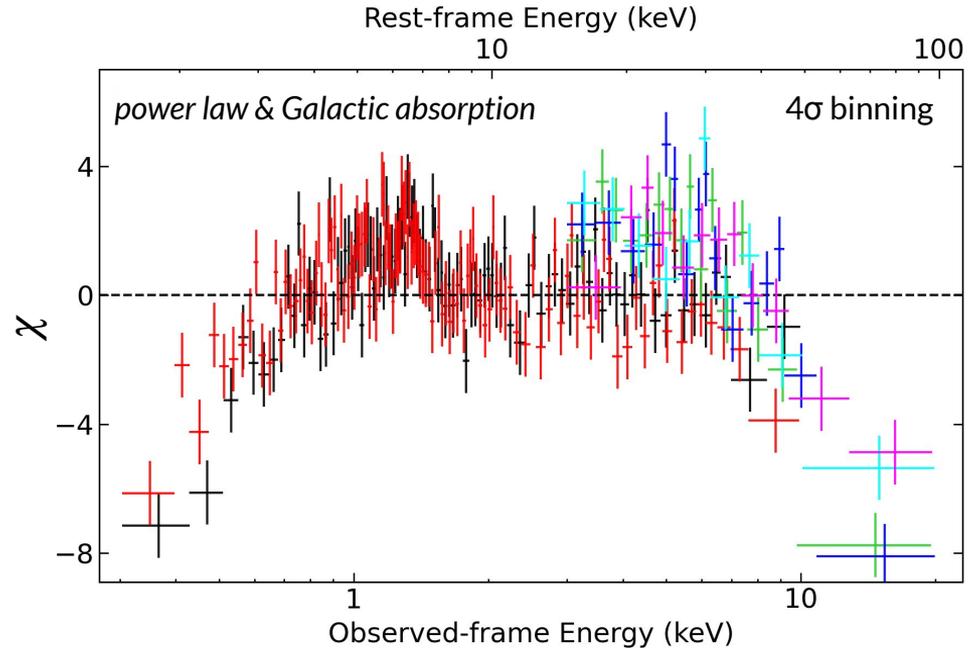
- **Double-velocity component UFOs** in *each* X-ray observation from 2002 to 2007 (Chartas+09, Saez+09,+11)
 - “New” joint **XMM-Newton** (31+33 ks) **and NuSTAR** (94+60 ks) observations (2019, PI: G. Lanzuisi)
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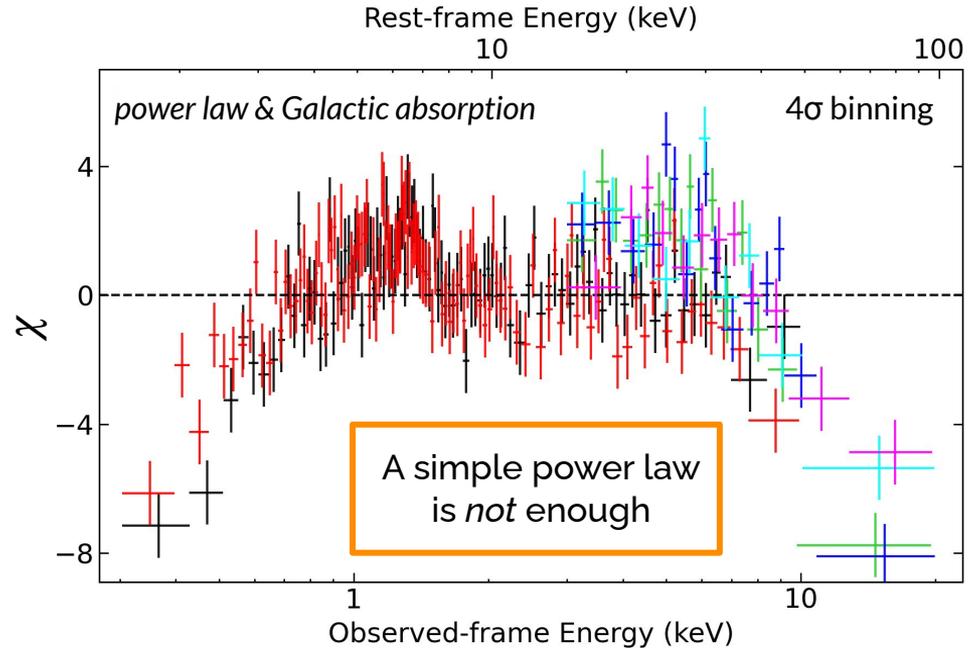


APM 08279+5255

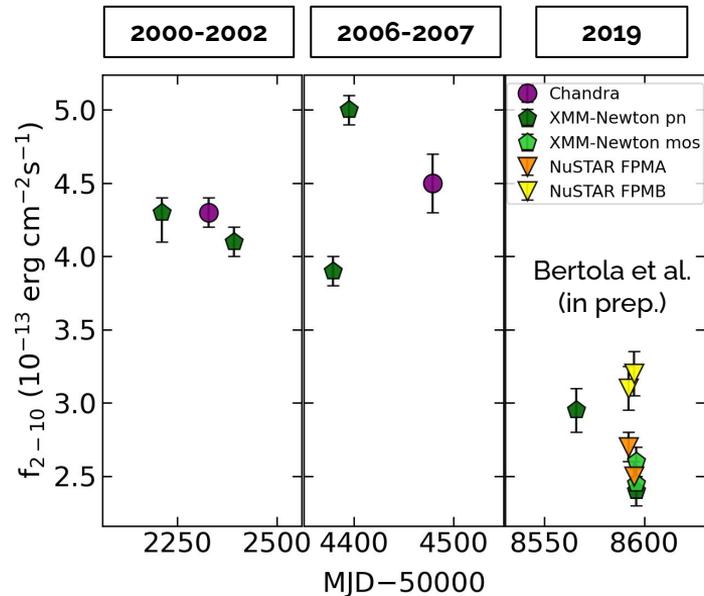
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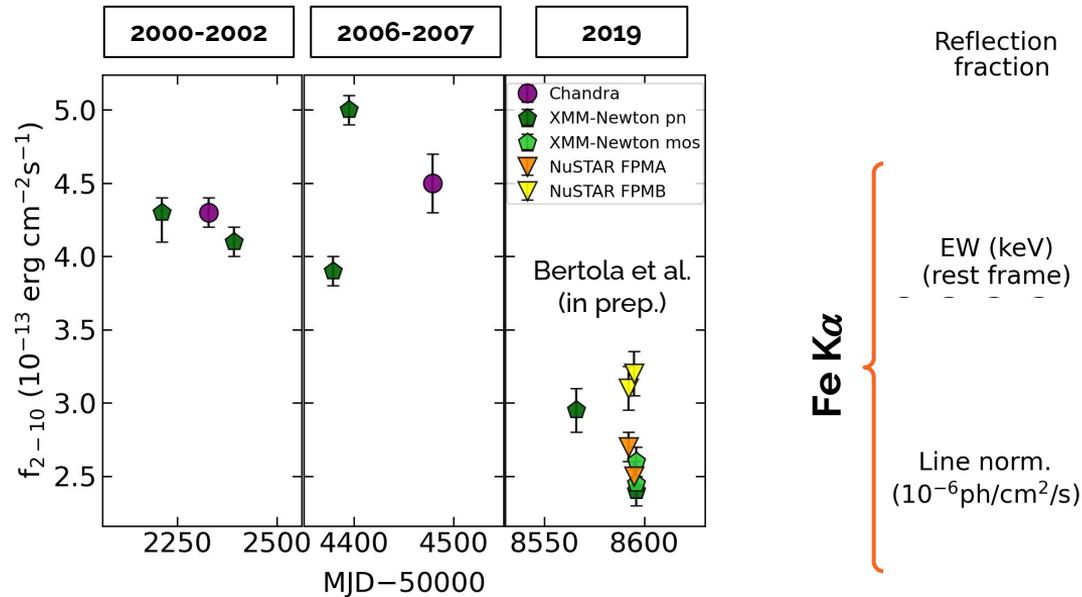


A long-lasting X-ray reflection in APM 08279



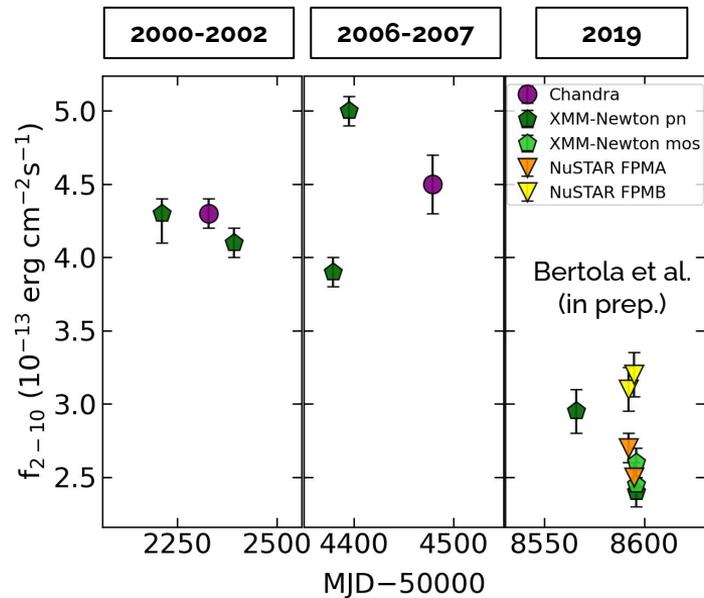
2-10 keV \rightarrow 9.8-49 keV @ $z=3.91$

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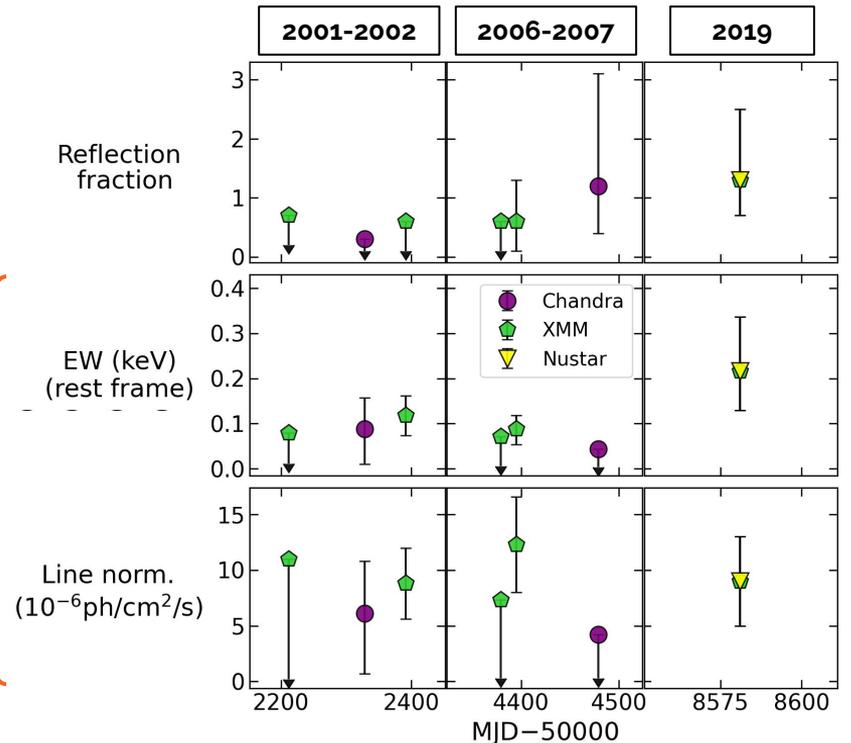


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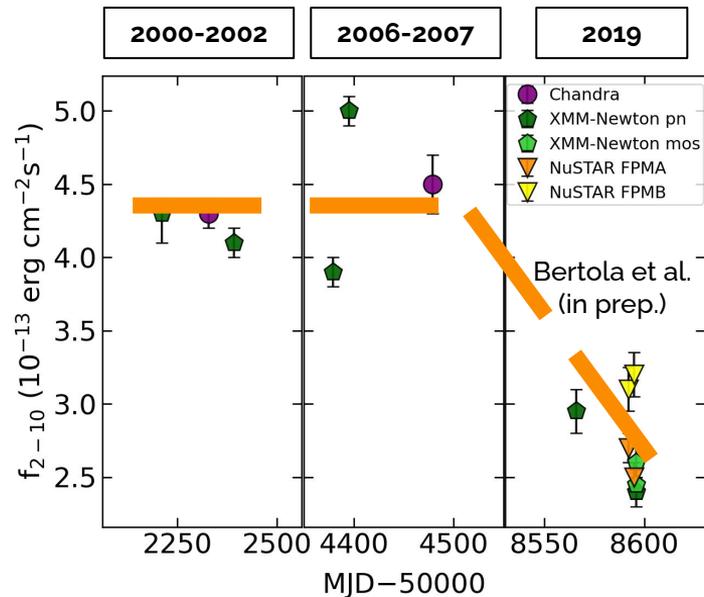


Fe $K\alpha$

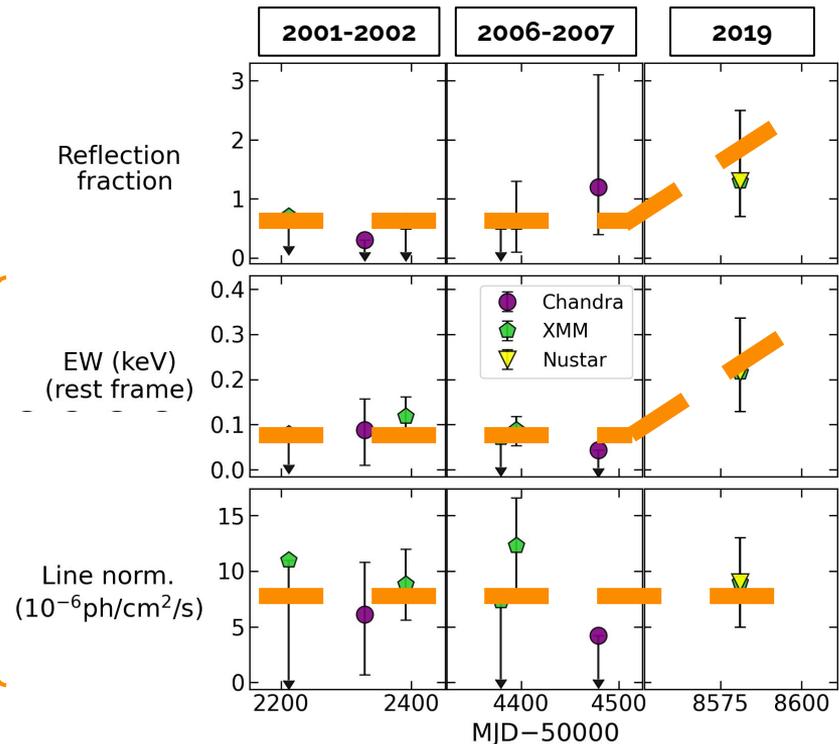


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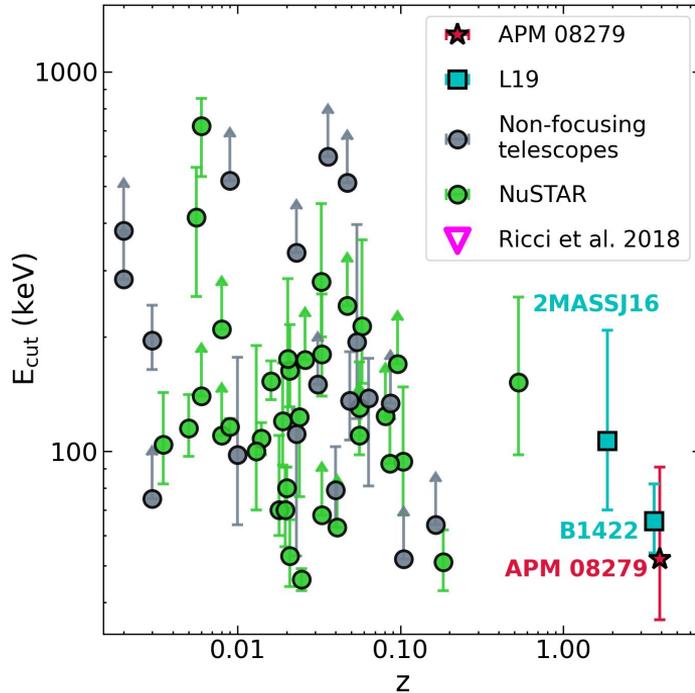


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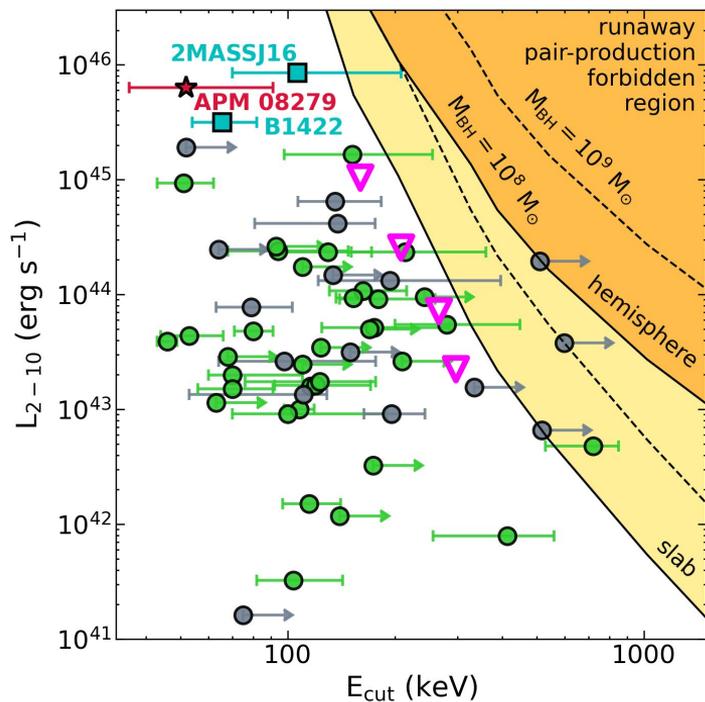
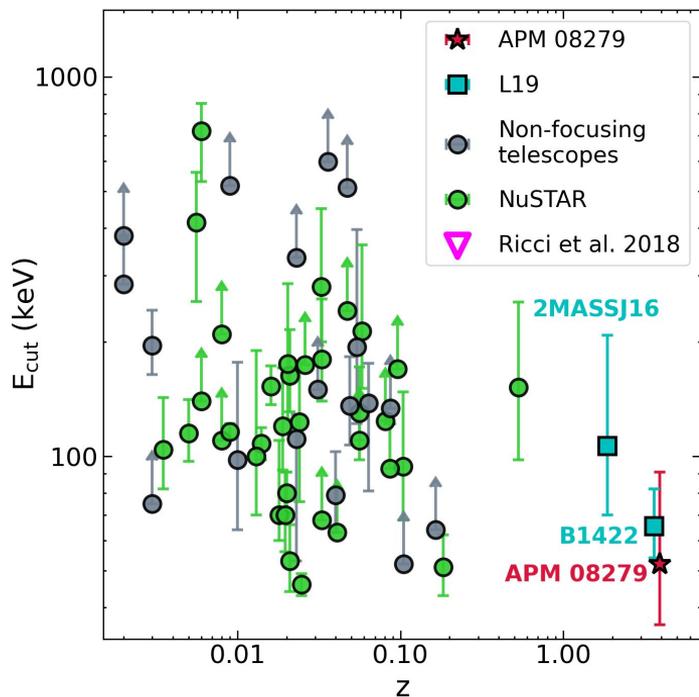
A new redshift record for the high-energy cutoff



Bertola et al.
(in prep.)

Updated from
Lanzuisi+19

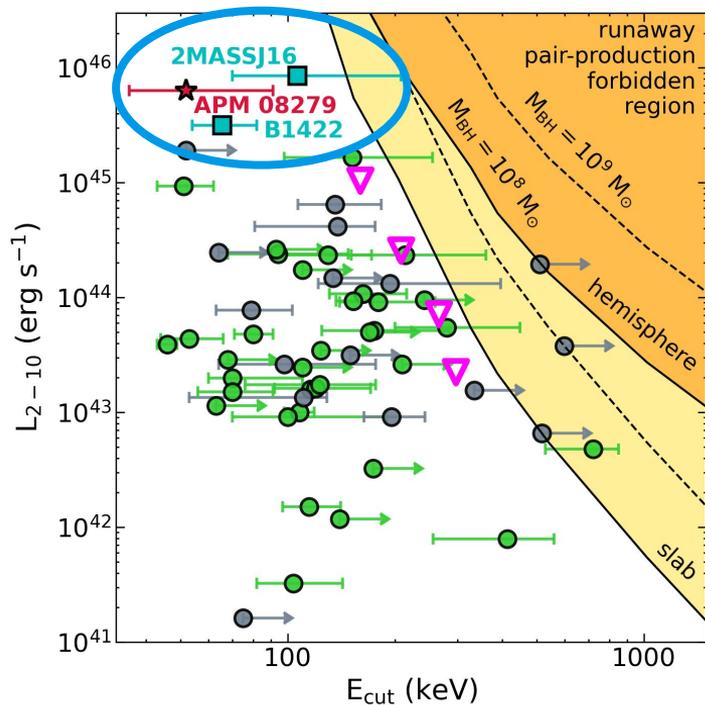
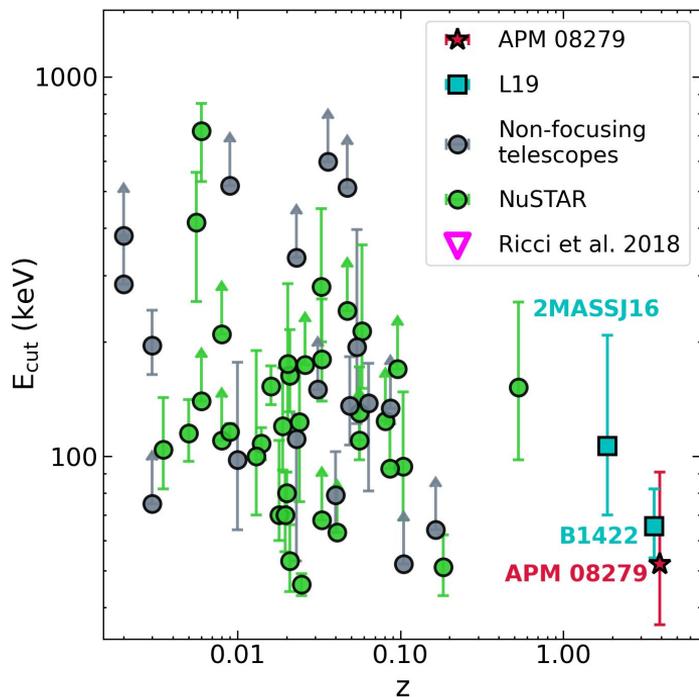
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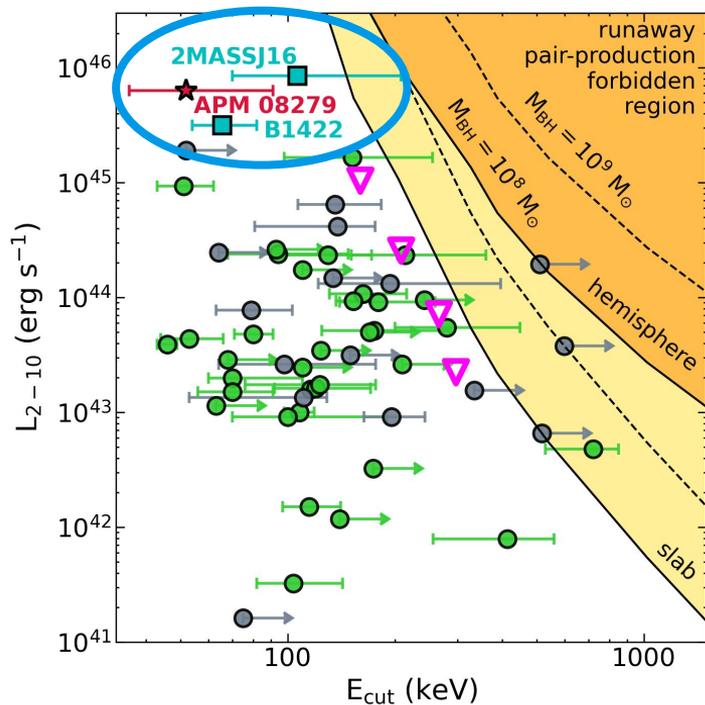
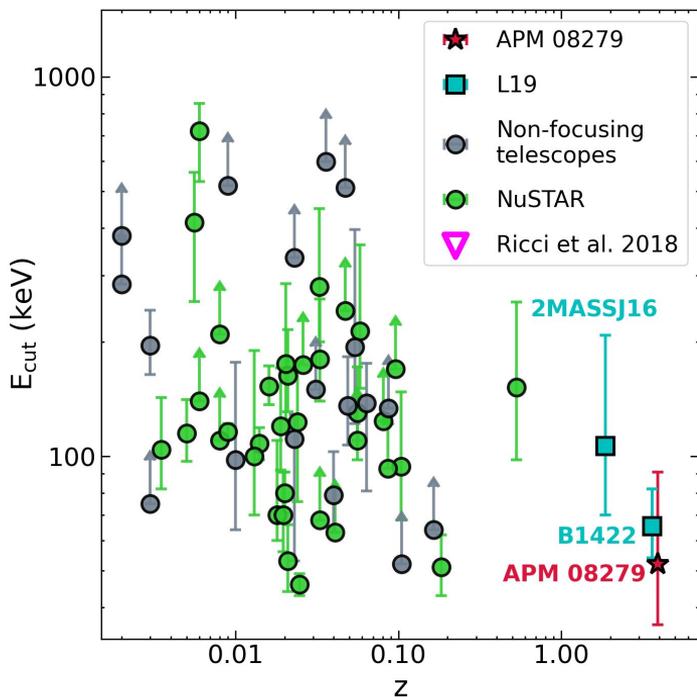
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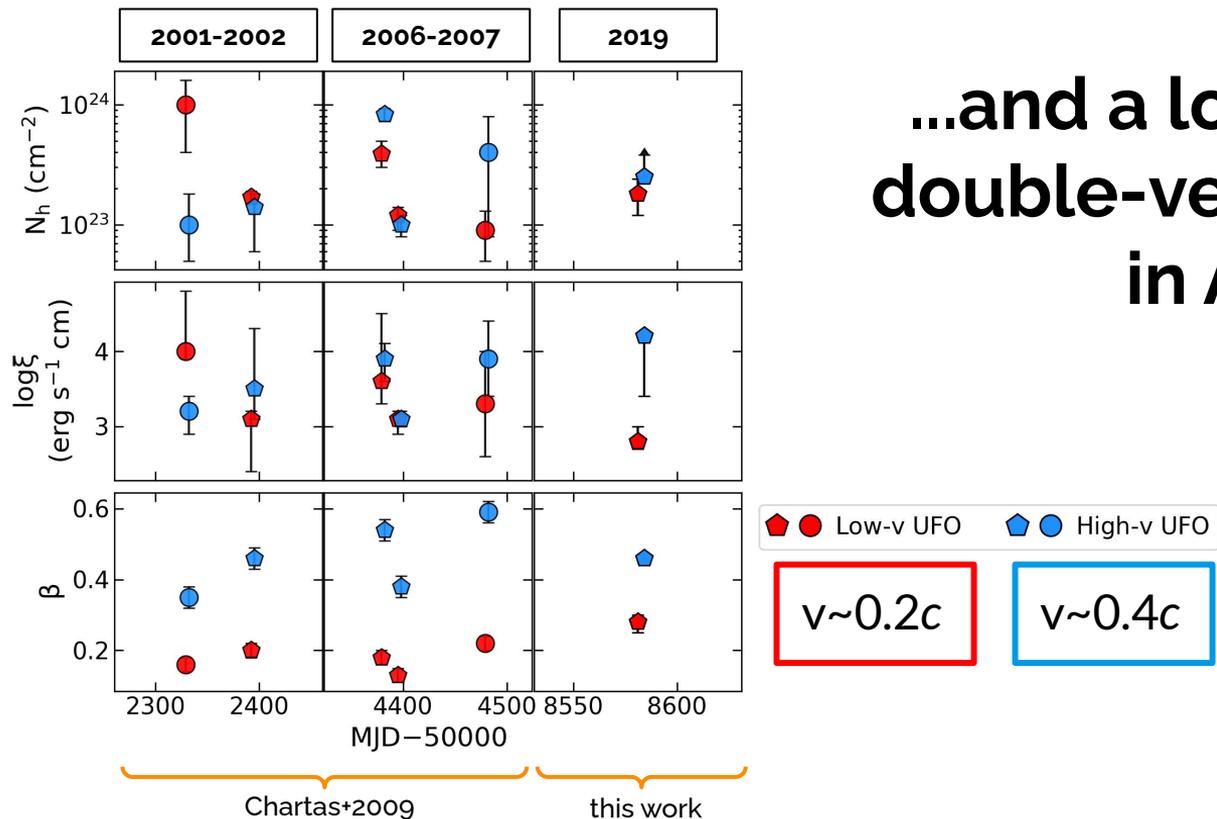
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$\lambda_{Edd} - E_{cut}$
anticorrelation
of BASS AGN
(Ricci+18)
does not apply to
high X-ray
luminosity AGN

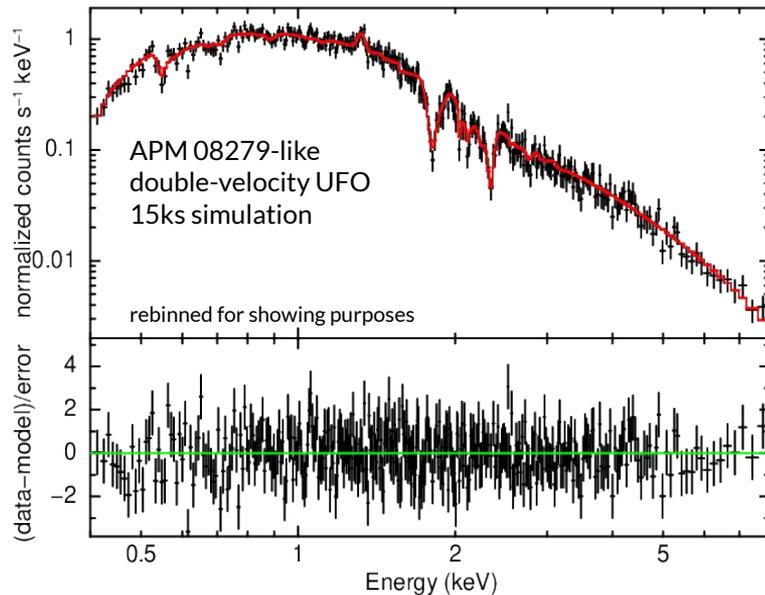
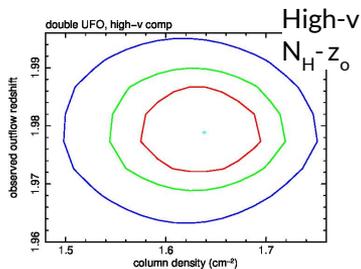
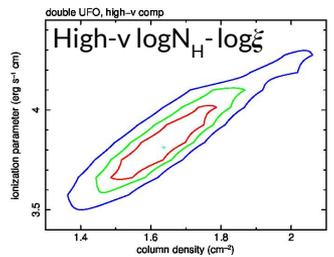
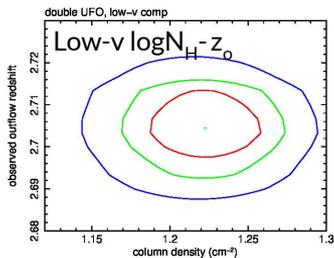
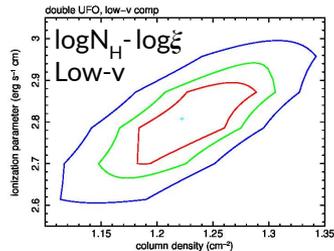
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...and a long-lasting
double-velocity UFO
in APM 08279

Athena X-IFU view of APM-like UFOs



XMM-Newton & Chandra

→ detection of variability down to (or >) days timescale

Athena

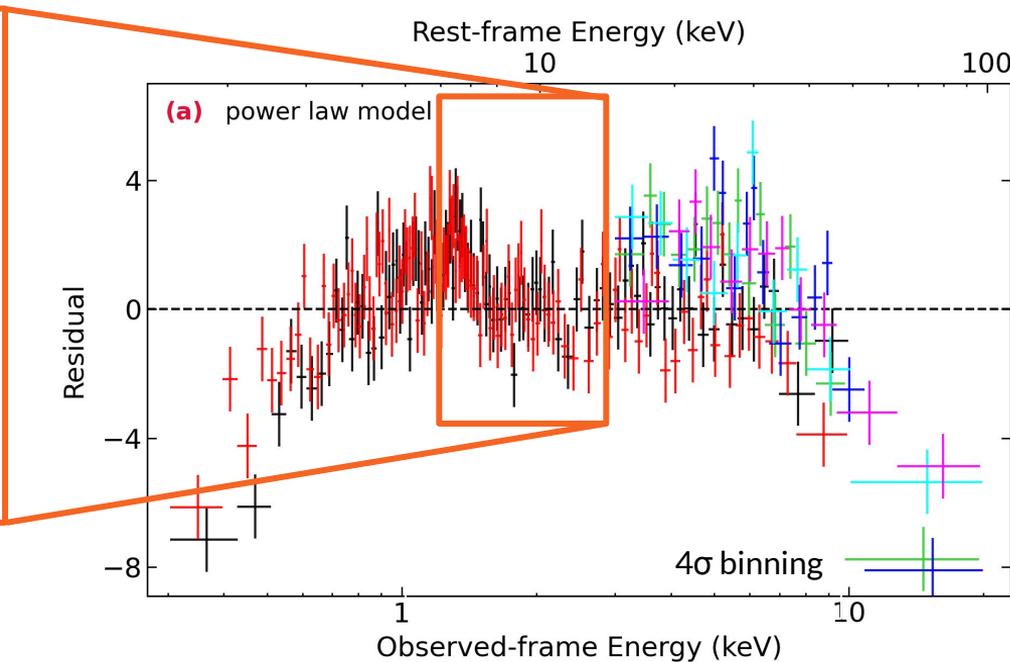
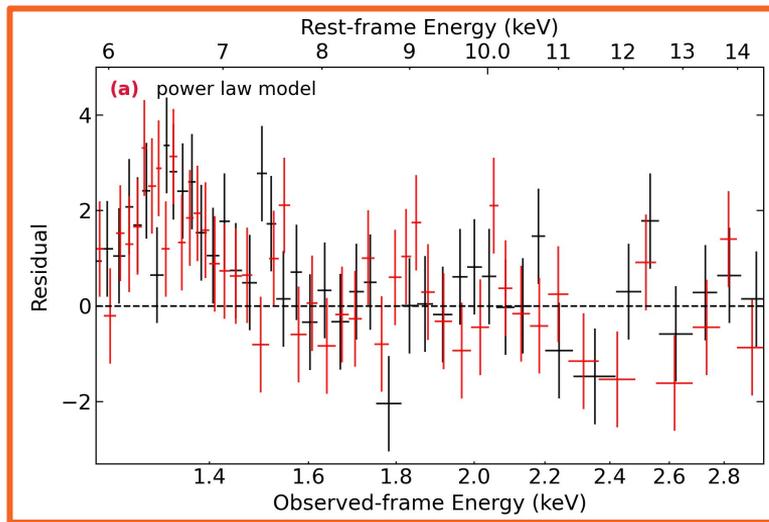
→ 15 ks exposure

→ detection of UFO variability

→ full physical characterization

Backup slides

APM 08279+5255: broadband spectrum



XMM 101 
XMM 301 

NuSTAR 002  
NuSTAR 004  

2019 data spectral fits

Model	Γ	N_{H}	E_{cut}	$E_{\text{Fe K}\alpha}$	$EW_{\text{Fe K}\alpha}$	R	$E_{\text{abs. lines}}$	$EW_{\text{abs. lines}}$	$C\text{stat } (\nu)$
pl	1.36 ± 0.03	–	–	–	–	–	–	–	2814.2 (2562)
acutpl	1.3 ± 0.1	4.9 ± 0.9	34^{+10}_{-7}	–	–	–	–	–	2332.9 (2560)
acutpl+K α	1.2 ± 0.1	4.1 ± 0.9	32^{+8}_{-5}	6.5 ± 0.1	270^{+133}_{-64}	–	–	–	2309.7 (2558)
arefl+K α	2.0 ± 0.3	6.5 ± 1.2	75^{+99}_{-27}	6.5 ± 0.1	265^{+98}_{-83}	$1.9^{+1.7}_{-0.9}$	–	–	2273.2 (2557)
arefl+K α +3al	1.8 ± 0.3	6.0 ± 1.2	52^{+39}_{-16}	6.5 ± 0.1	216^{+121}_{-86}	$1.3^{+1.2}_{-0.6}$	$8.8^{+0.5}_{-0.4}$	-196^{+167}_{-158}	2255.2 (2550)
							11.5 ± 0.2	-363^{+152}_{-192}	
							13.1 ± 0.2	-231^{+10}_{-447}	

	UFO1	UFO2	zphabs	pexrav		Fe K α line		$C\text{stat } (\nu)$
N_{H}	18^{+11}_{-10}	> 25	5.5 ± 1.1	Γ	1.9 ± 0.3	E	6.5 ± 0.2	2241.2 (2551)
$\log \xi$	$2.8^{+0.2}_{-0.3}$	$4.2^{+0.1}_{-0.9}$	–	E_{cut}	58^{+74}_{-18}	σ	0.1	
z_0	$2.7^{+0.2}_{-0.1}$	$1.97^{+0.07}_{-0.14}$	3.91	R	$1.8^{+0.5}_{-0.9}$	EW	167^{+64}_{-108}	

Notes. All errors are given at 90% confidence, all parameter values are rest frame. Equivalent width is given in eV units; energies and line width are given in keV units. Column densities are in units of $\cdot 10^{22} \text{cm}^{-2}$ and ionization states in $\text{erg s}^{-1} \text{cm}$.

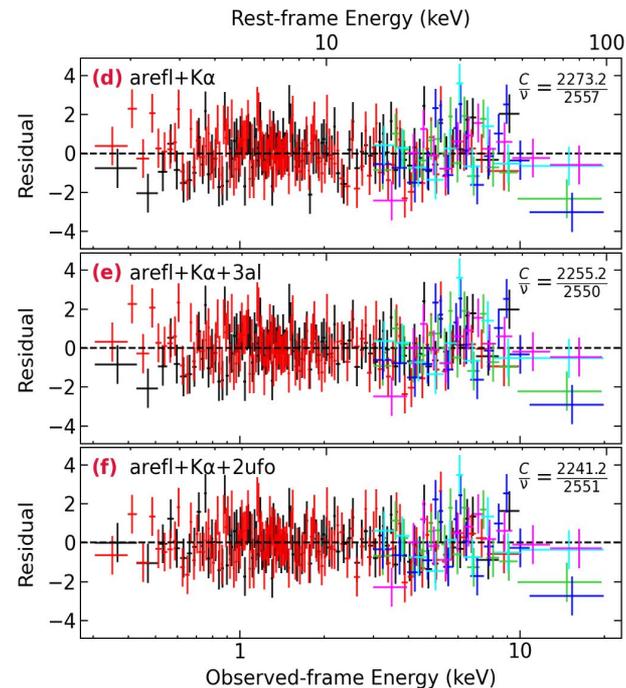
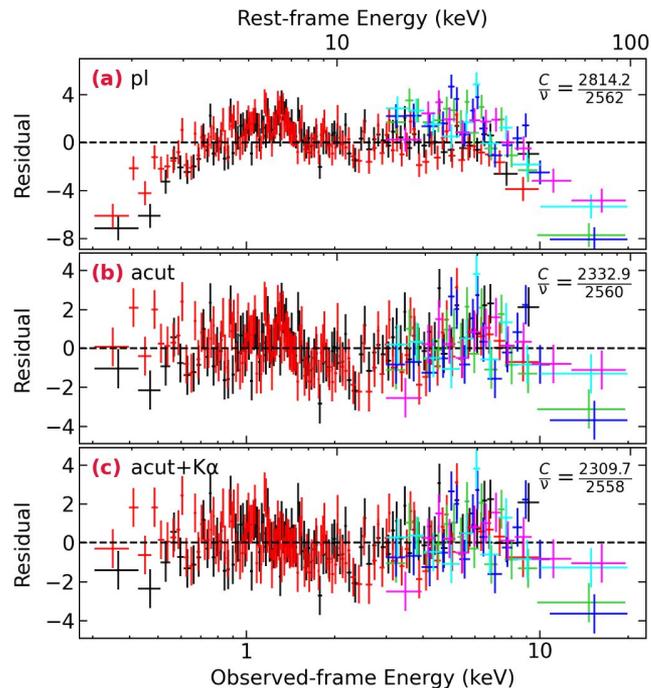
2019 data residuals

2019 data

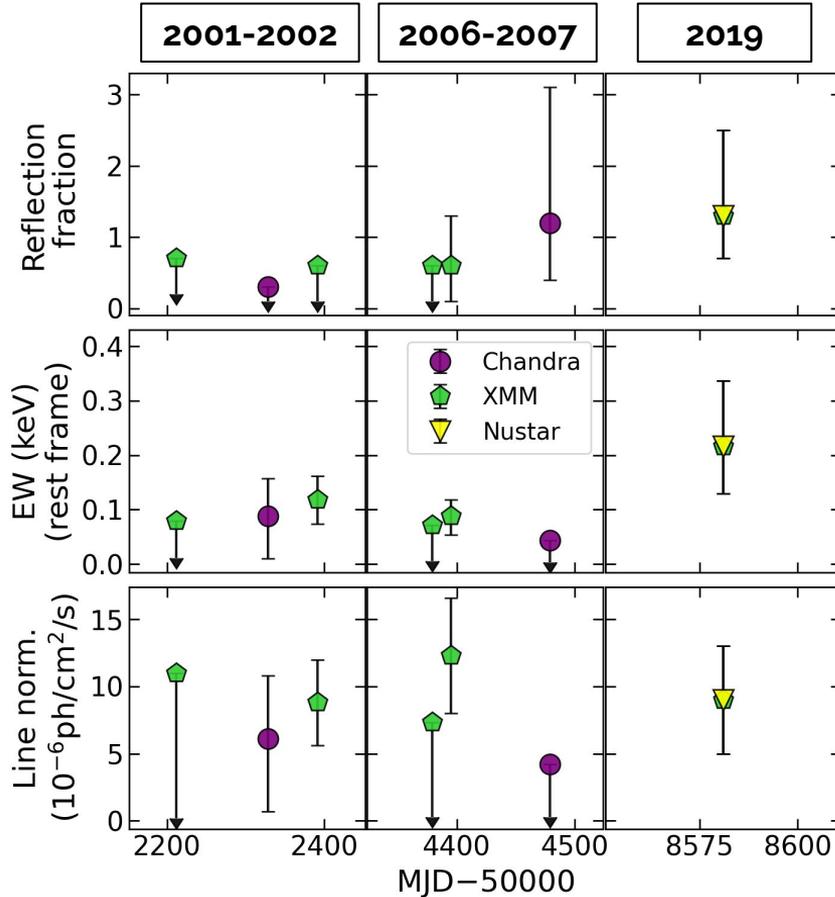
$$E_{\text{cut}} = 52_{-16}^{+39} \text{ keV}$$

$$R = 1.8_{-0.9}^{+0.5}$$

$$EW_{\text{FeK}\alpha} = 216_{-86}^{+121} \text{ keV}$$



APM 08279 X-ray reflection



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