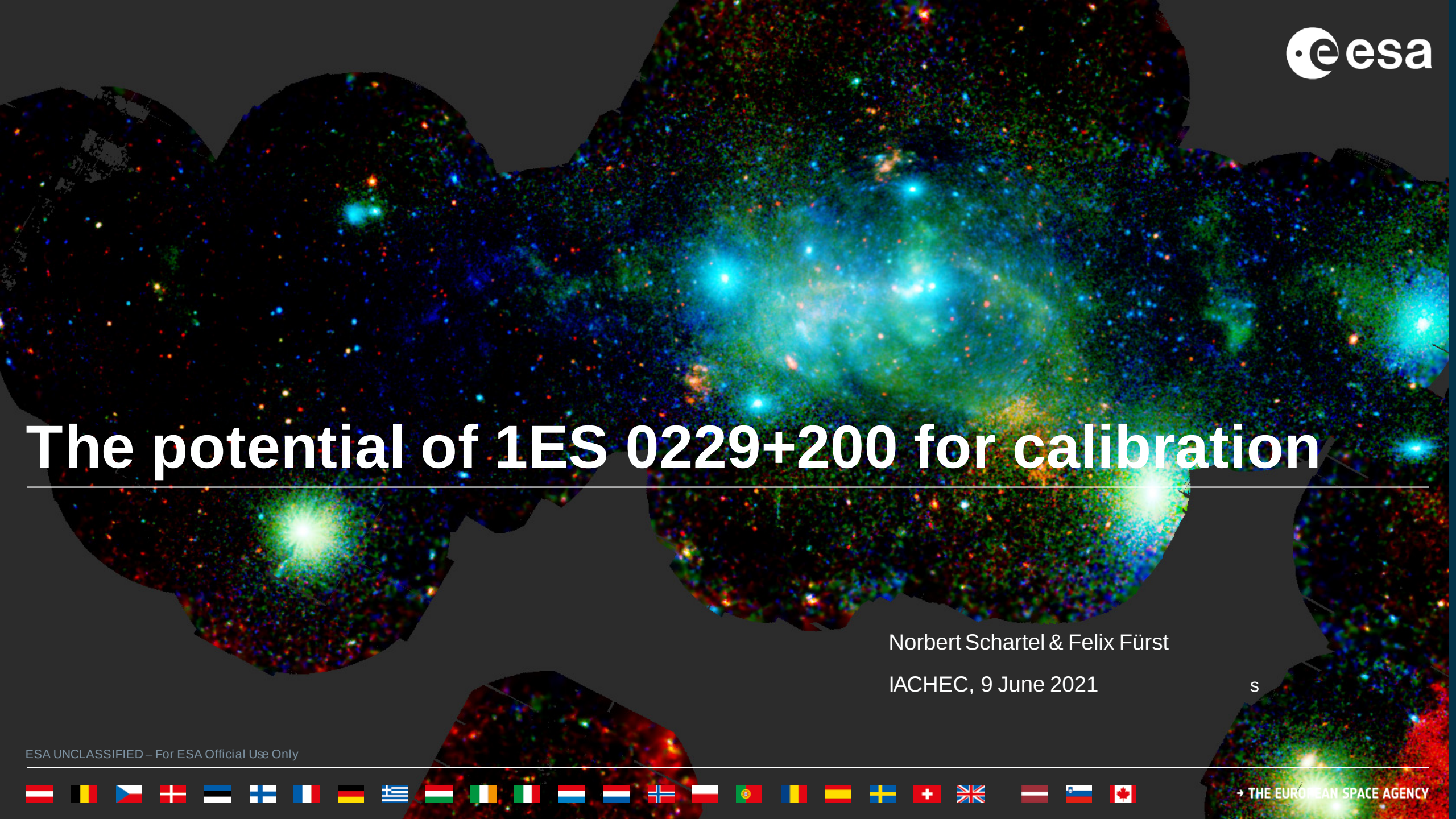

The potential of 1ES 0229+200 for calibration

Norbert Schartel & Felix Fürst

IACHEC, 9 June 2021

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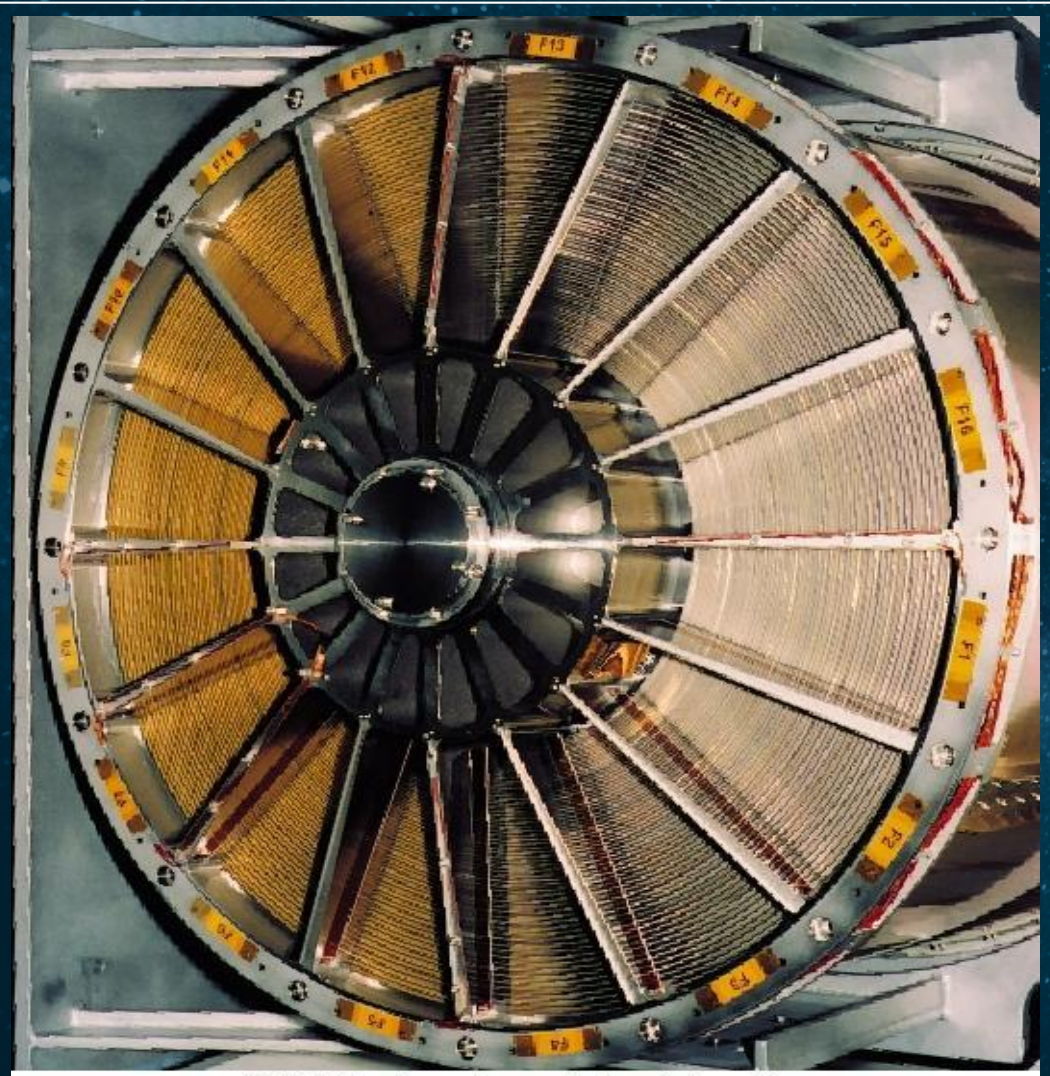
What is in Space?



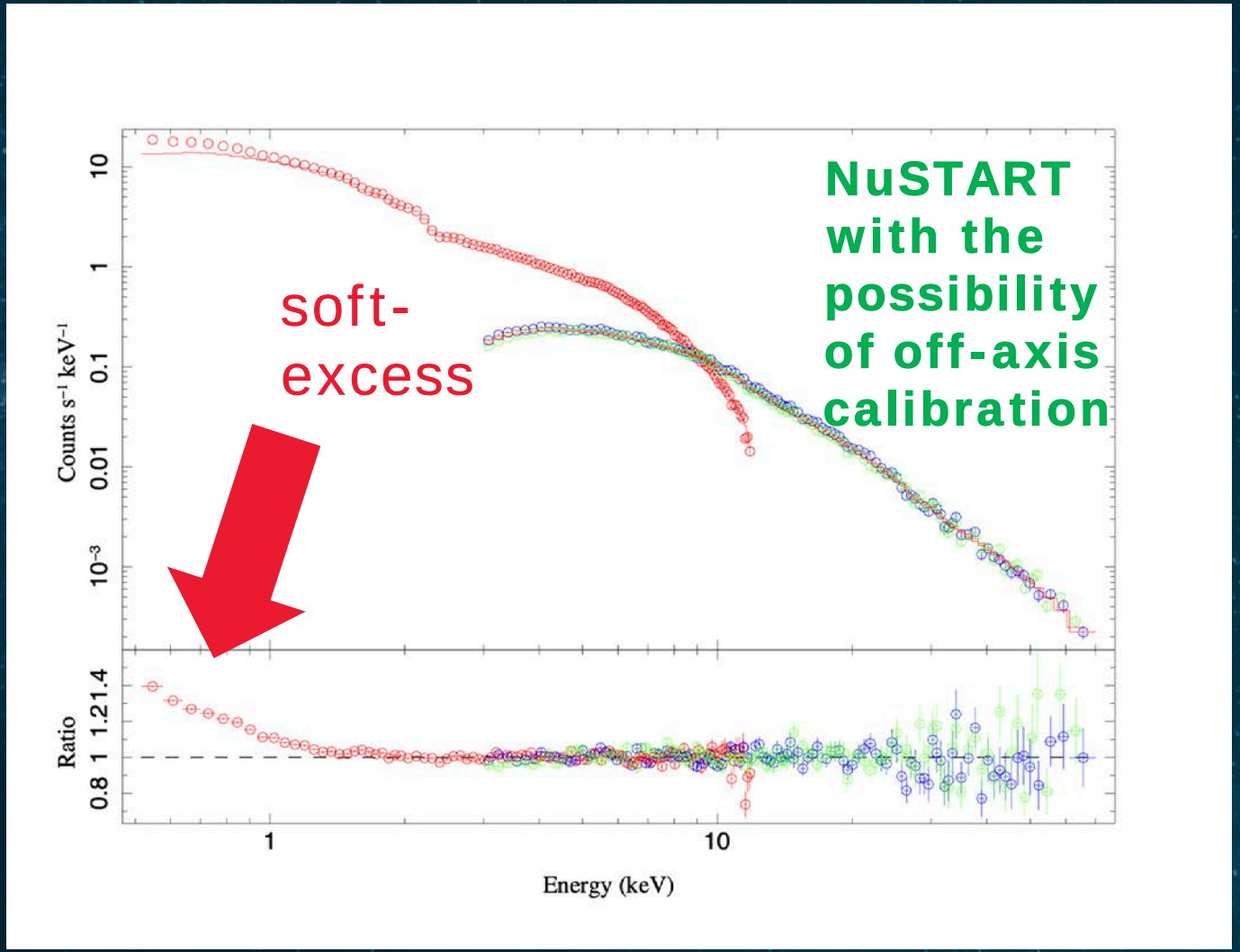
XMM-Newton mirrors during integration

Image courtesy of Dornier Satellitensysteme GmbH European Space Agency

- 58 gold-coated nested Mirrors
- Devils advocate: Can we have lost two or three mirror shells
- Dust on the mirrors was measured carefully on ground. But how much does this tell about the dust on the mirrors in space?

3C 273

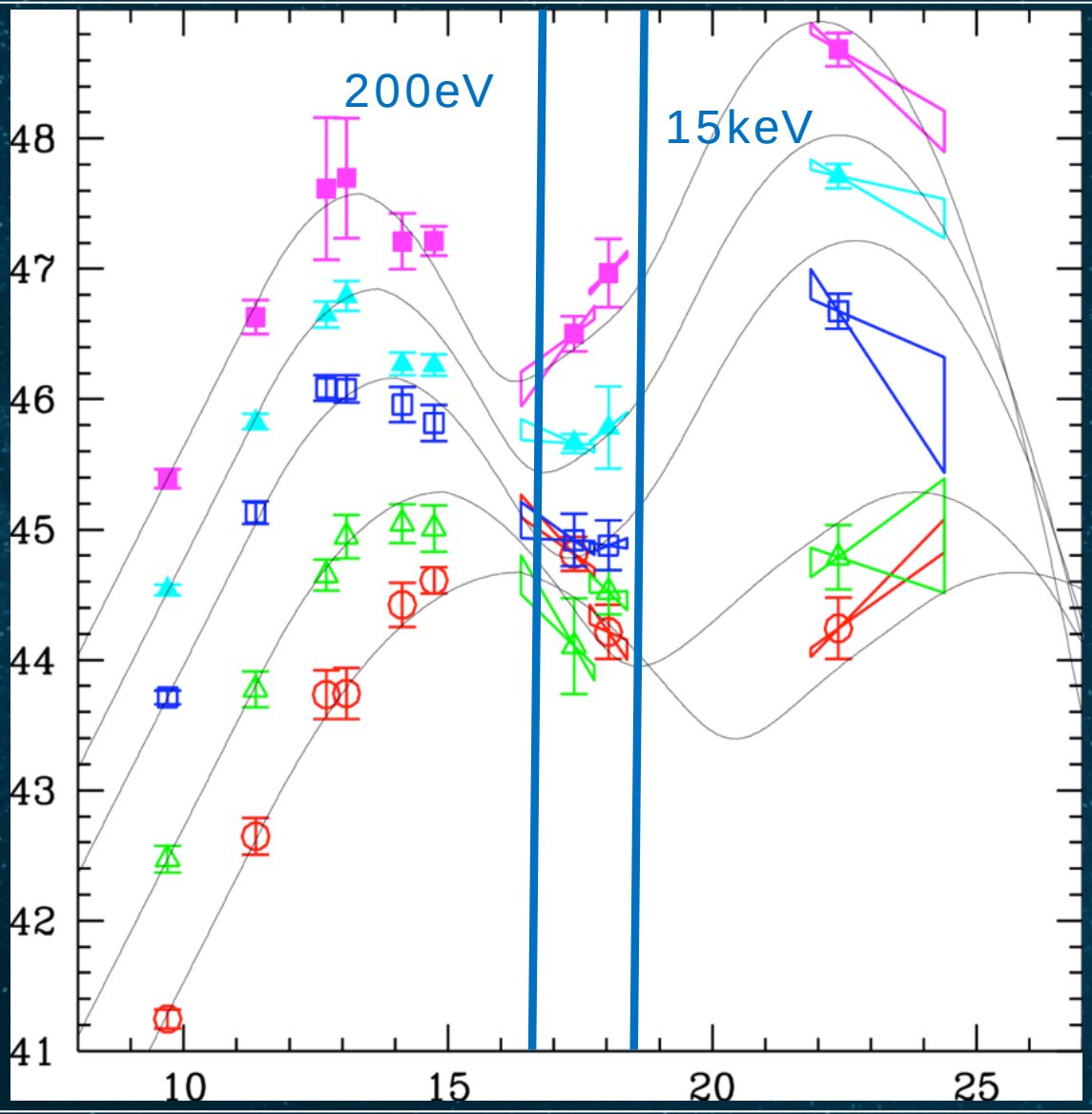
XMM-Newton/pn and NuSTAR observation of 3C273 for (cross)-calibration



Soft-Excess:

- Broken-power-law?
- Blackbody?
- Disk?
- Reflections?

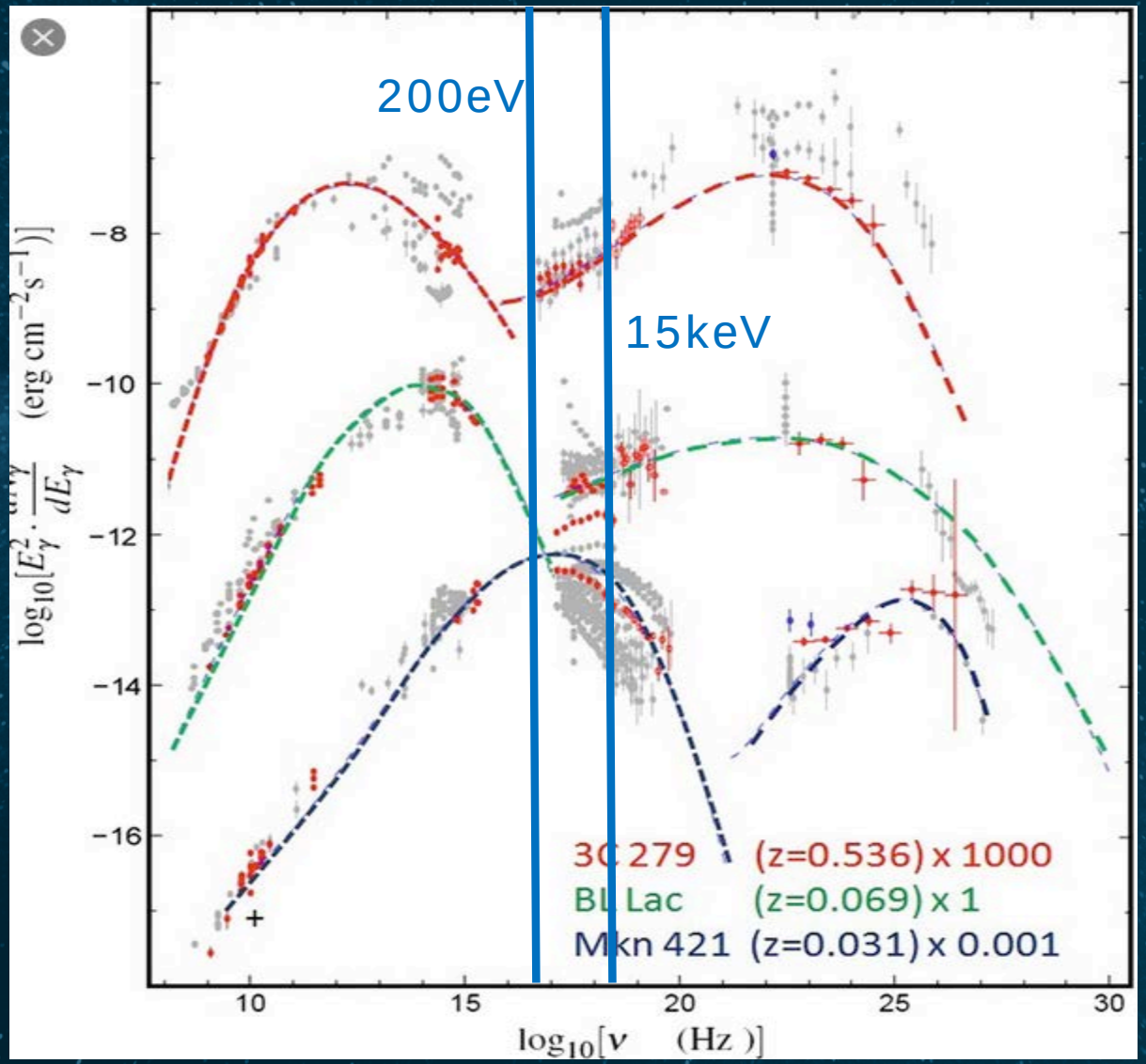
Blazars as Calibration Sources



SED of the blazars studied by Fossati et. al. 1998

SED of Blazars

Mkn 421 used for XMM-Newton (RGS) calibrations



1ES 0229+200 / Kaufmann et al. 2011

- At some point I saw the “wide: SED of 1ES 0229-200 in a paper, but I am not sure which one
- Kaufmann et al, 2011 A&A 531, A30
- X-ray data from XMM-Newton, Swift, and RXTE

A&A 534, A130 (2011)
DOI: 10.1051/0004-6361/201117215
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Astronomy & Astrophysics

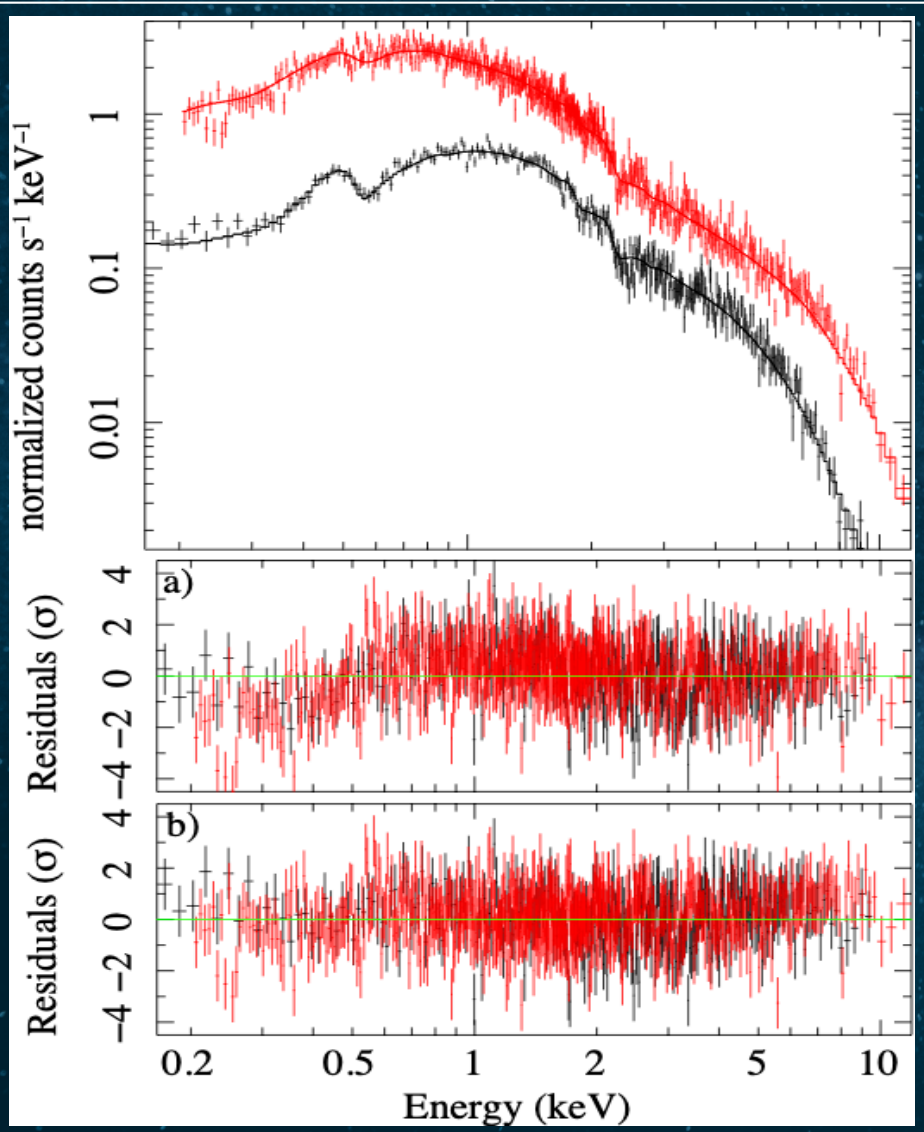
1ES 0229+200: an extreme blazar with a very high minimum Lorentz factor

S. Kaufmann[1], S. J. Wagner[1], O. Tibolla[2], and M. Hauser[1]

Kaufmann et al., 2011, A&A 534, A30

1ES 0229+200 / Kaufmann et al. 2011

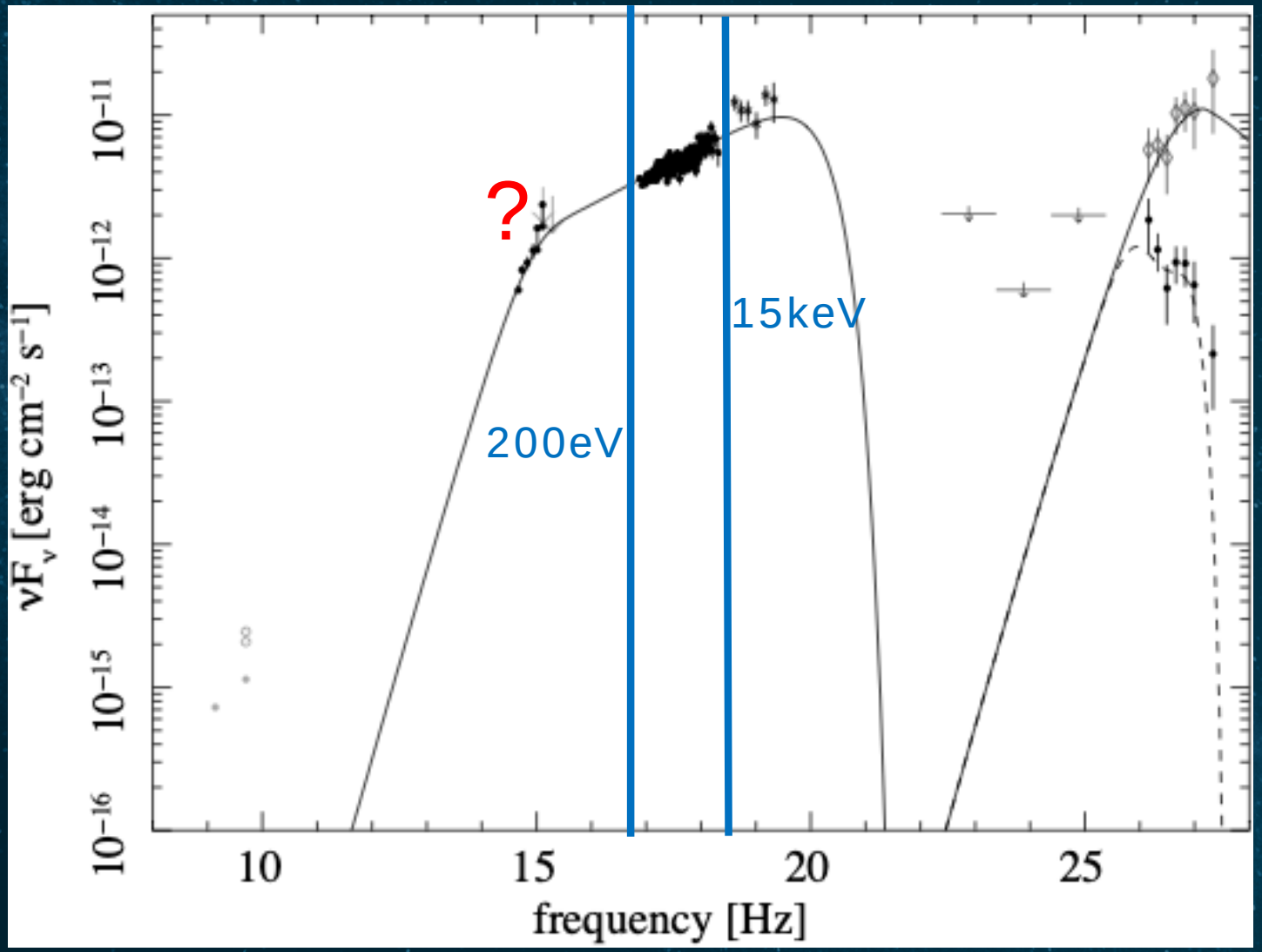
Kaufmann et al., 2011, A&A 534, A30



XMM-Newton MOS1 (black) and PN (red) spectrum of 1ES 0229+200 from August 21, 2009. The spectra can be well fit with a power-law model taking into account an absorption larger than the Galactic absorption. In panel a), we plot the residuals for a power law considering the Galactic absorption as fixed parameter, and in panel b) residuals for a power law with a free absorption.

1ES 0229+200 / Kaufmann et al. 2011

Kaufmann et al., 2011, A&A 534, A30



- Spectral energy distribution of 1ES 0229+200 with simultaneous measured optical, UV, and X-ray fluxes, all corrected for host galaxy emission, Galactic extinction, and Galactic absorption is shown as black data points. The 58 months Swift/BAT spectrum is shown >10 keV (black crosses). In grey (filled and open circles), historical radio and UV data are shown and their origin is discussed in the text.

1ES 0229+200 / Wierzcholska & Wagner

- Wierzcholska & Wager, 2020, MNRAS 496, 1295
- Data from NuSTAR, Swift, ATOM, 2MSDD and WISE
- Synthetic host galaxy profiles generated with GRASIL

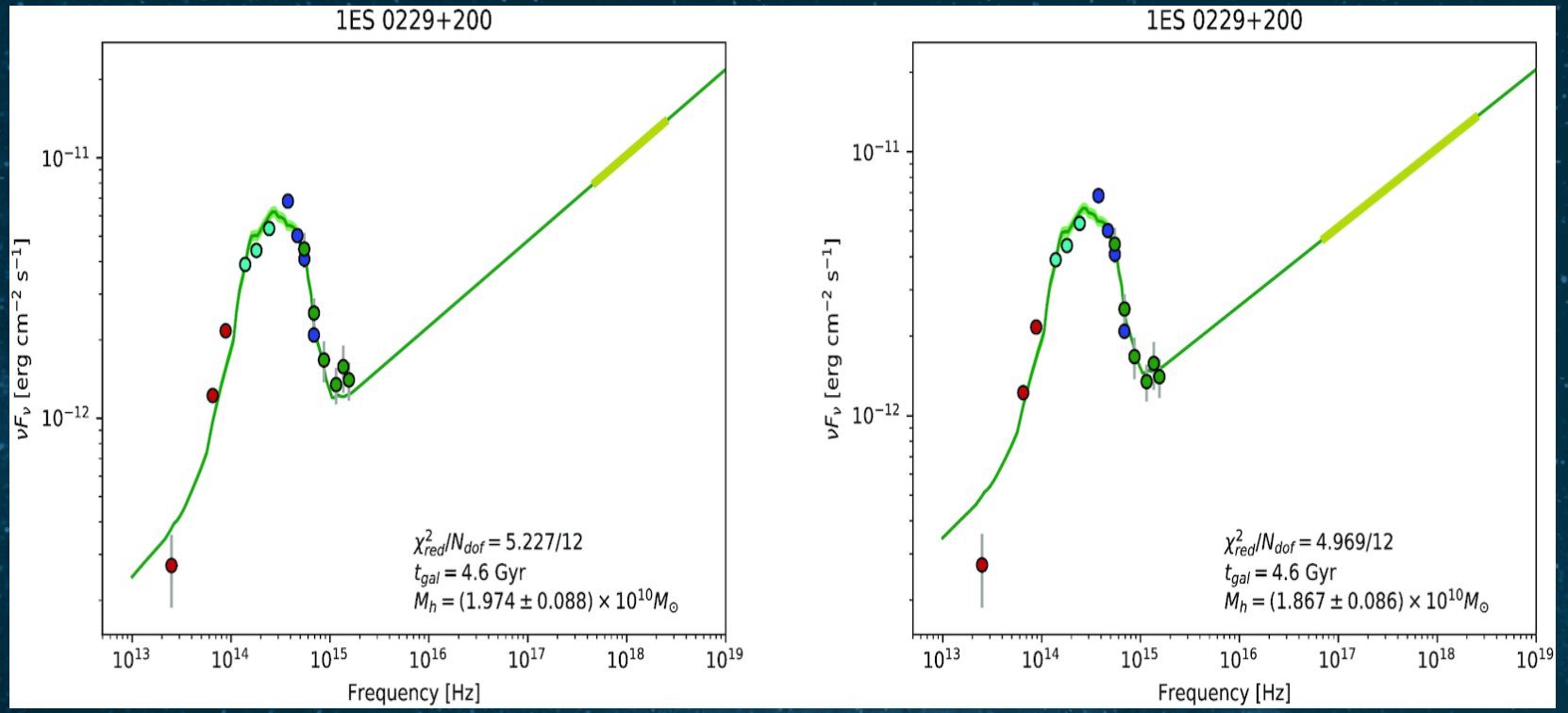
Constraining X-ray emission in HBL blazars using multiwavelength observations

Alicja Wierzcholska ✉, Stefan J Wagner

Monthly Notices of the Royal Astronomical Society, Volume 496, Issue 2, August 2020, Pages 1295–1306, https://doi.org/10.1093/mnras/staa1537

Published: 03 June 2020 **Article history** ▾

1ES 0229+200 / Wierzcholska & Wagner

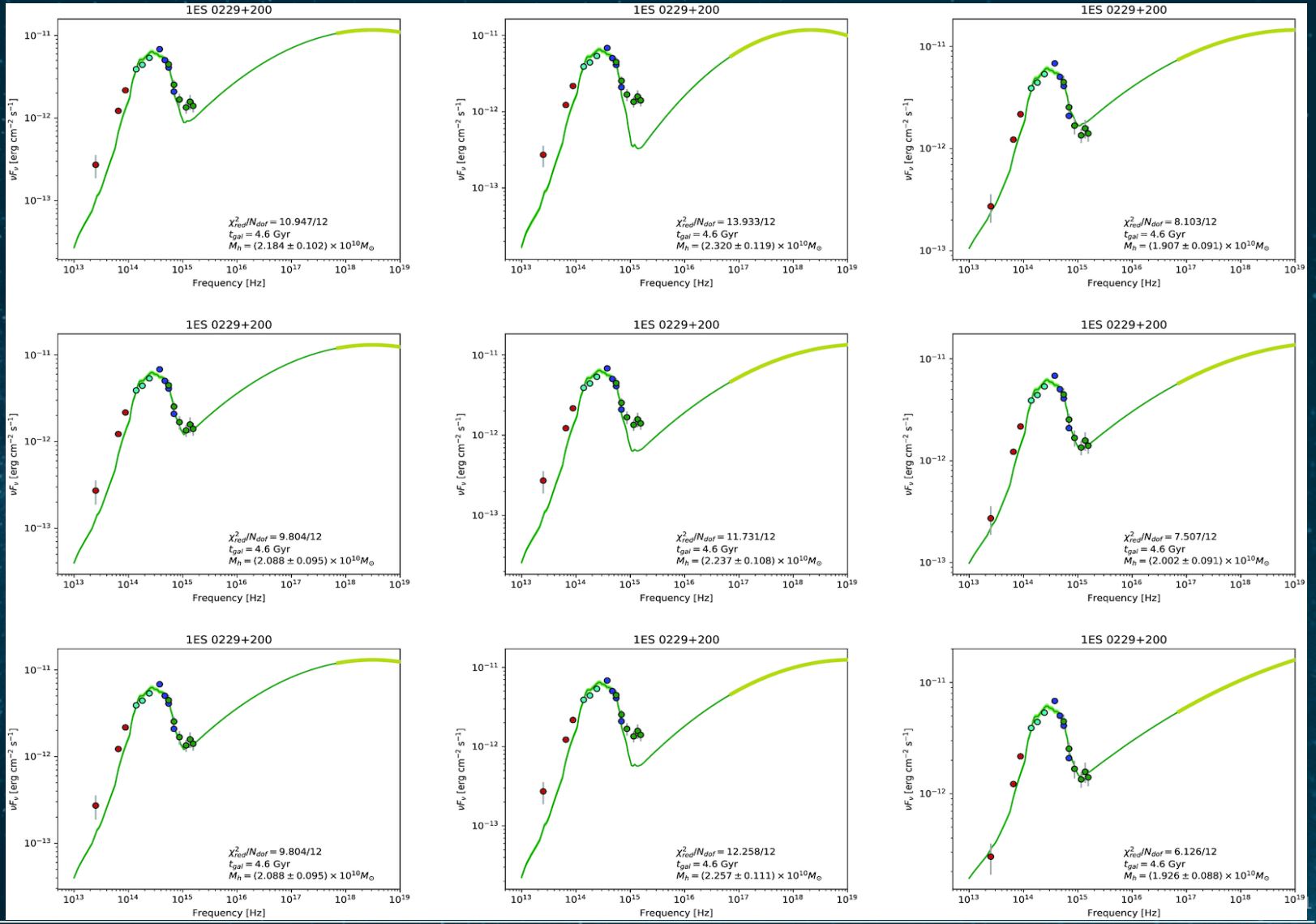


Wierzcholska & Wager, 2020, MNRAS 496, 1295

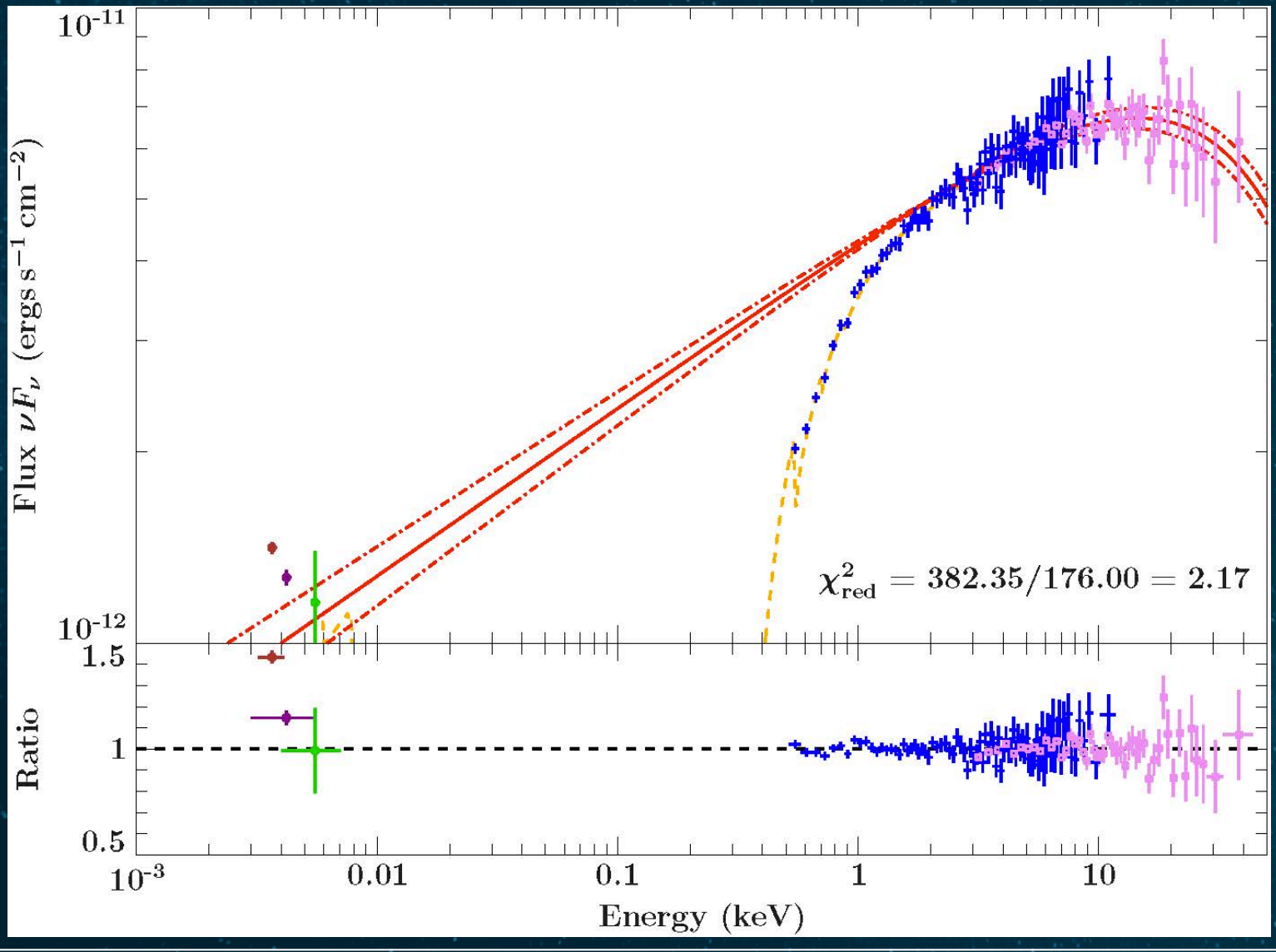
Broad-band SED of 1ES 0229+200. Left-hand panel: modelling with the X-ray spectrum fitted with the power-law model in the energy range of 2.0–10 keV with NH value taken from Kalberla et al. (2005); right-hand panel: modelling with the X-ray spectrum fitted with the power-law model in the energy range of 0.3–10 keV with NH value taken from Willingale et al. (2013). Red points present WISE data, light blue points present 2MASS data, dark blue points present ATOM data, and green points present Swift-UVOT data.

1ES 0229+200 / Wierzcholska & Wagner

SED of 1ES 0229+200 derived from the extrapolated NuSTAR X-ray spectra. First row: observations with the ObsID of nu60002047002. From the left- to right-hand side: the logparabola fit to the NuSTAR data only in the energy range of 3–79 keV, the joint Swift/XRT-NuSTAR fit in the energy range of 0.3–79 keV with the logparabola model and NH value as provided by Kalberla et al. (2005), the joint Swift/XRT-NuSTAR fit in the energy range of 0.3–79 keV with the logparabola model and NH value as provided by Willingale et al. (2013). Second row: same as top panels but for the ObsID of nu60002047004. Last row: same as the first but for the ObsID of nu60002047006.

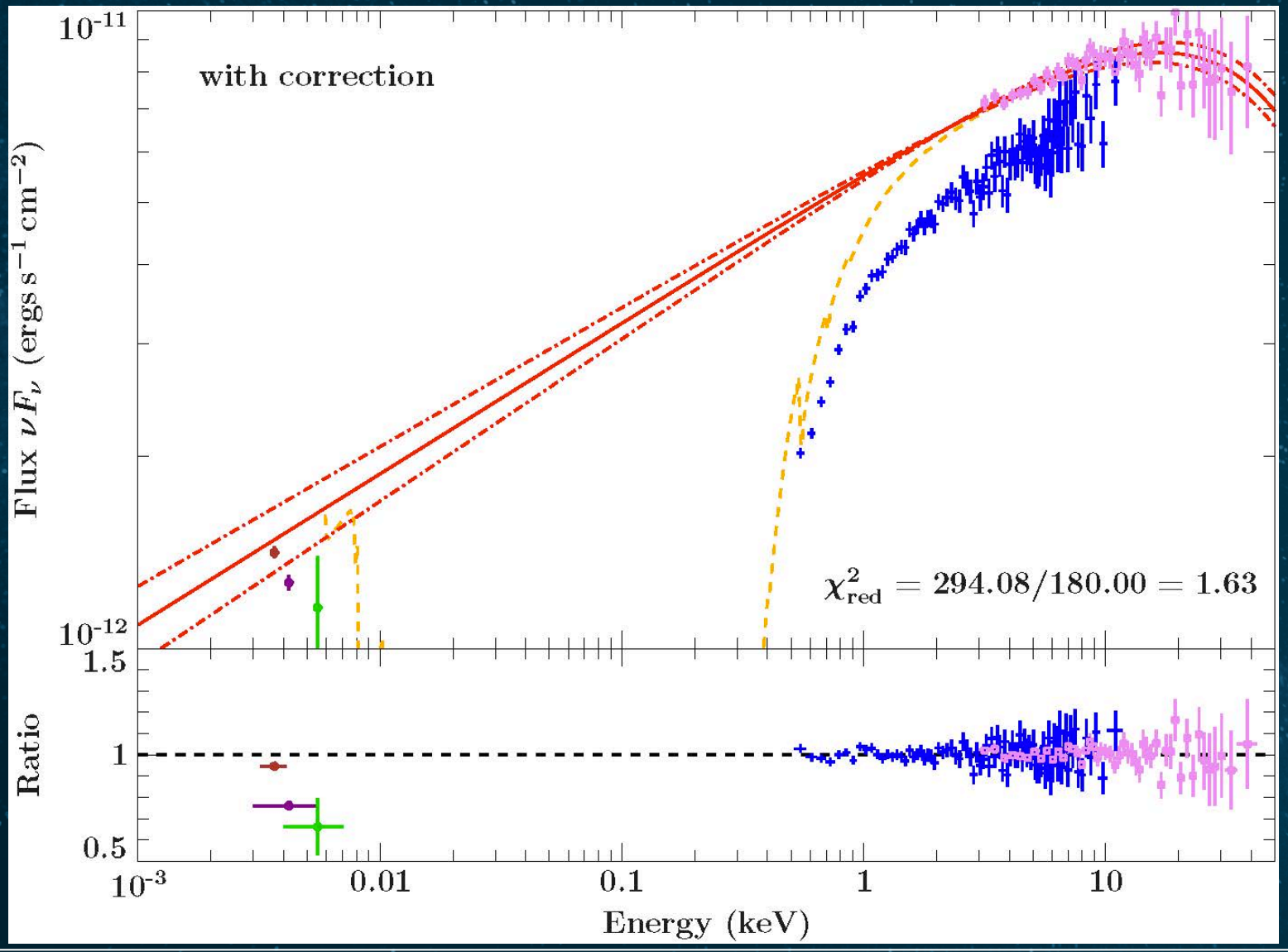


XMM-Newton pn & OM UV data + 100 ks NuSTAR simulated



- UV OM data are de-reddened
- Power-law extrapolated to UV
- NuSTAR data are simulated

XMM-Newton pn & OM UV data + 100 ks NuSTAR simulated



- UV OM data are de-reddened
- Power-law extrapolated to UV
- NuSTAR data are simulated

1ES 0229+200

- flux is about 1.79e-11 erg/s/cm^2 in the 0.5-20keV band (compared to 1.45e-10 erg/s/cm^2 for 3C 273)
- Count-rate in the 3-12 keV band is about 5ct/s (5x lower than for 3C273 (24cts/s).

TABLE 1
MODEL PARAMETERS FOR DIFFERENT SIMULATED EXPOSURE TIMES.

	300ks		120ks	
Parameter	no corr.	w/ corr	no corr.	w/ corr
$N_{\rm H}$ (10^{22} cm^{-2})	0.1076 ± 0.0022	0.1111 ± 0.0022	0.108 ± 0.004	0.112 ± 0.004
Norm.	$(3.87 \pm 0.04) \times 10^{-3}$	$\left(3.98^{+0.05}_{-0.04}\right) \times 10^{-3}$	$(3.83 \pm 0.05) \times 10^{-3}$	$(3.94 \pm 0.06) \times 10^{-3}$
Γ	1.719 ± 0.009	1.733 ± 0.009	1.721 ± 0.012	1.740 ± 0.012
$E_{\rm fold}$ (keV)	$33.8^{+2.3}_{-2.1}$	$33.6^{+2.3}_{-2.1}$	$34.4^{+2.7}_{-2.4}$	$35.9^{+2.9}_{-2.6}$
$CC_{\rm pn}$	0.702 ± 0.006	0.881 ± 0.008	0.708 ± 0.007	0.891 ± 0.009
$CC_{\rm A}$	—	—	—	—
$CC_{\rm B}$	1.041 ± 0.010	1.041 ± 0.010	1.053 ± 0.010	1.053 ± 0.010
χ^2/d.o.f.	490.72/573	513.27/573	536.85/571	553.42/571
$\chi^2_{\rm red}$	0.856	0.896	0.940	0.969

TABLE 2
MODEL PARAMETERS FOR DIFFERENT SIMULATED EXPOSURE TIMES.

	80ks		40ks	
Parameter	no corr.	w/ corr	no corr.	w/ corr
$N_{\rm H}$ (10^{22} cm^{-2})	0.104 ± 0.004	0.108 ± 0.004	0.102 ± 0.006	0.106 ± 0.006
Norm.	$(3.82 \pm 0.06) \times 10^{-3}$	$(3.92 \pm 0.06) \times 10^{-3}$	$(3.81 \pm 0.08) \times 10^{-3}$	$(3.90 \pm 0.08) \times 10^{-3}$
Γ	$1.709^{+0.013}_{-0.014}$	1.729 ± 0.013	1.712 ± 0.017	1.732 ± 0.017
$E_{\rm fold}$ (keV)	$32.0^{+2.5}_{-2.2}$	$33.6^{+2.8}_{-2.4}$	$33.3^{+3.1}_{-2.6}$	$35.5^{+3.5}_{-2.9}$
$CC_{\rm pn}$	0.706 ± 0.008	$0.888^{+0.010}_{-0.009}$	0.710 ± 0.009	0.894 ± 0.011
$CC_{\rm A}$	—	—	—	—
$CC_{\rm B}$	1.052 ± 0.010	1.052 ± 0.010	1.047 ± 0.010	1.047 ± 0.010
χ^2/d.o.f.	537.66/569	554.15/569	519.68/562	527.99/562
$\chi^2_{\rm red}$	0.945	0.974	0.925	0.939

1ES 0229+200 / Conclusions

- 1ES 0229+200 has very simple SED, ideally for calibration and cross-calibration
- Unique chance to calibrate the energy range from UV up to NuSTAR,
- UV is well calibrated in connection with the optical standard calibrations
- NuSTAR off-axis observations would establish an absolute calibration above 5 keV

- Proposal would be one multi-facilities observations to explore the potential
- May observation every 0.5 years

- Caveat: The source is variable and we may not always get a perfect match