Unveiling the High Energy Universe with NuSTAR

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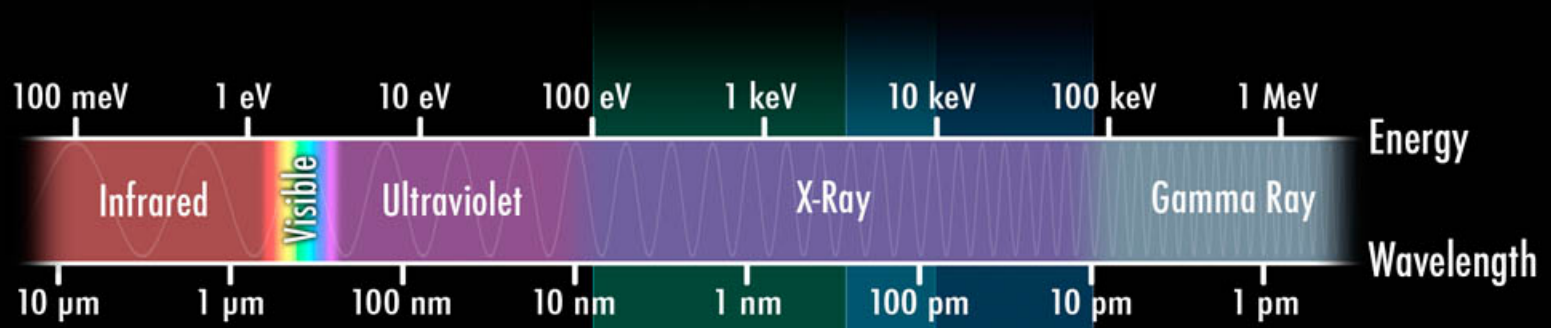
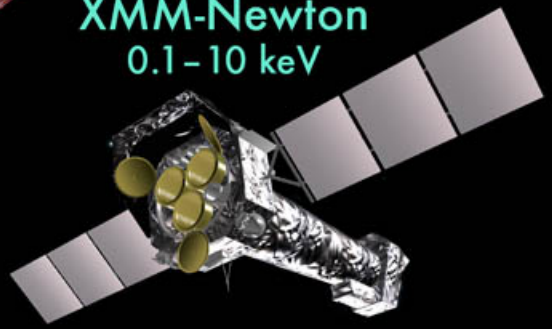
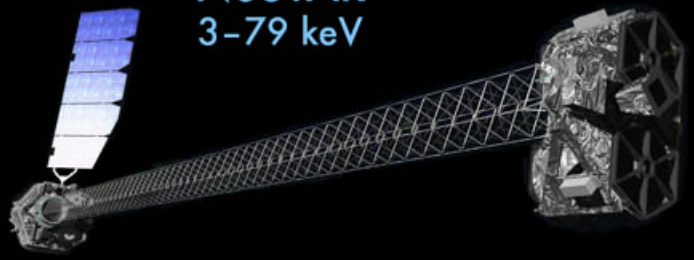
X-Ray Telescopes & the Electromagnetic Spectrum



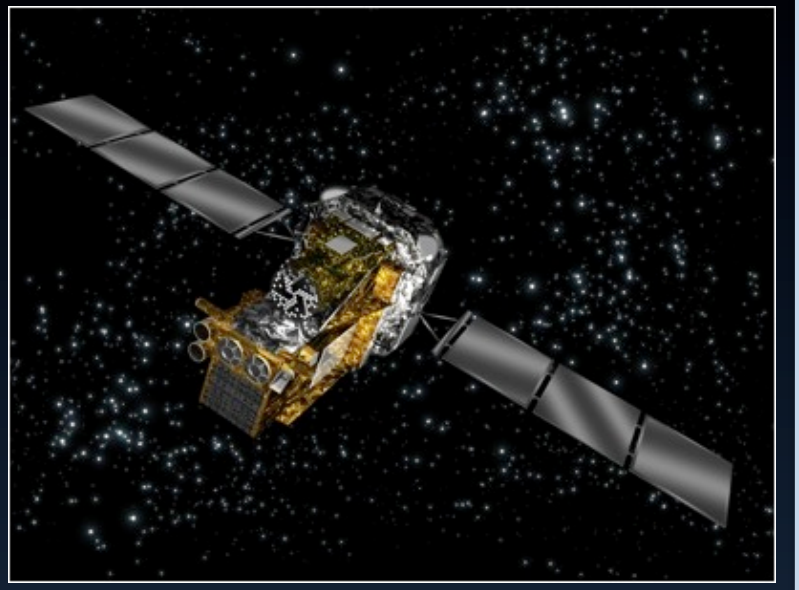
Chandra &
XMM-Newton
0.1–10 keV

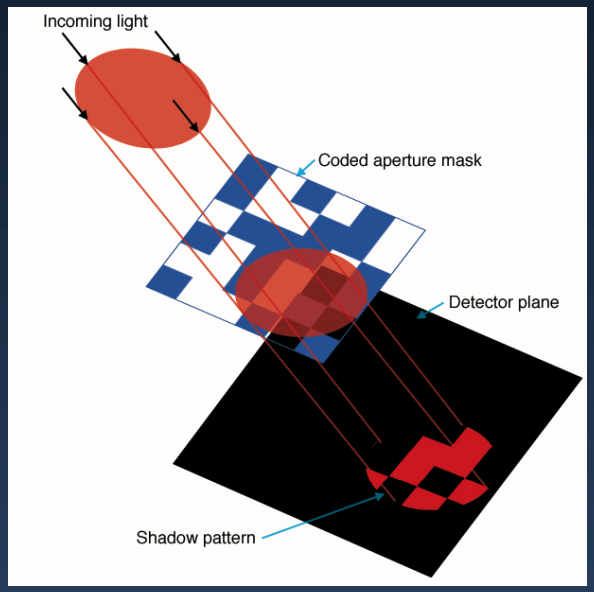


NuSTAR
3–79 keV

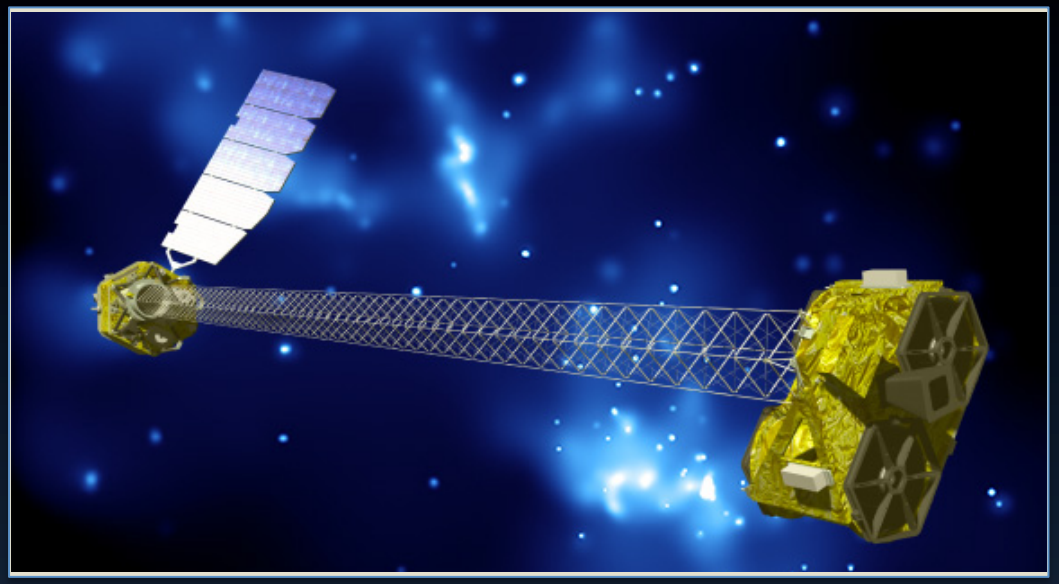


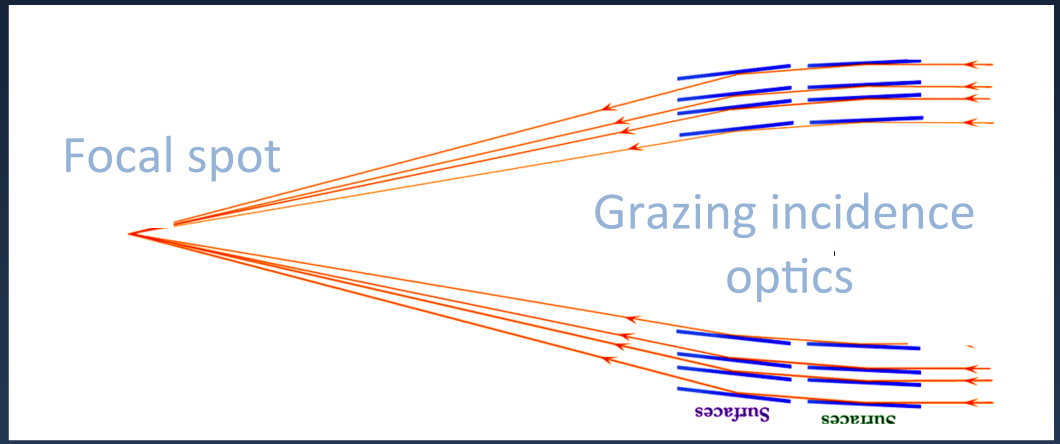
INTEGRAL, Swift BAT



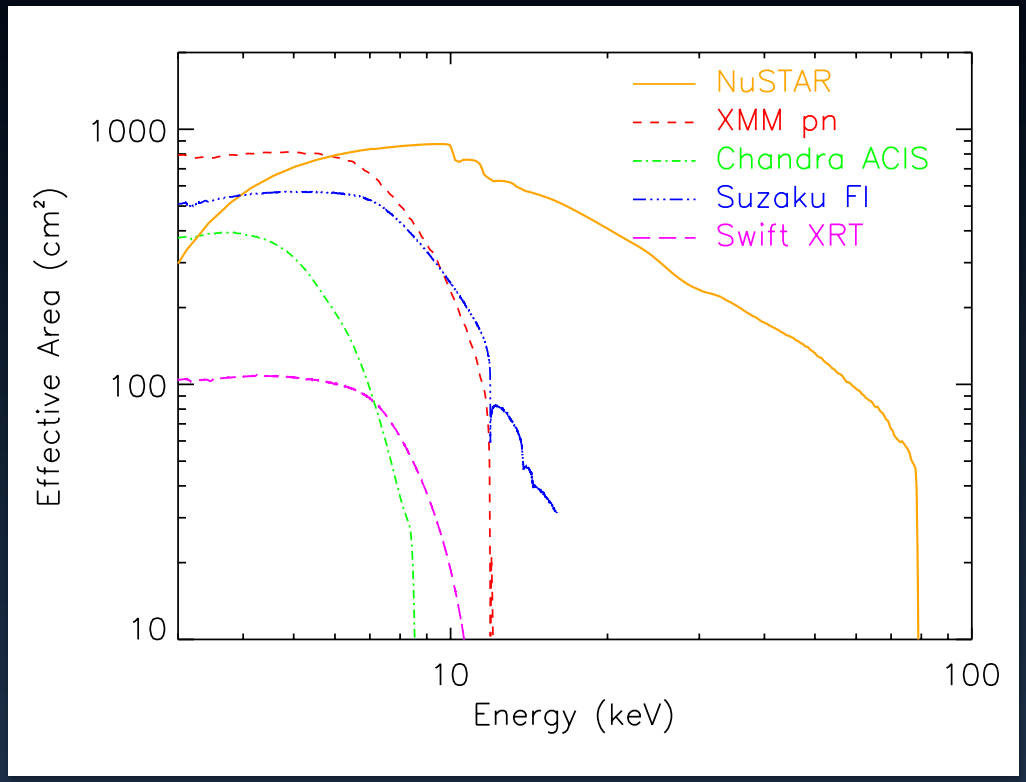


NuSTAR





Sensitivity



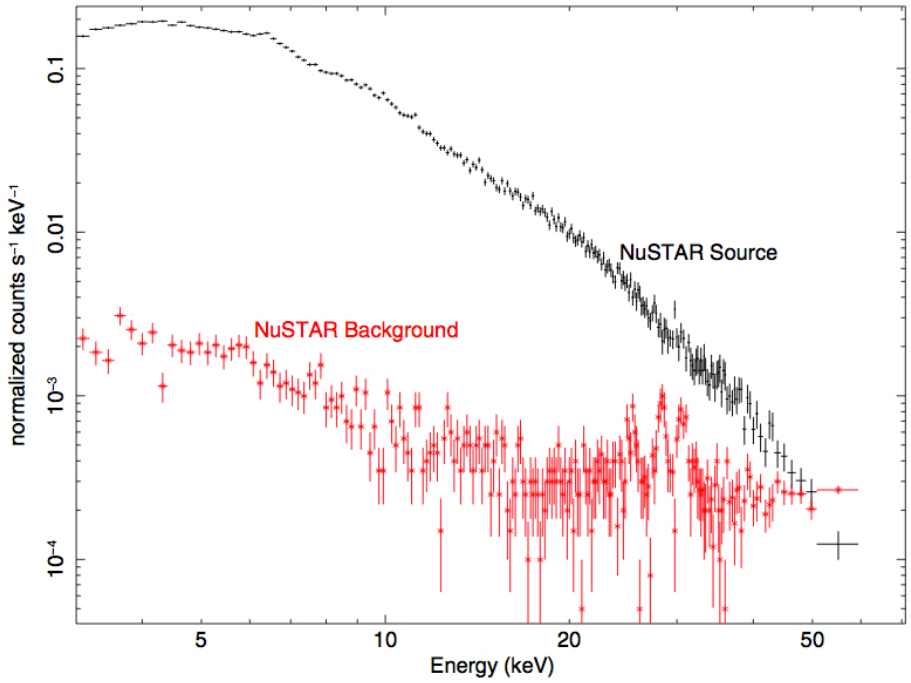
NuSTAR two-telescope total collecting area

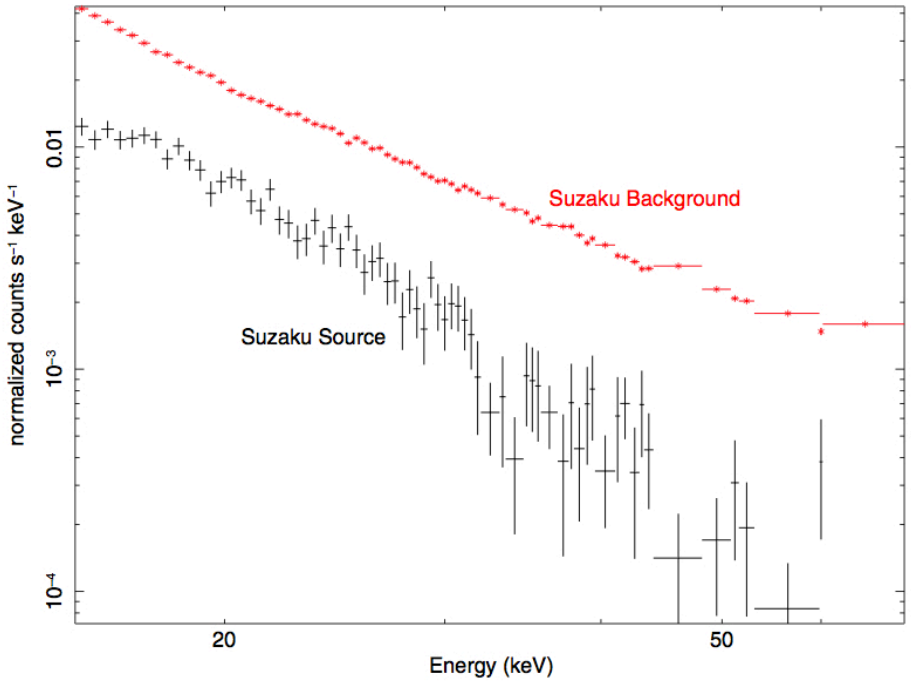
Satellite (instrument)	Sensitivity
INTEGRAL (ISGRI)	~0.5 mCrab (20-100 keV) with >Ms exposures
Swift (BAT)	~0.8 mCrab (15-150 keV) with >Ms exposures
NuSTAR	1 μCrab (10-40 keV) in 1 Ms

Sensitivity comparison

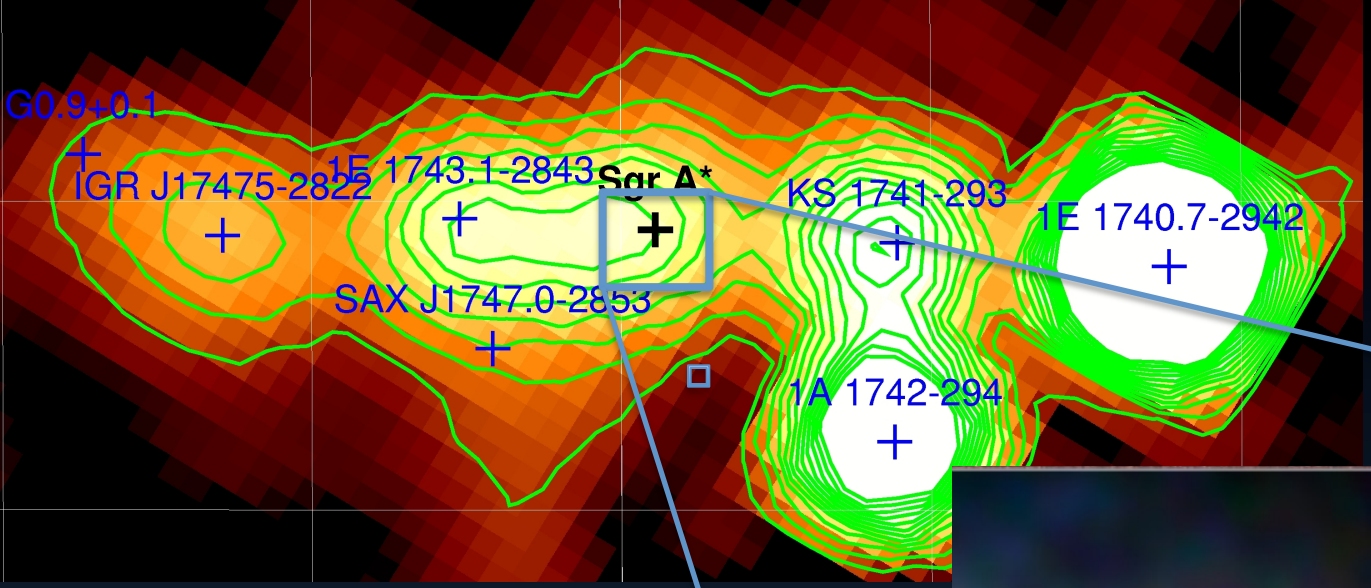
Sensitivity

X-ray spectra of a bright AGN (MCG-6-30-15) taken with NuSTAR and Suzaku (~same flux level)





Marinucci et al. 2014

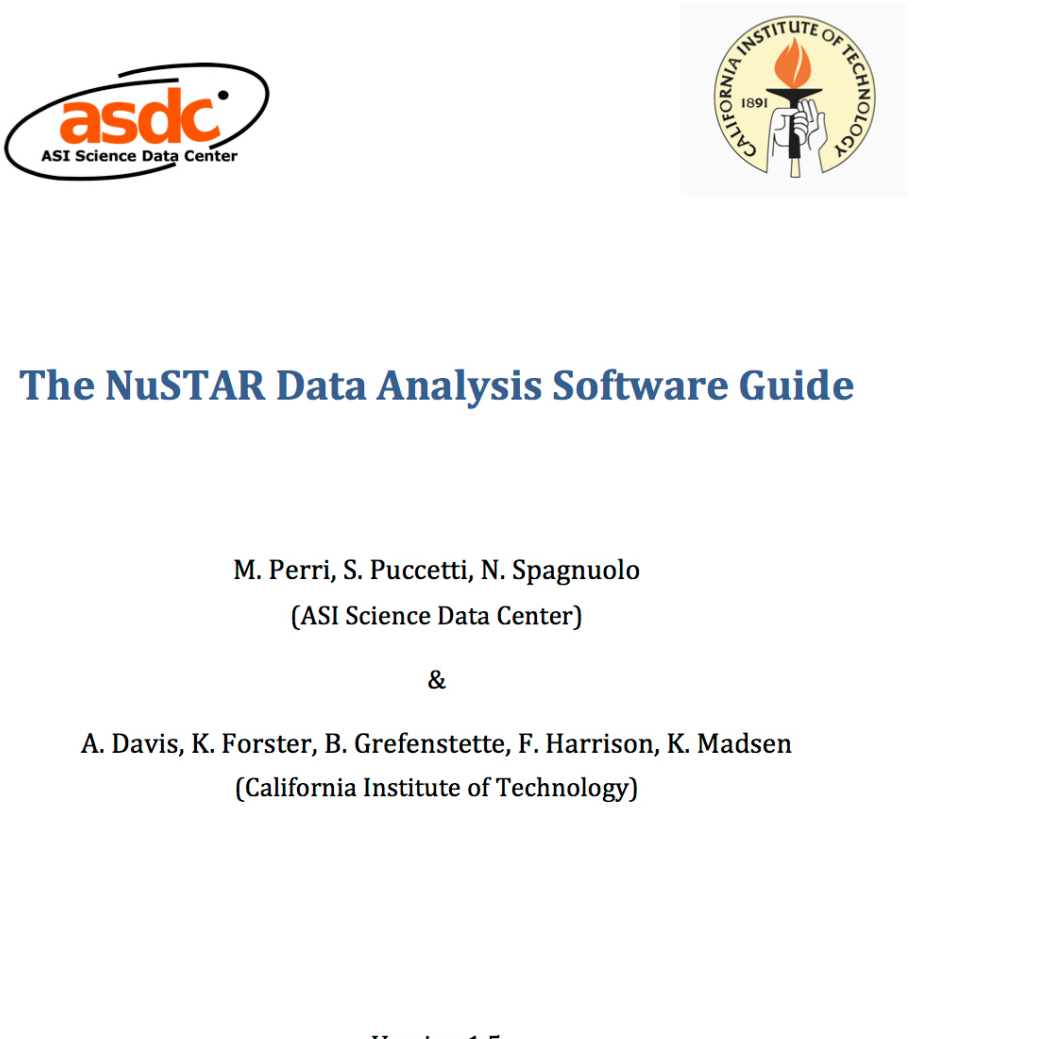


Previous high-energy X-ray view of the heart of the Milky Way

NuSTAR is a NASA small mission, approved for 2 (2.5) years. Hopefully extended for 2 more years → GO

ITALIAN CONTRIBUTIONS:

- Malindi station
- Calibration (ASDC)
- Strong presence in science groups



asdc
ASI Science Data Center

CALIFORNIA INSTITUTE OF TECHNOLOGY 1891

The NuSTAR Data Analysis Software Guide

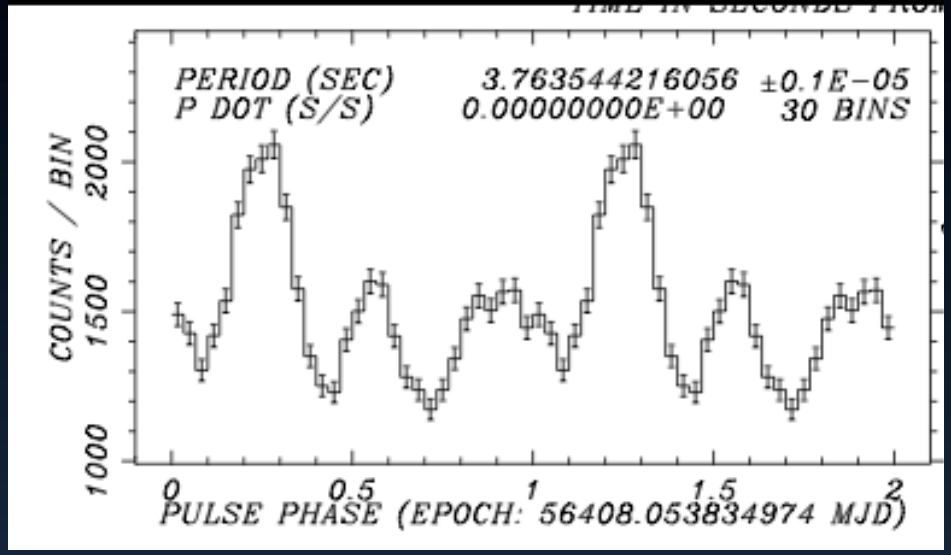
M. Perri, S. Puccetti, N. Spagnuolo
(ASI Science Data Center)

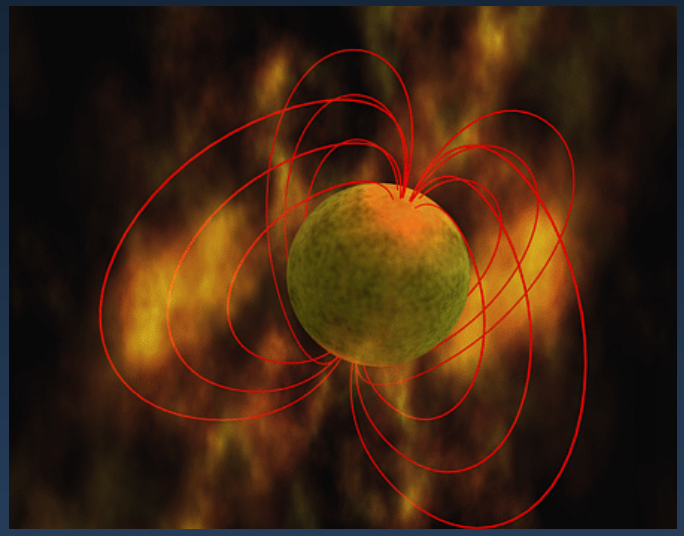
&

A. Davis, K. Forster, B. Grefenstette, F. Harrison, K. Madsen
(California Institute of Technology)

A New Magnetar – SGR J1745-29

Mori et al ApJL 2013

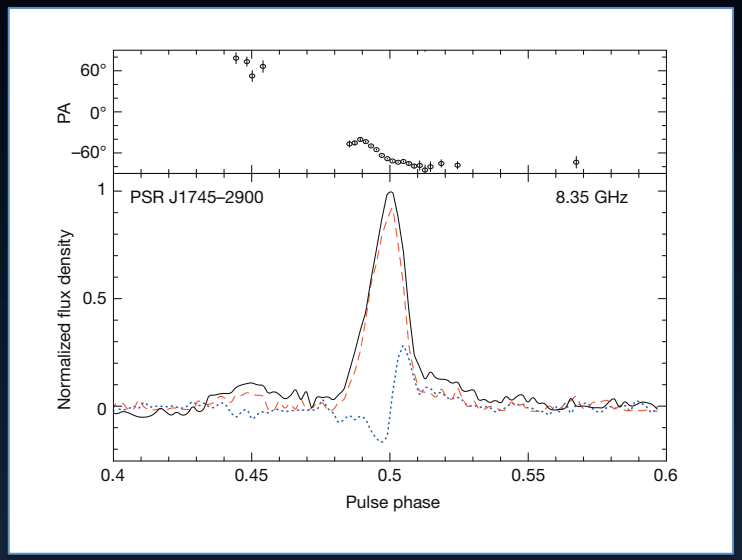




- $\dot{P}$= (6. 5 ± 1. 4) X 10^{-12}
- E=5 X 10^{33} erg s^{-1}
- B=1.6 x 10^{14} G

- Associated with disk of high-mass stars near Sgr A*?
- Progenitor ~40 M_{sun}
- Sadly – not a stable pulsator *(Kaspi et al ApJ 2013)*

Magnetic Field near Sgr A*



Eatough et al Nature 2013

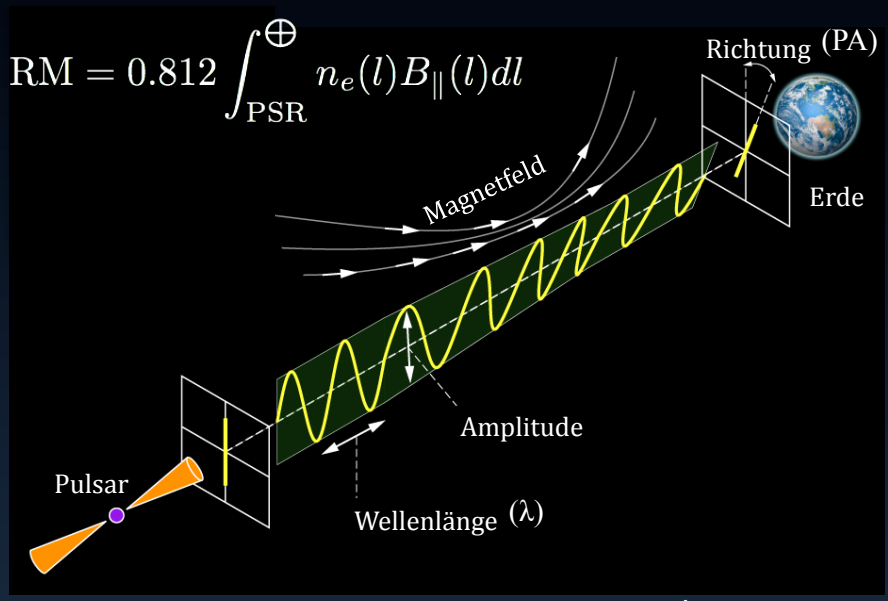


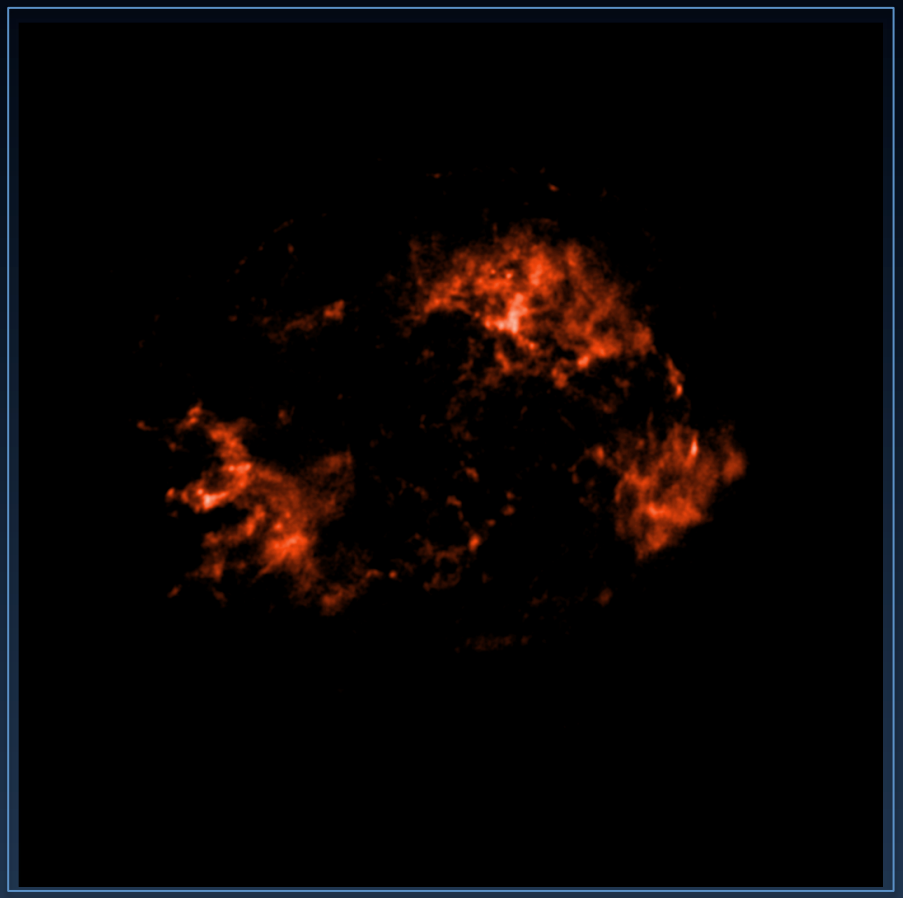
Image credit A. Noutsos

Near event horizon B~30 – 100 G

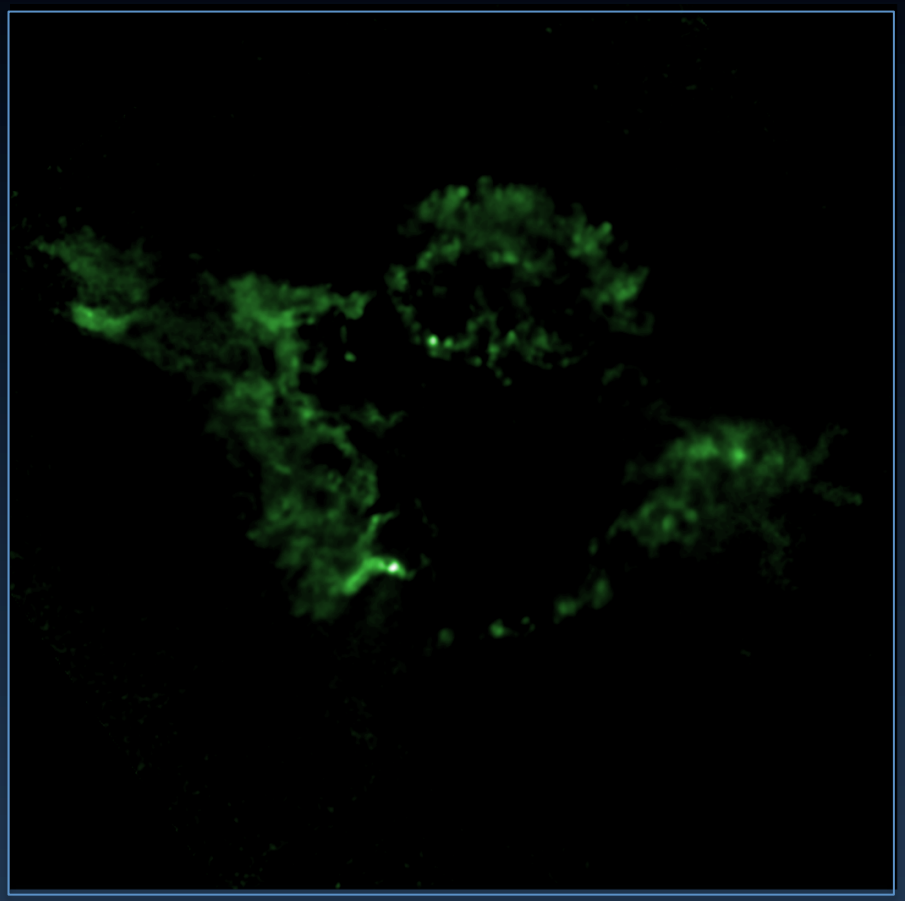
At D~0.12 pc (~10^5Rs in hot gas component), ordered B-field $\geq$ 8 mG

- makes (proposed) jet formation viable
- could lead to super equipartion fields closer in -> radiatively inefficient flow

Cassiopeia A

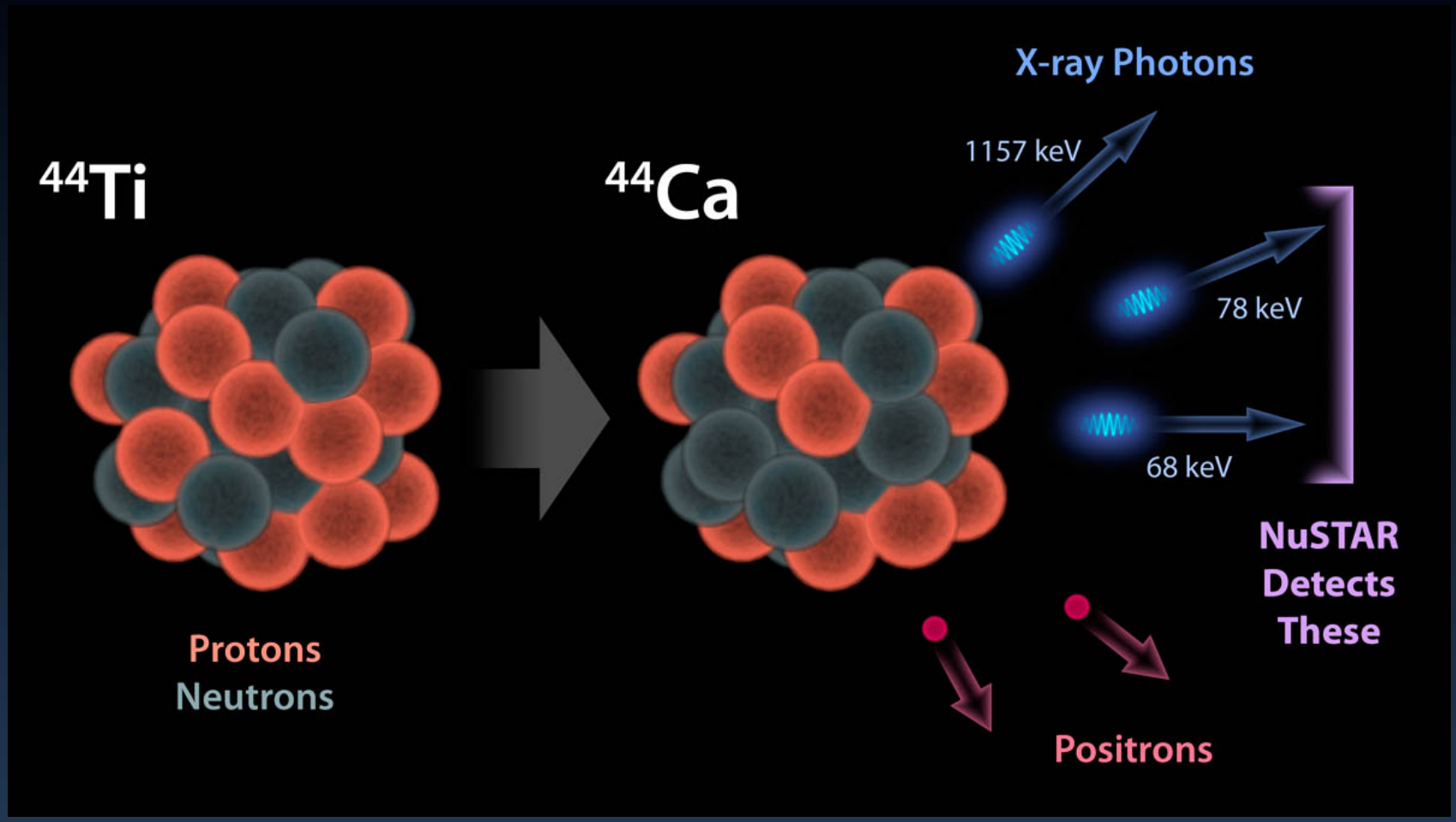


Iron

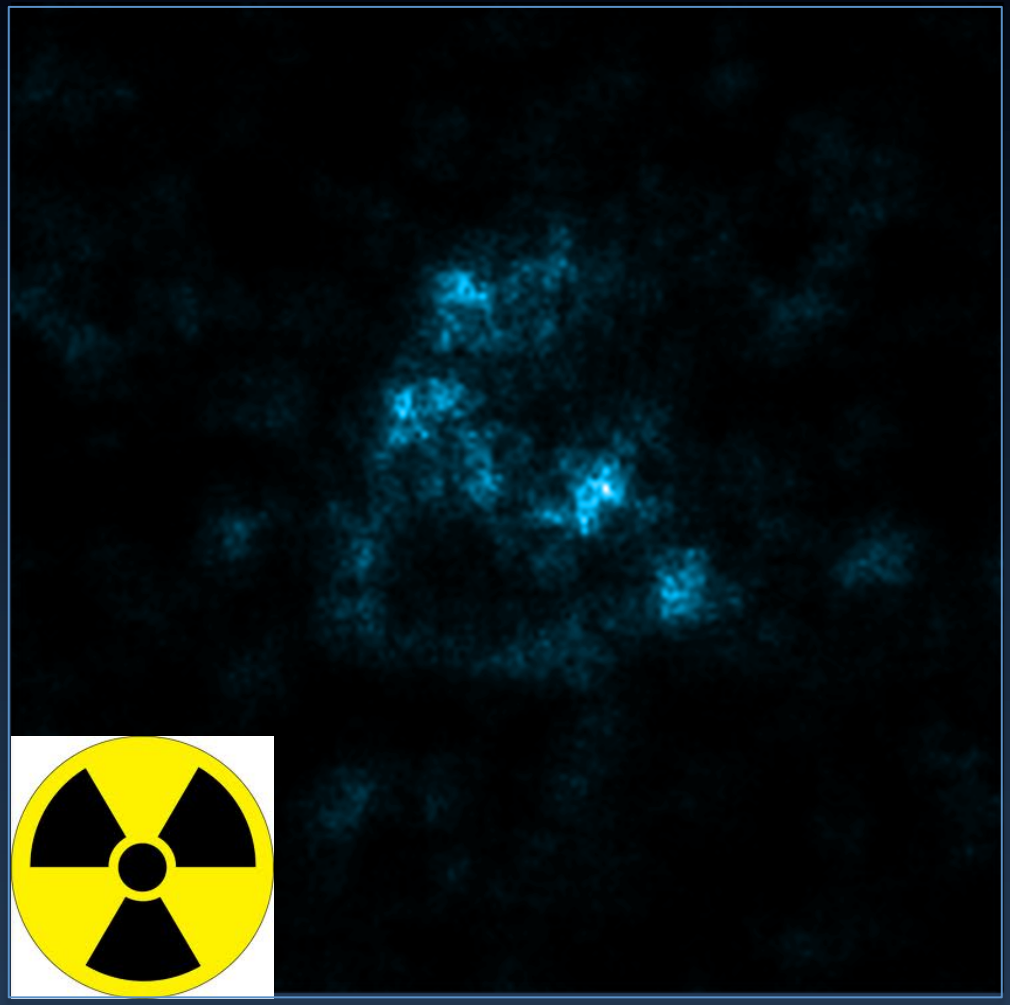


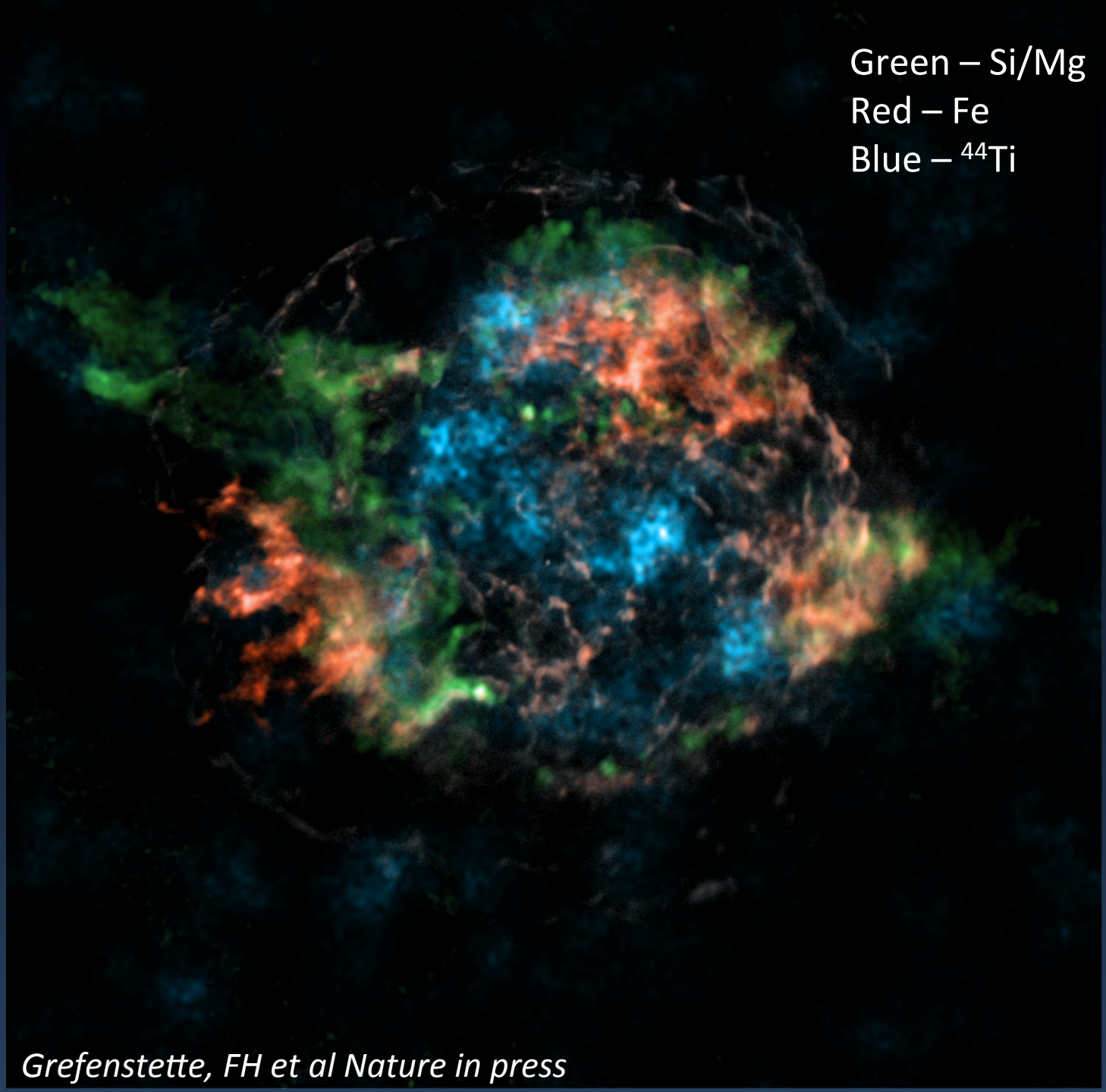
Silicon/Magnesium

Radioactive ^{44}Ti



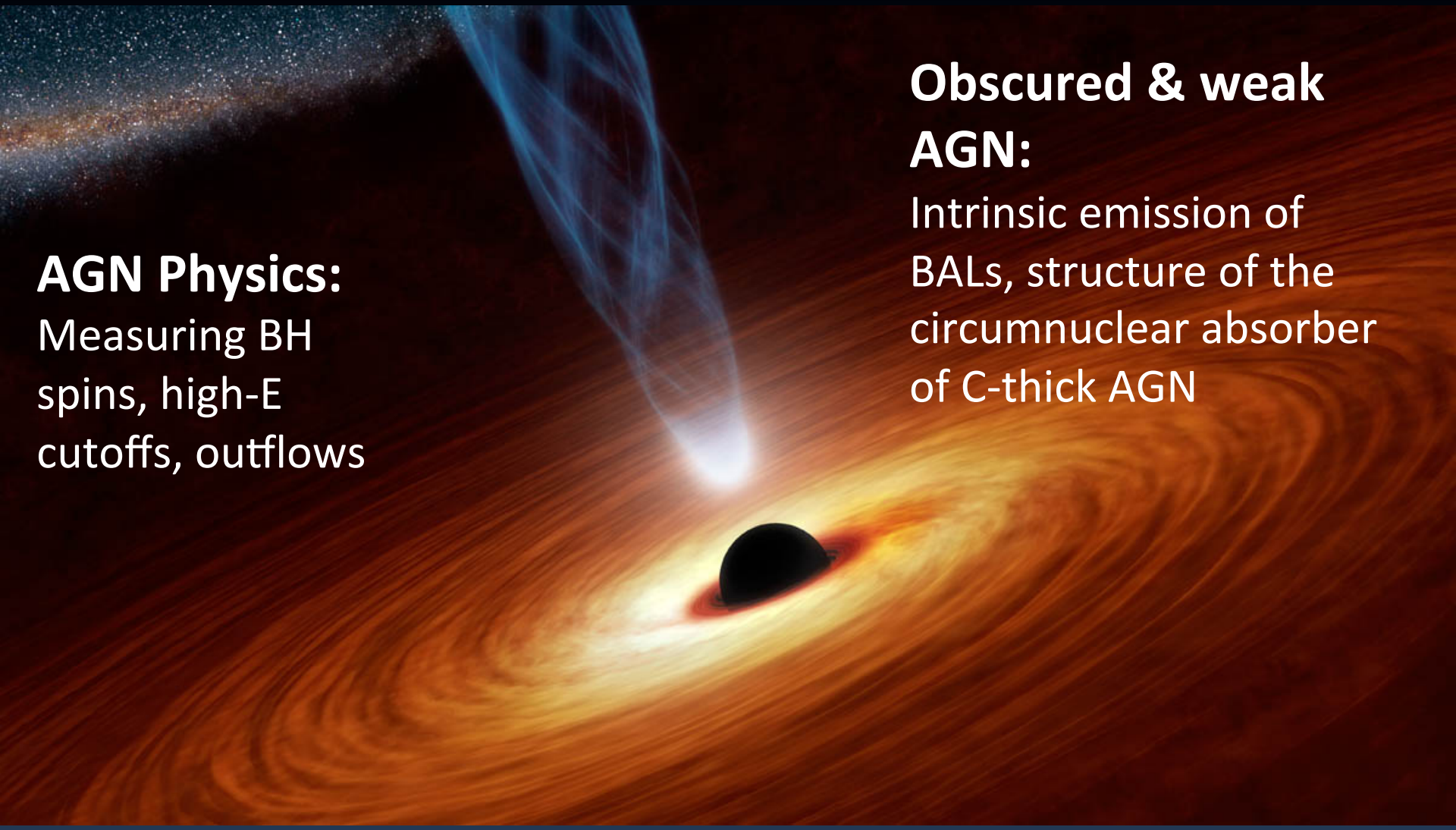
Cas A in Radioactivity





Grefenstette, FH et al Nature in press

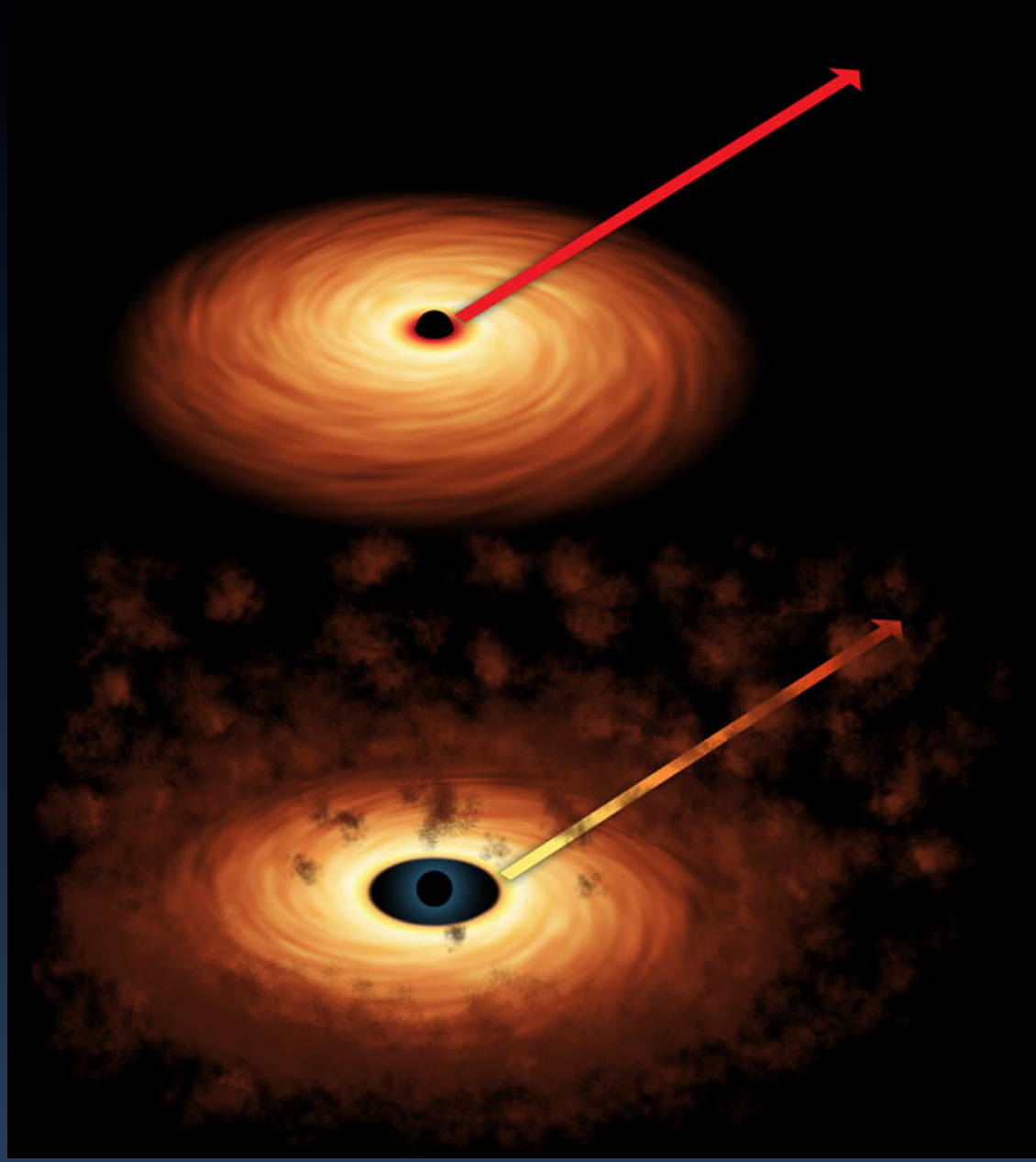
Active Galactic Nuclei



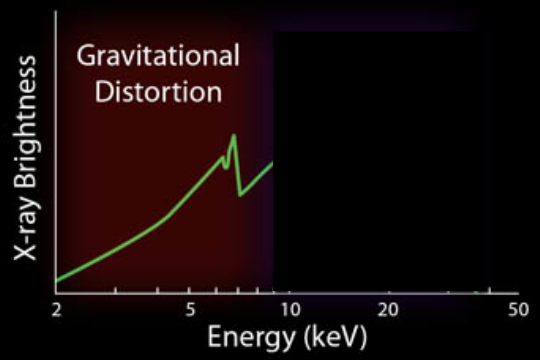
AGN Physics:
Measuring BH spins, high-E cutoffs, outflows

Obscured & weak AGN:
Intrinsic emission of BALs, structure of the circumnuclear absorber of C-thick AGN

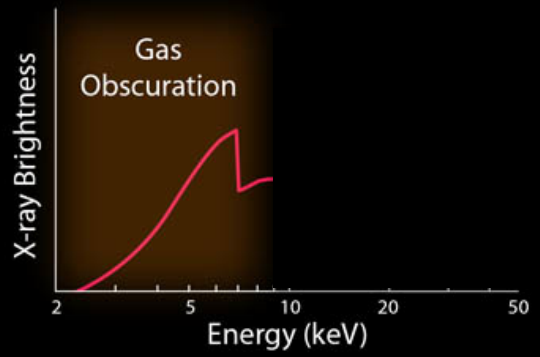
Measuring Black Hole spins



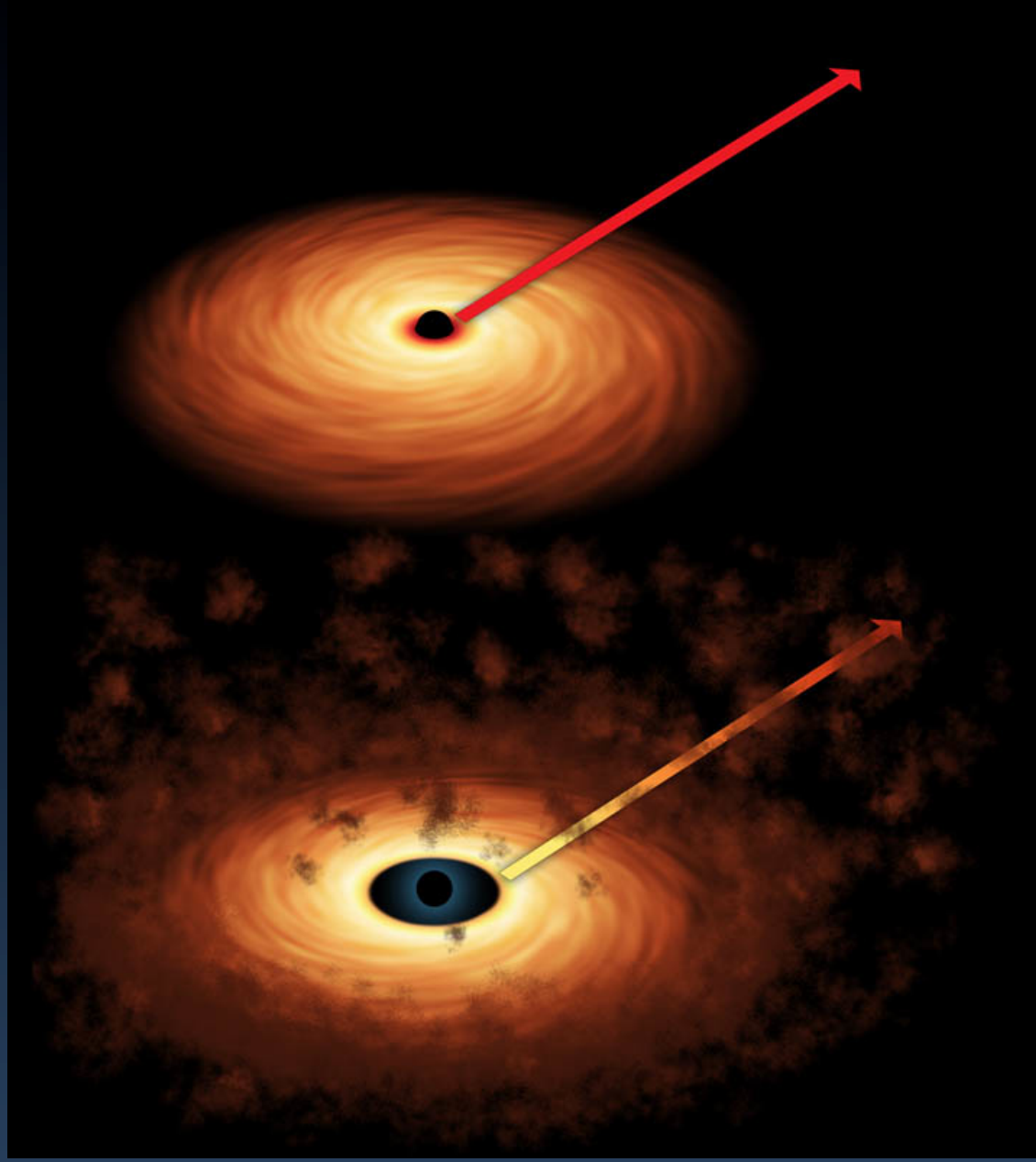
Prograde Rotation Model

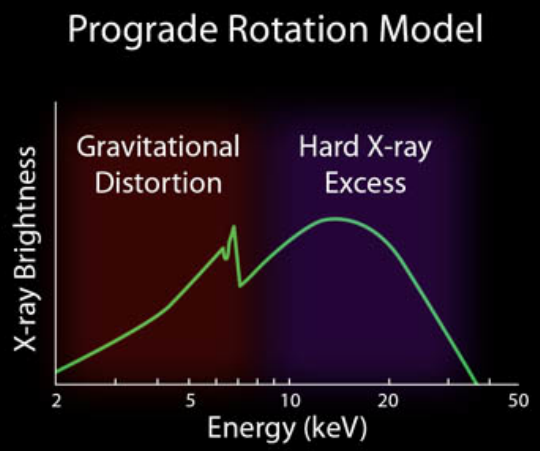


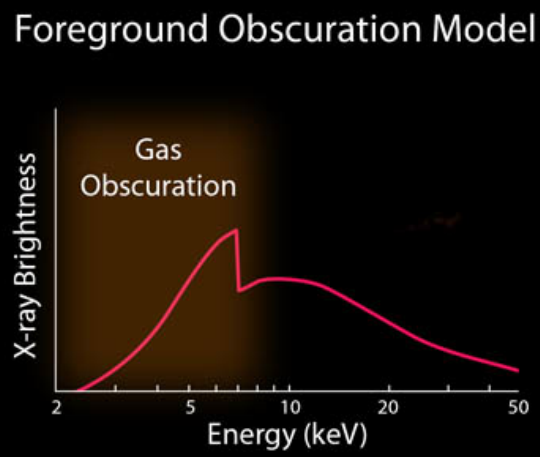
Foreground Obscuration Model



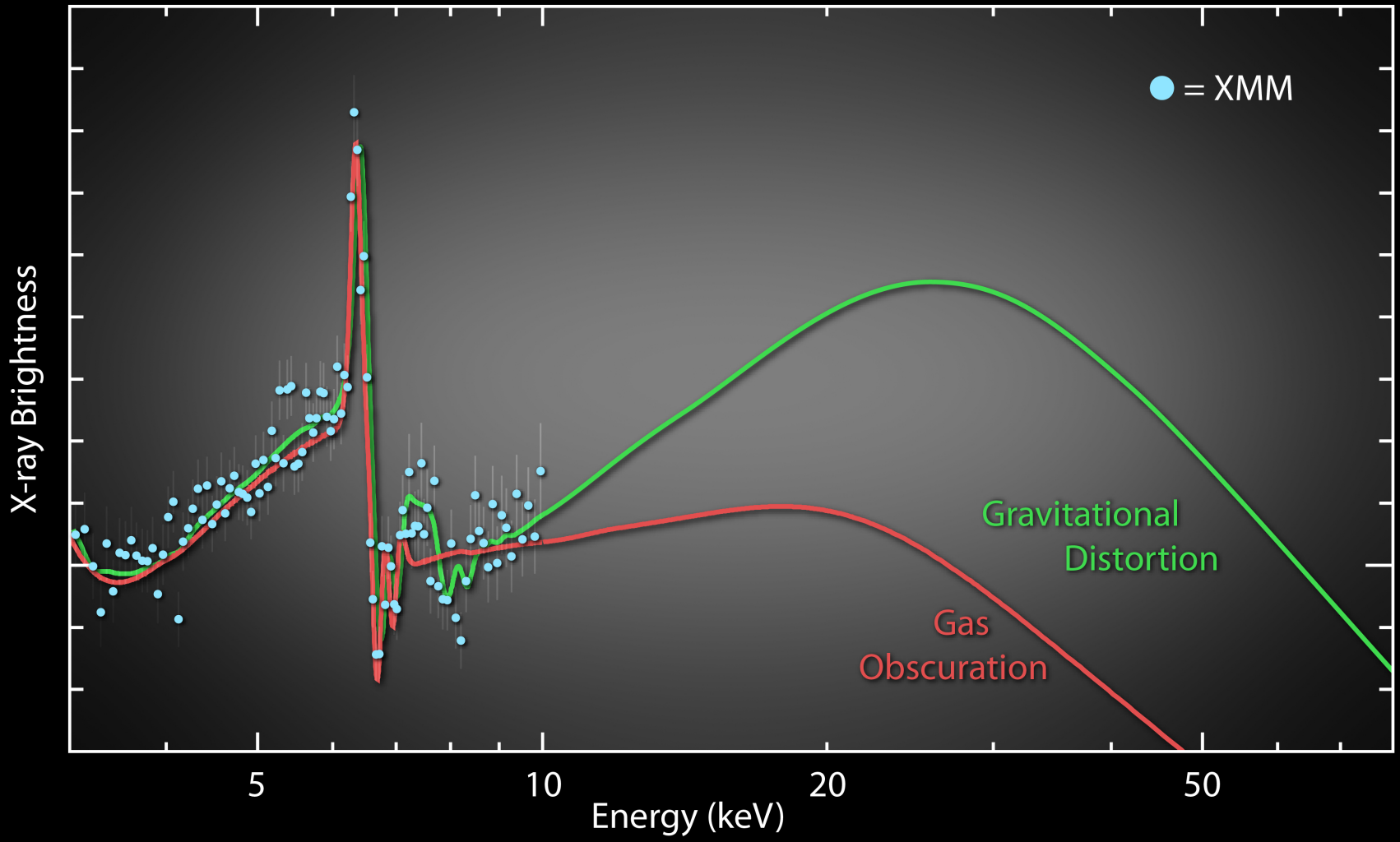
Measuring Black Hole spins



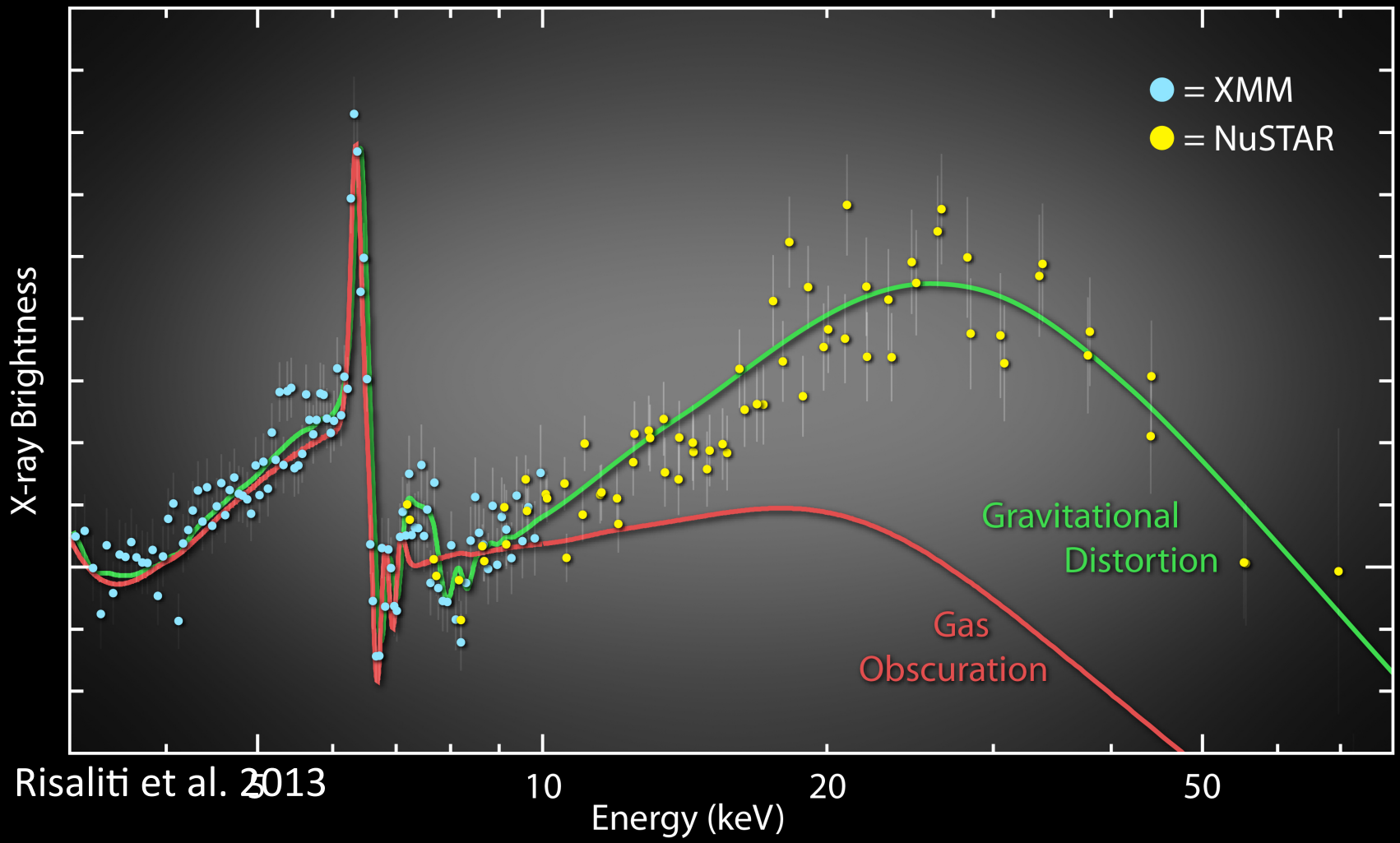




The case of NGC 1365: Fit to XMM data alone

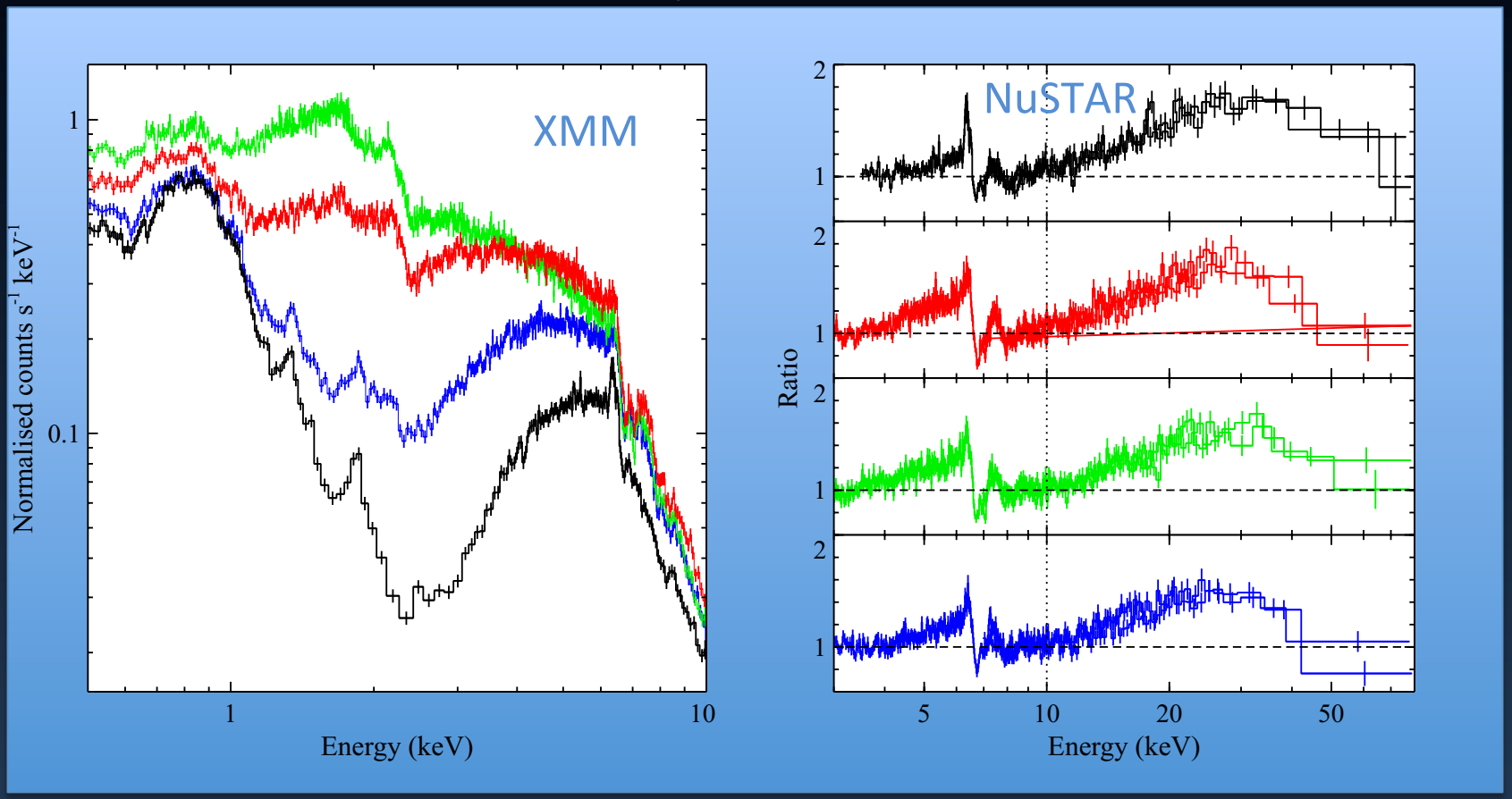


Fit adding NuSTAR data

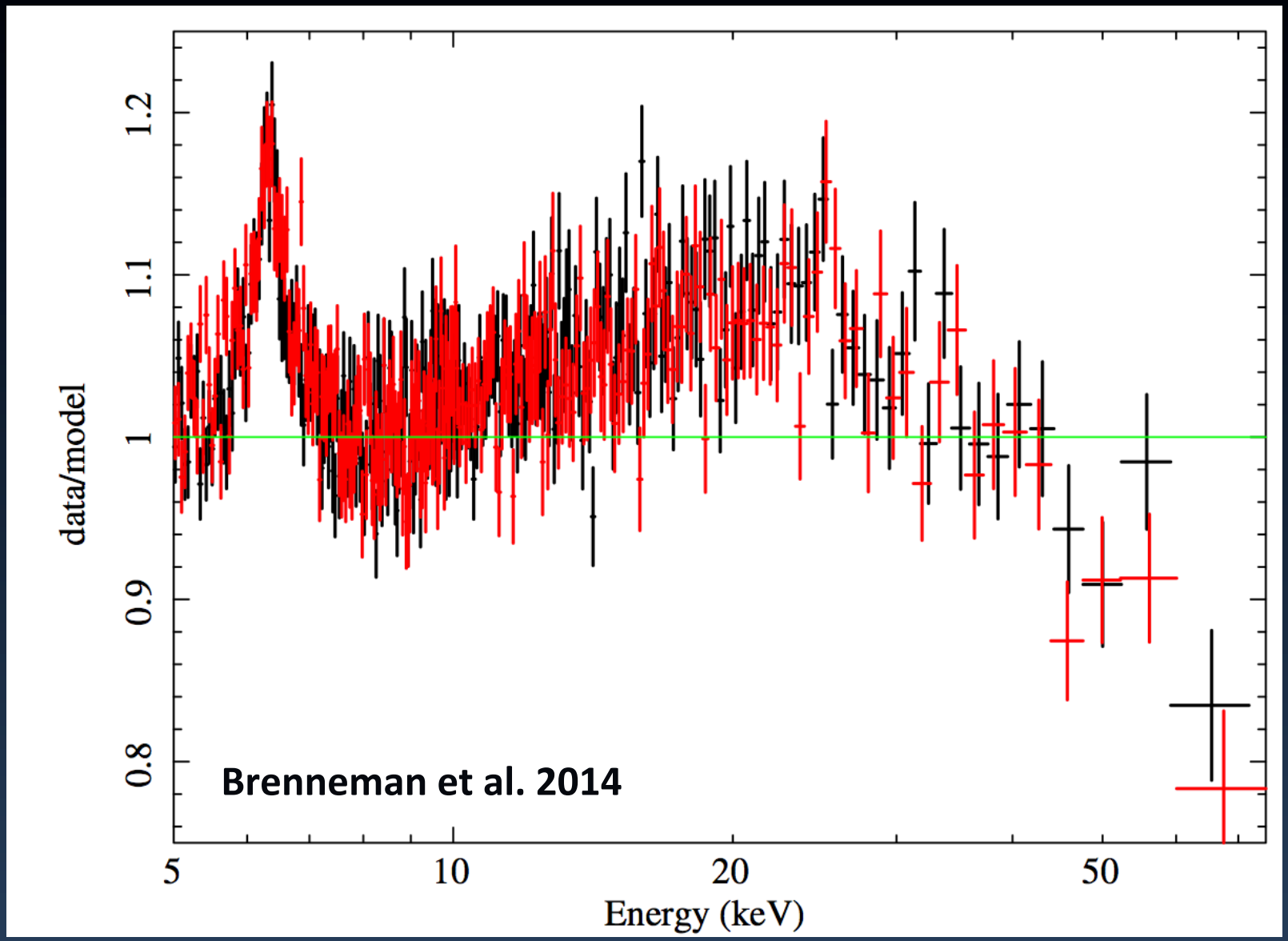


NGC 1365

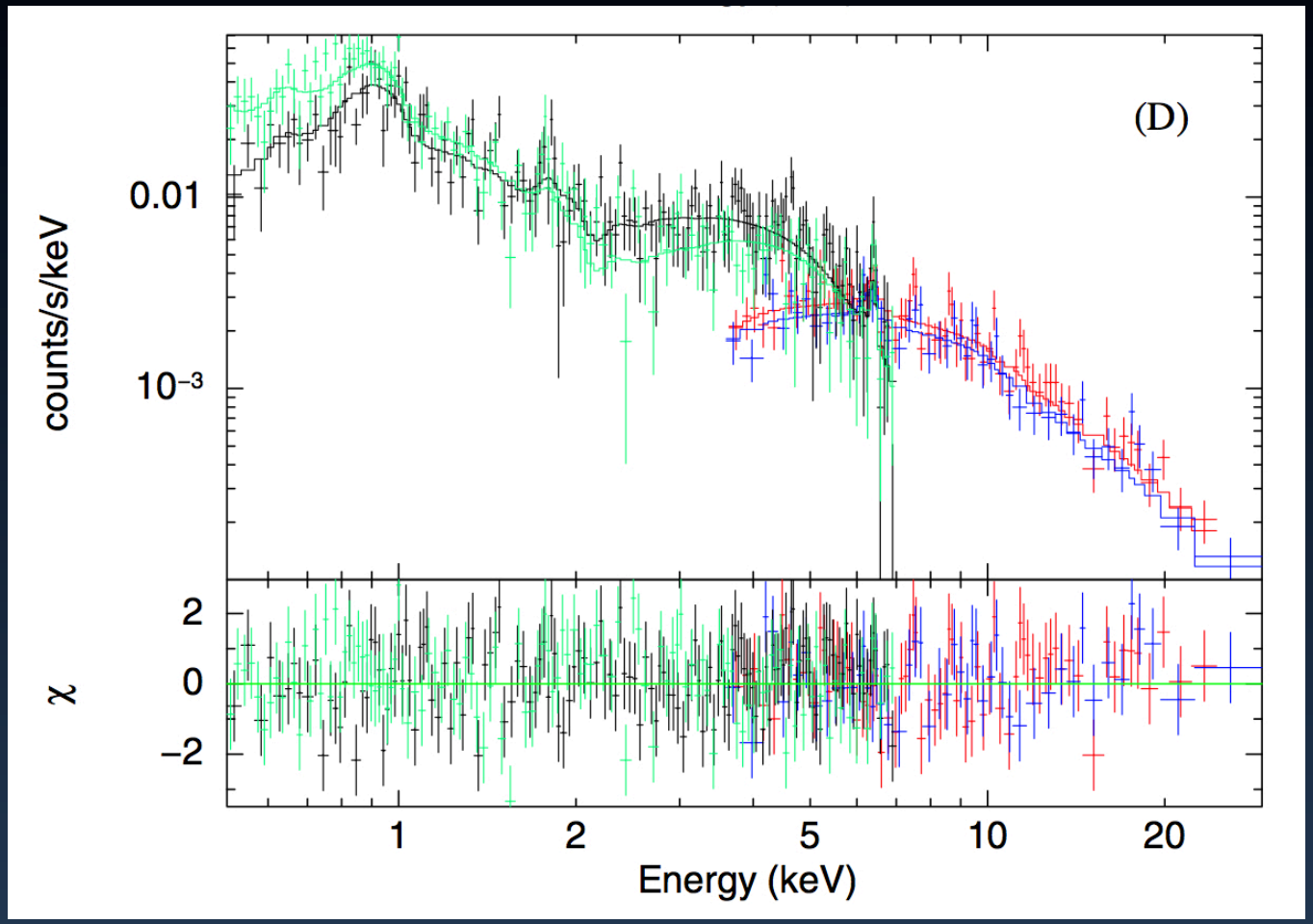
Walton, et al. 2014, MNRAS, accepted (arXiv 1404.5620)



Measuring the Coronal Properties of IC 4329A



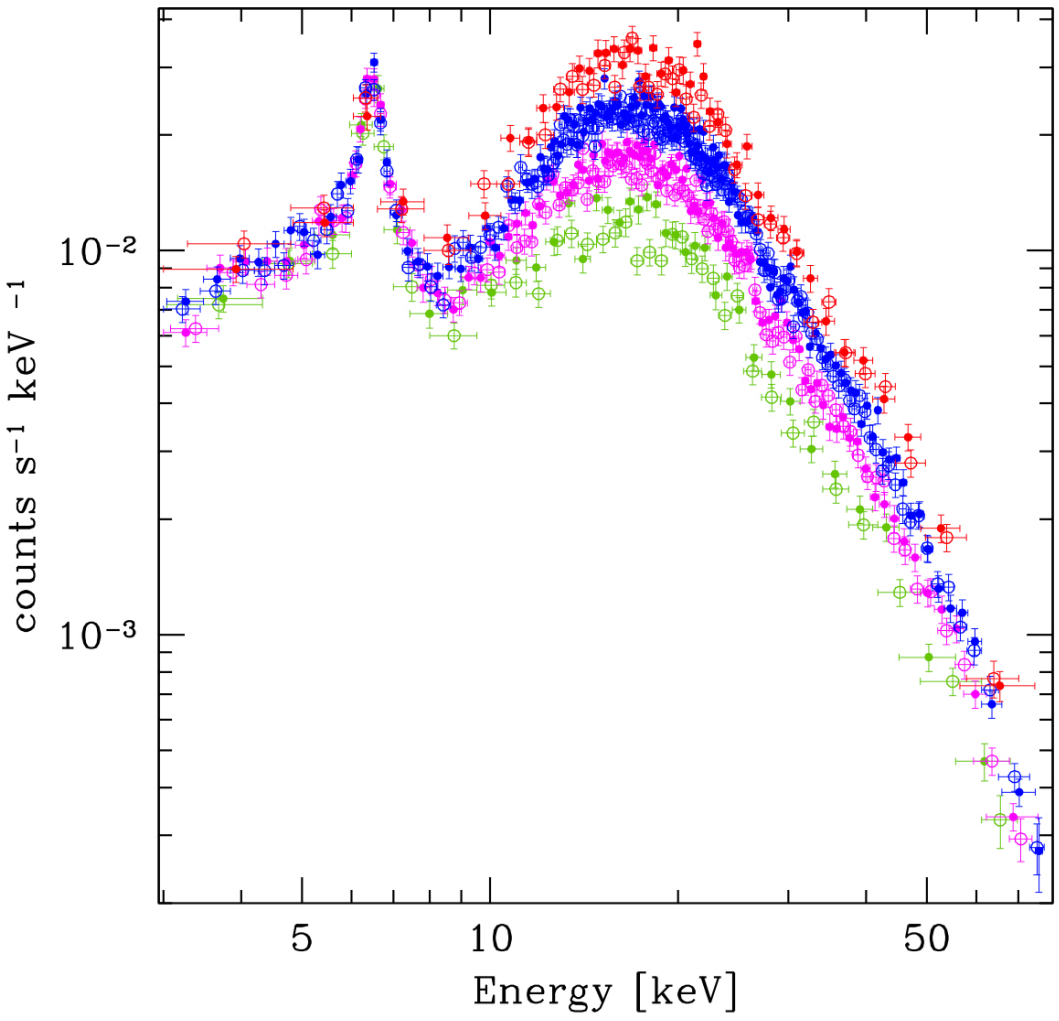
Obscured AGN and intrinsically X-ray weak AGN



Intrinsic X-ray weak emission in the ULIRG-Quasar-BAL Mrk 231

Teng et al. 2013

Obscured AGN and intrinsically X-ray weak AGN



A low covering factor “ring” around the C-thick AGN in NGC 4945

Puccetti et al. 2014, subm.

Summary & Future

- **NuSTAR is performing perfectly**
  Stable, well calibrated, easy to manage (TOOs, coordinated observations, etc…

- **Exciting Scientific results & new discoveries**
  ~50 scientific papers, big impact

- **NASA approval for two-year extension expected any moment (cross fingers…)**

- **If extended, GO program for 2015-2016**