Using 1E 0102.2-7219 and N132D as Standard Candles

Paul Plucinsky on behalf of the IACHEC Thermal SNR Working Group

Thermal SNR Working Group

One of the "Standard candle" working groups.

This presentation is a summary report of this group's work:

XMM-Newton RGS	Andy Pollock & Matteo Guainazzi (ESAC)
Chandra HETG	Dan Dewey (MIT)
XMM-Newton MOS	Steve Sembay (Leicester)
XMM-Newton pn	Frank Haberl (MPE)
Chandra ACIS	Joe DePasquale, Paul Plucinsky (SAO)
Suzaku XIS	Eric Miller (MIT)
Swift XRT	Andrew Beardmore (Leicester)
Models	Randall Smith (SAO)

Chandra X-Ray Observatory

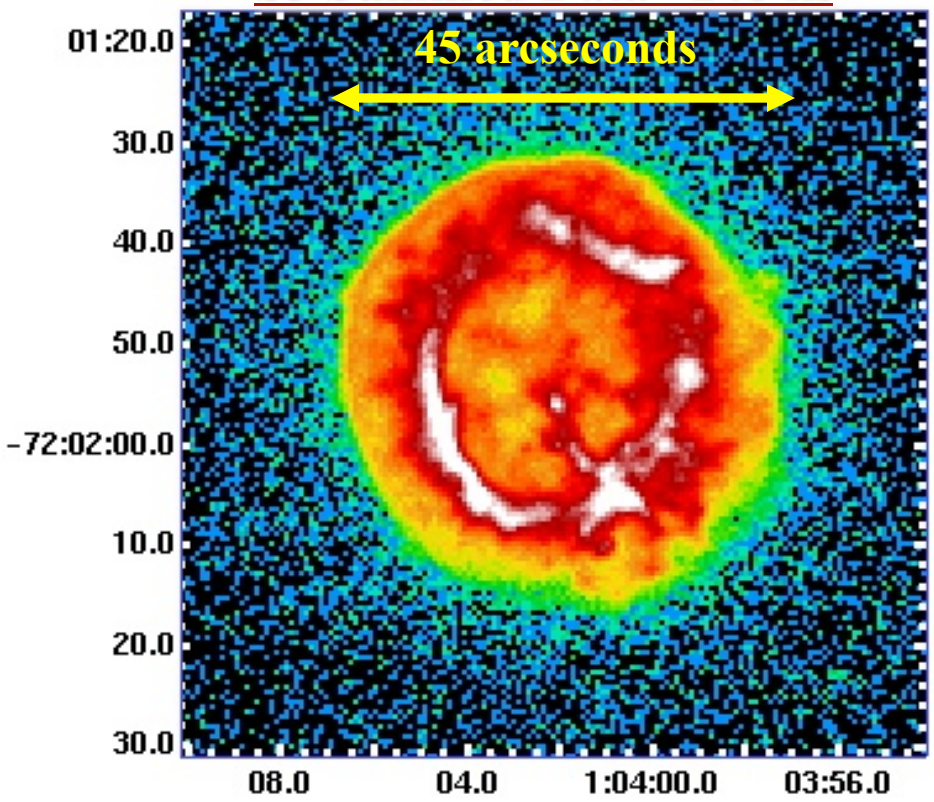
CXC

E0102 "The Nearly Perfect Calibration Source"

- Simple morphology - but significant spectral variations as a function of position
- Extended source - minimizes pileup, small size minimizes impact of PSF effects
- Simple spectrum – very little or perhaps no Fe !
- Constant – very little time variability

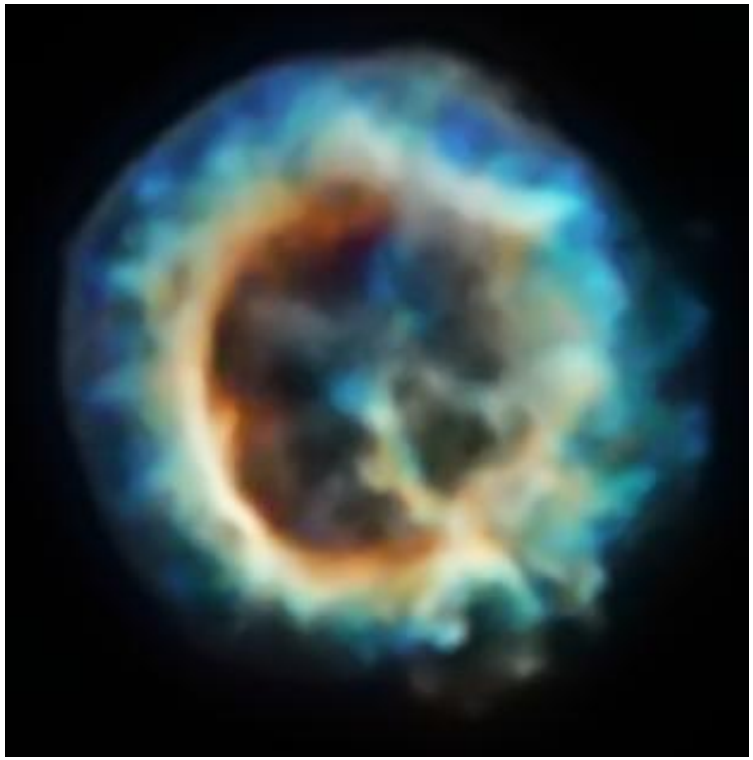
DePasquale (SAO)

S3 Summed Data ~248 ks

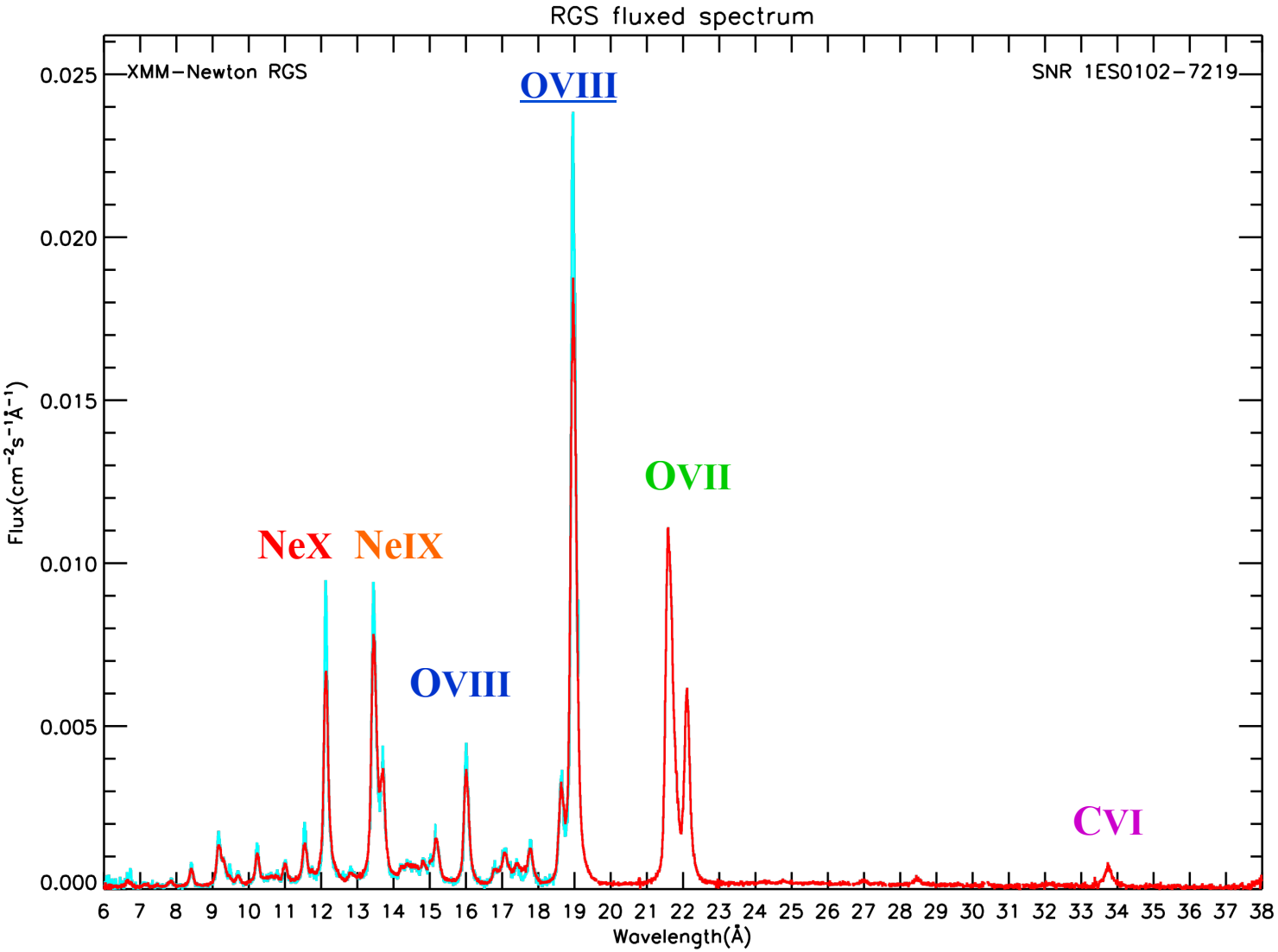


Three Color Image

Red: 0.2-0.75 keV, Green: 0.8-1.1 keV, Blue: 1.1-2.0 keV



XMM-Newton RGS Spectrum of E0102:



Pollock (ESAC)

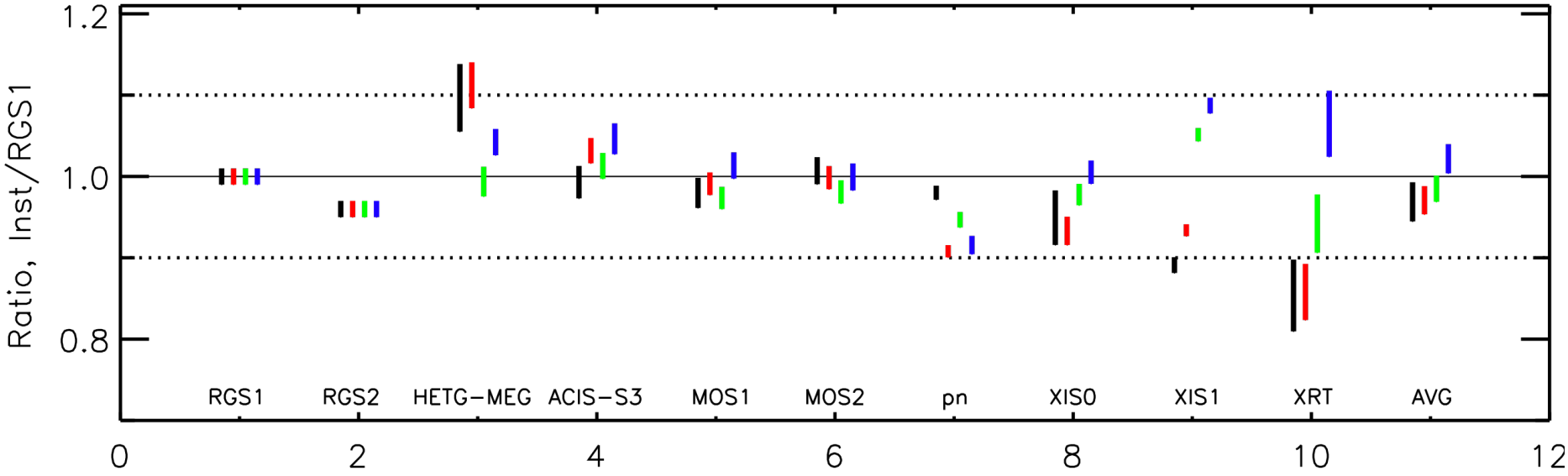
Relatively simple spectrum dominated by O & Ne,

little or no Fe emission

Comparison of Fluxes for Bright Line Complexes:

- Thermal SNR WG developed a standard IACHEC model used by all instrument teams
- Results published in 2008 SPIE (Plucinsky et al. 2008, SPIE, Vol. 7011, arXiv:0807:2176)
- Only 5 or 7 free parameters, normalizations for the OVII triplet (560-574 eV), the OVIII Ly-a (654 eV), the NeIX triplet (905-922 eV), and the NeX Ly-alpha line (1022 eV) and gain for some of the instruments
- Fitted normalizations for the OVII, OVIII, NeIX, and NeX line complexes agree to +/- 10%
- Plot below has updated values for ACIS since 2008 paper due to a revised contamination model

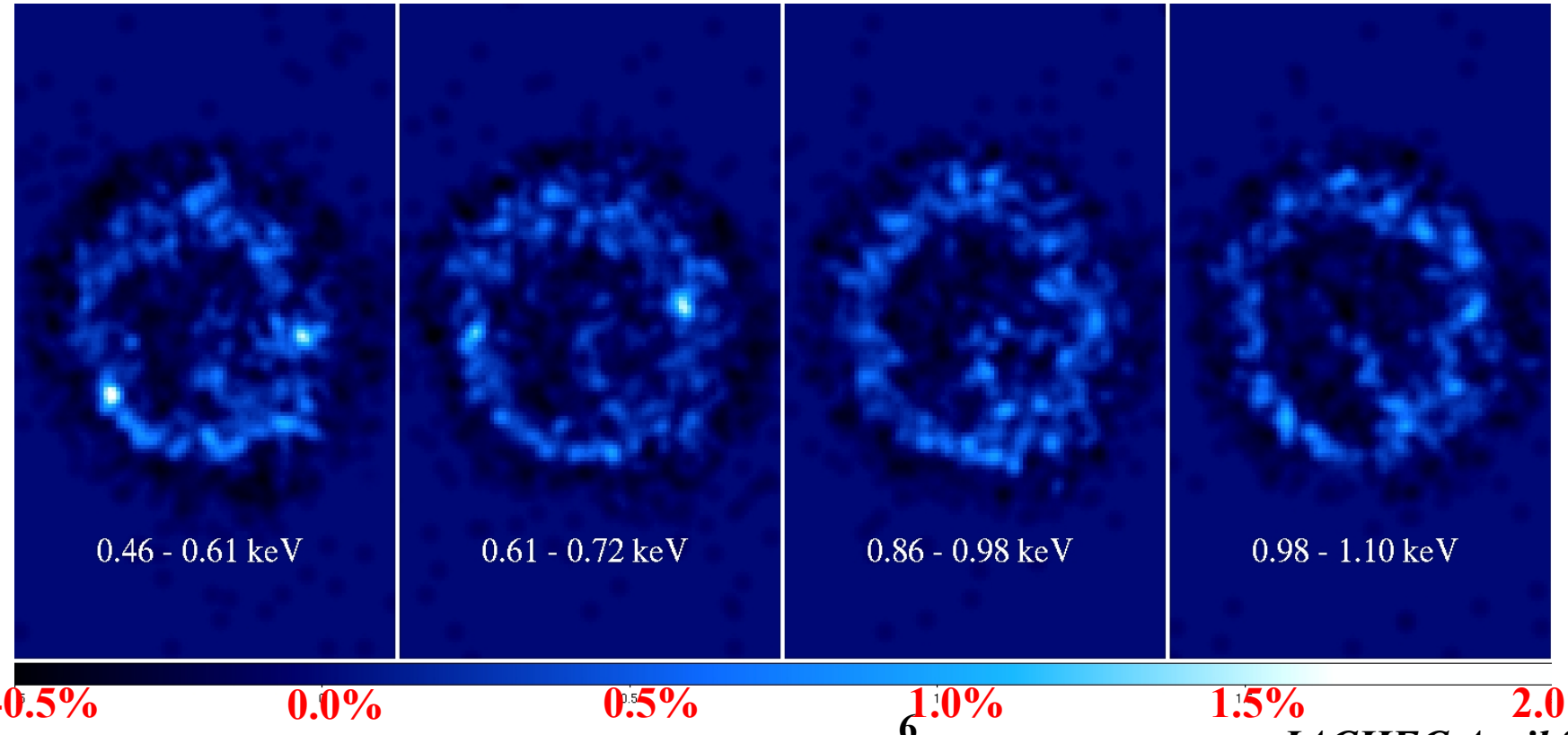
OVII black **OVIII red** **NeIX green** **NeX blue** ***DePasquale(SAO)***



Is E0102's X-ray Emission Constant in Time ?

- Hughes et al. 2000, measure an expansion rate of 0.1%/yr comparing to ROSAT data over a 20 yr baseline
- XMM pn measured total flux has been consistent within +/- 1.3%

DePasquale(SAO)



What is Left to be Done ?

• 2008 analysis included only a subset of data from mostly early in the respective missions. There are considerably more data at later times that should be analyzed and compared in a similar manner.

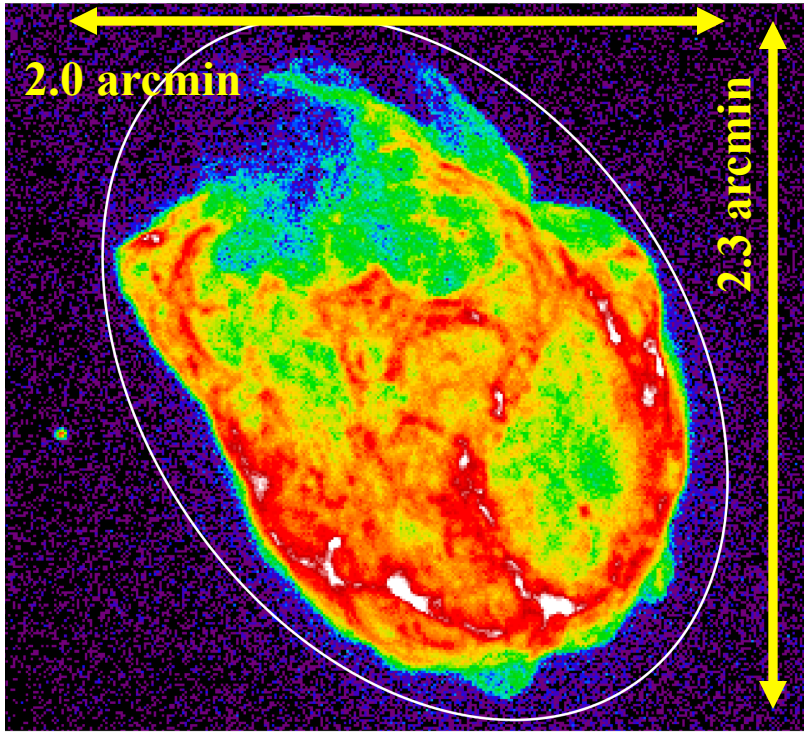
• lingering issues with the spectral model, there are weak features that have been identified as Fe lines but if these lines are present there should be other lines of Fe

• fitting methodology – should the IACHEC take the lead in using the C statistic to encourage the community to adopt the C statistic as the default ? ** Should be discussed by the entire IACHEC **

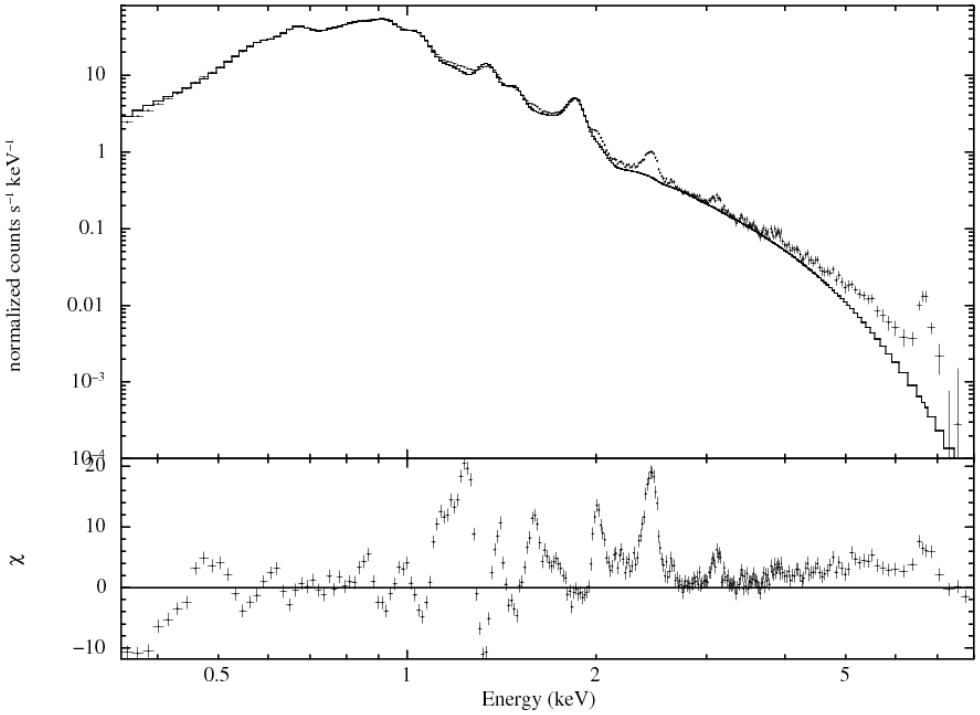
• new analysis should be an A&A paper like our G21.5-0.9 paper by Tsujimoto et al. 2010

N132D: Brightest SNR in the LMC

- spatial, larger than E0102 and more complicated, absorption varies significantly across the remnant
- spectrum is significantly more complicated due to significant Fe emission, but RGS data provide a lot of information on the lines in the 0.5-2.0 keV band



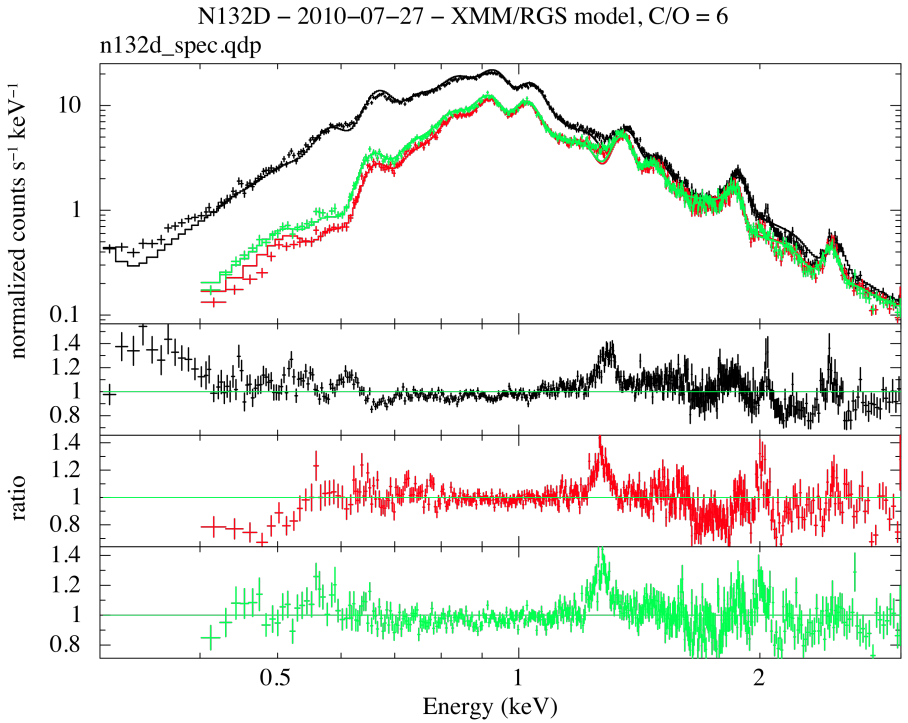
ACIS S3: 89 ks, fit with RGS model

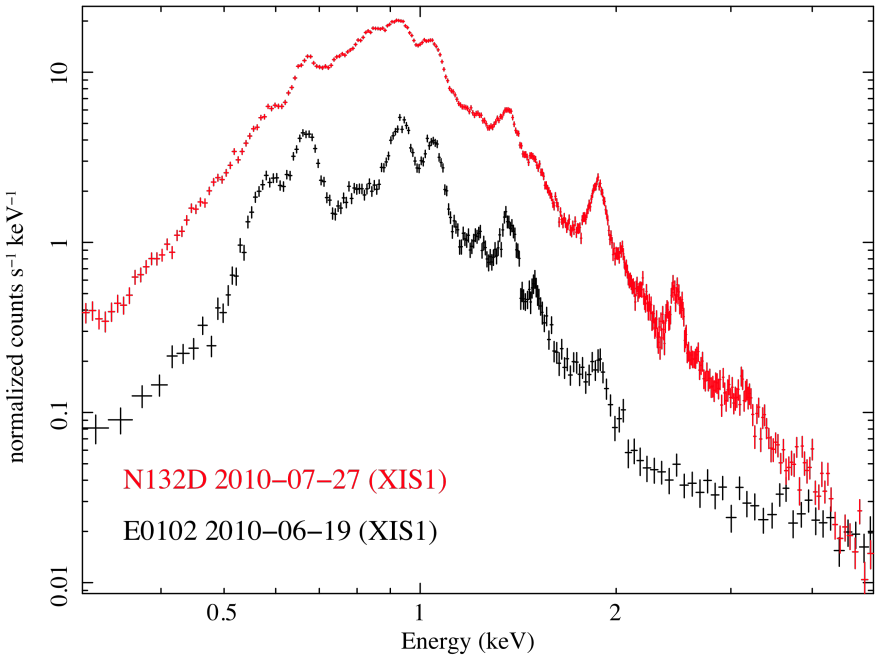


Suzaku Specturm of N132D

- Suzaku specturm with RGS model folded through, E0102 spectrum shown for reference
- agreeing on a "IACHEC standard" model will require significantly more work than with E0102

Miller(MIT)





Summary

1 E0102-7219:

- Analysis is mature, some work still needs to be done, but we should have the standard model and results on the normalizations of the bright line complexes published in an A&A paper

N132D:

- effort to develop a standard model is just beginning in earnest
- more difficult task than E0102 but hopefully we have learned from the E0102 process