

# Leveraging High Resolution Spectroscopy to Understand the Disk and Relativistic Iron Line of Cygnus X-1

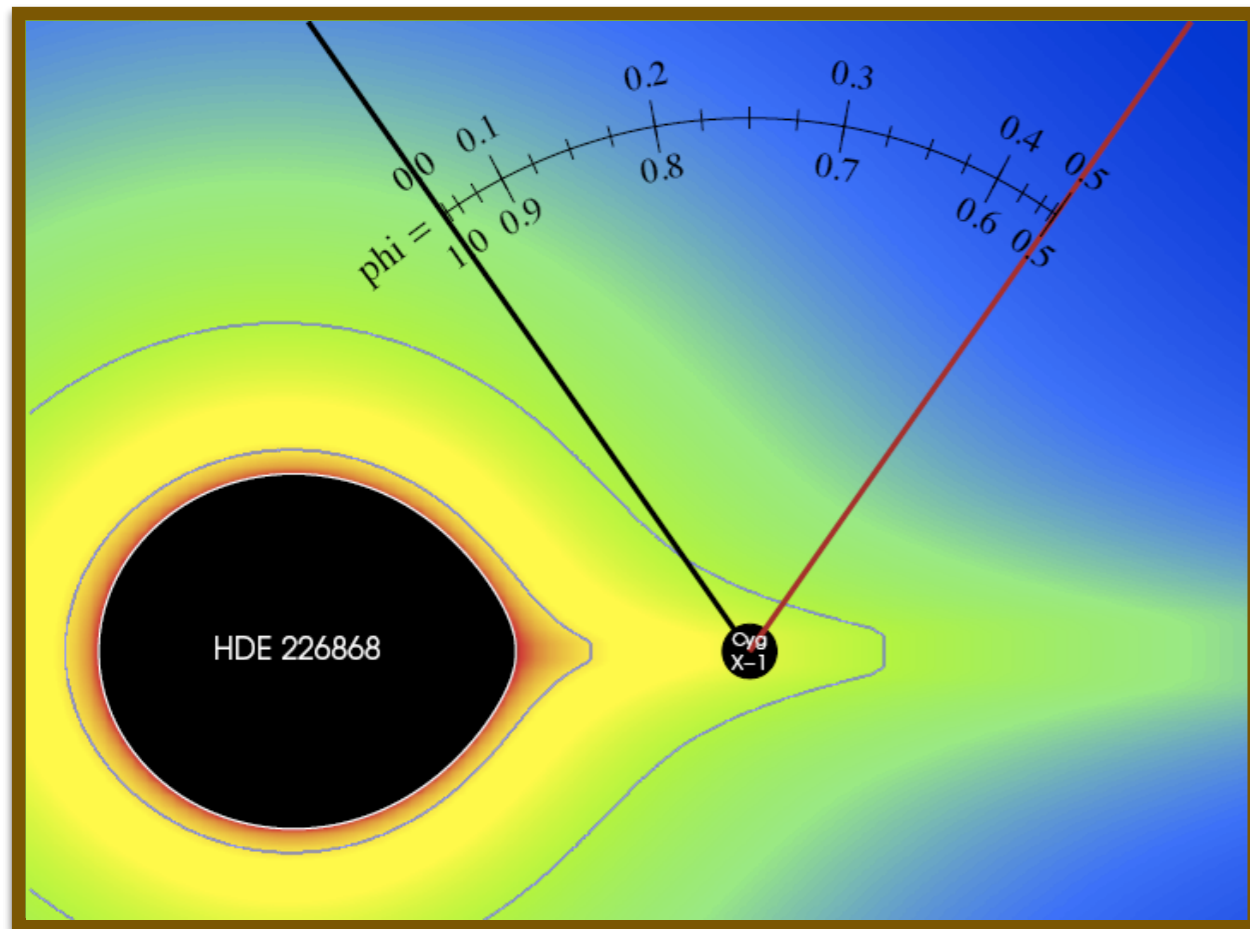
Michael A. Nowak (MIT-Kavli Institute for Astrophysics and Space Research )

-with-

Jörn Wilms, Katja Pottschmidt, Victoria Grinberg, Norbert Schulz, & Lia Corrales

# Messy Astrophysics:

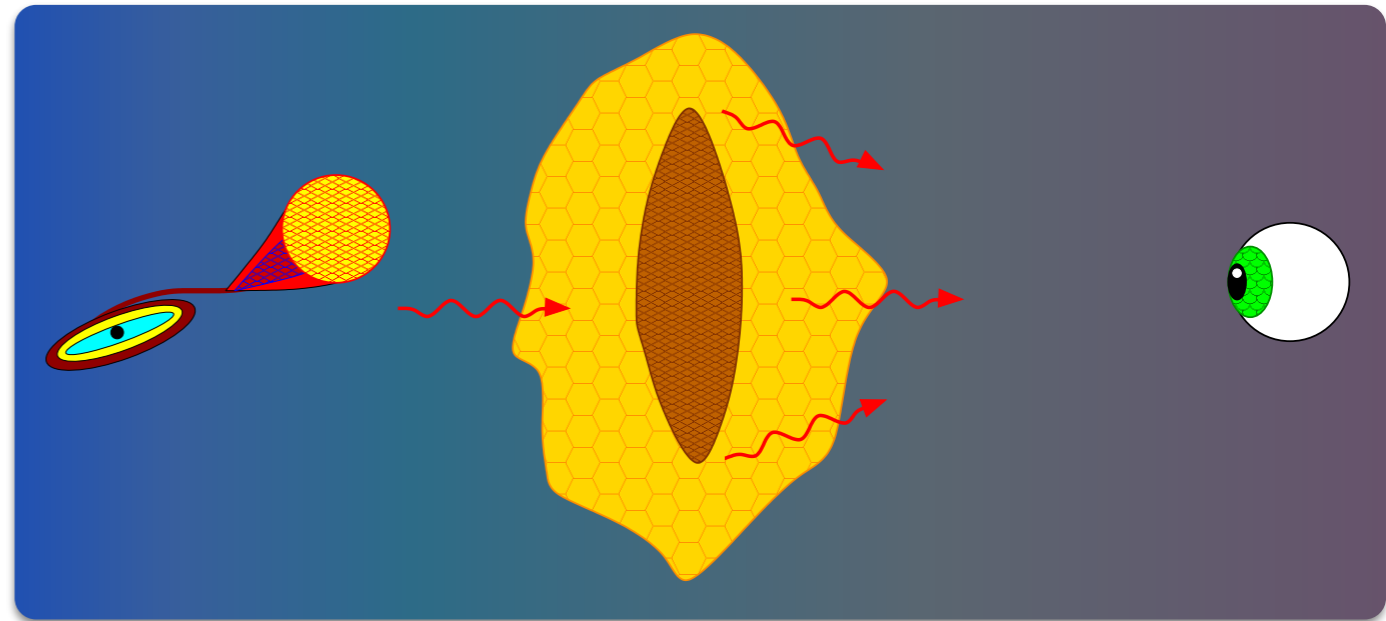
## *Stellar Winds:*



(Hanke et al. 2009, ApJ, 690, 330)

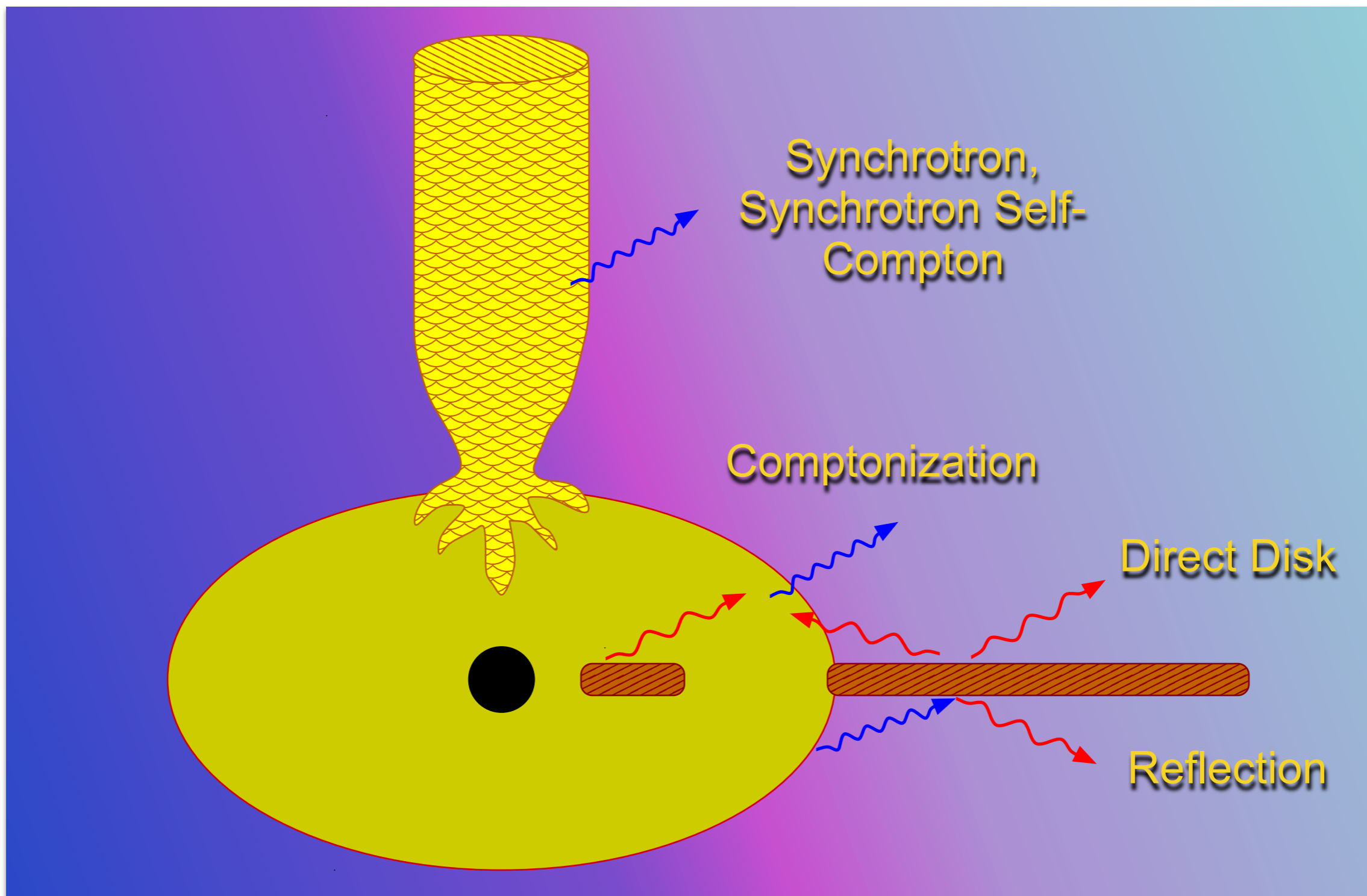
Poster: D03, V. Grinberg

## *Dust Halos:*



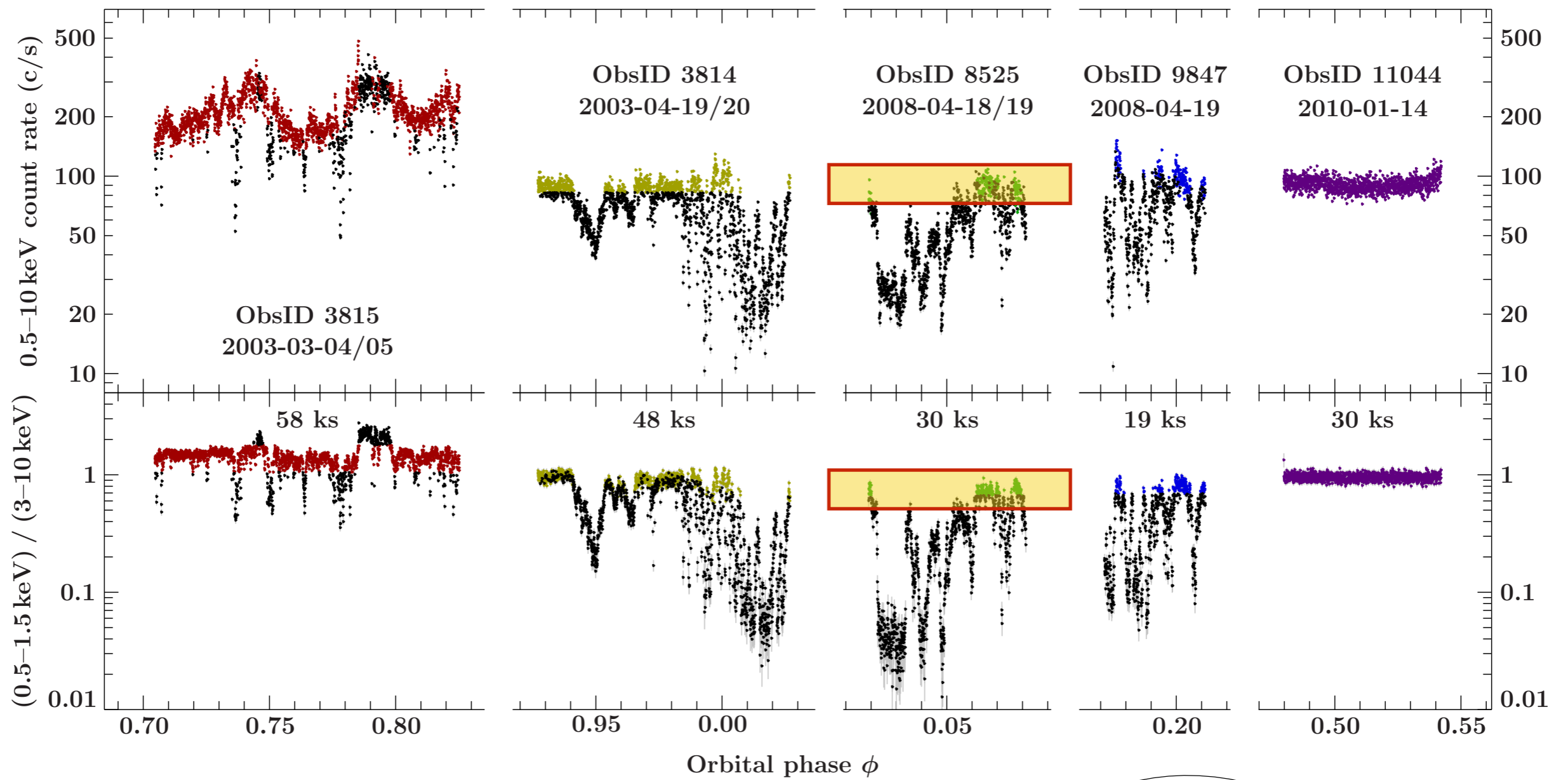
Poster: B03, L. Corrales

# The Question:

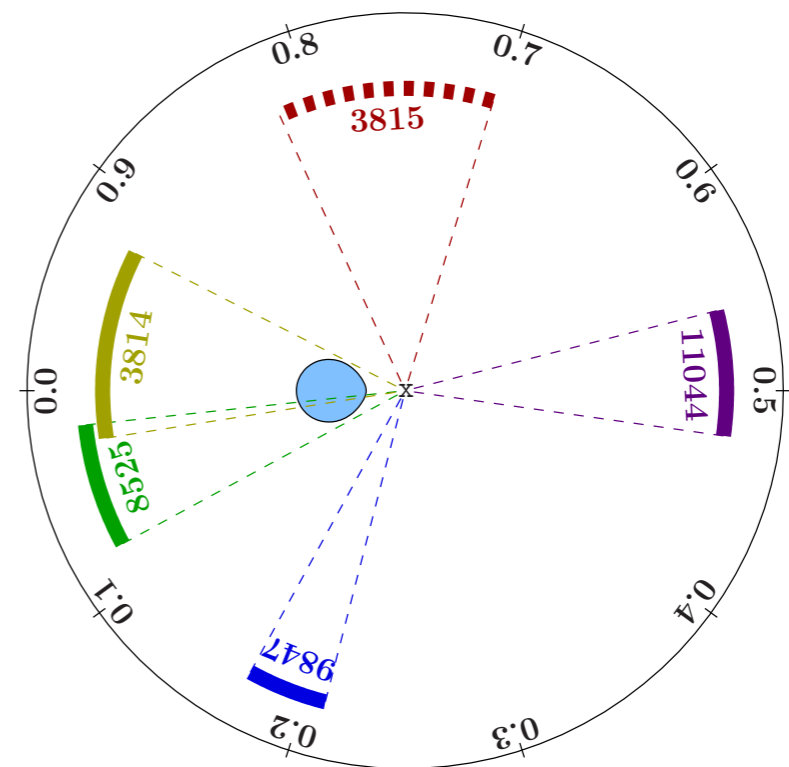


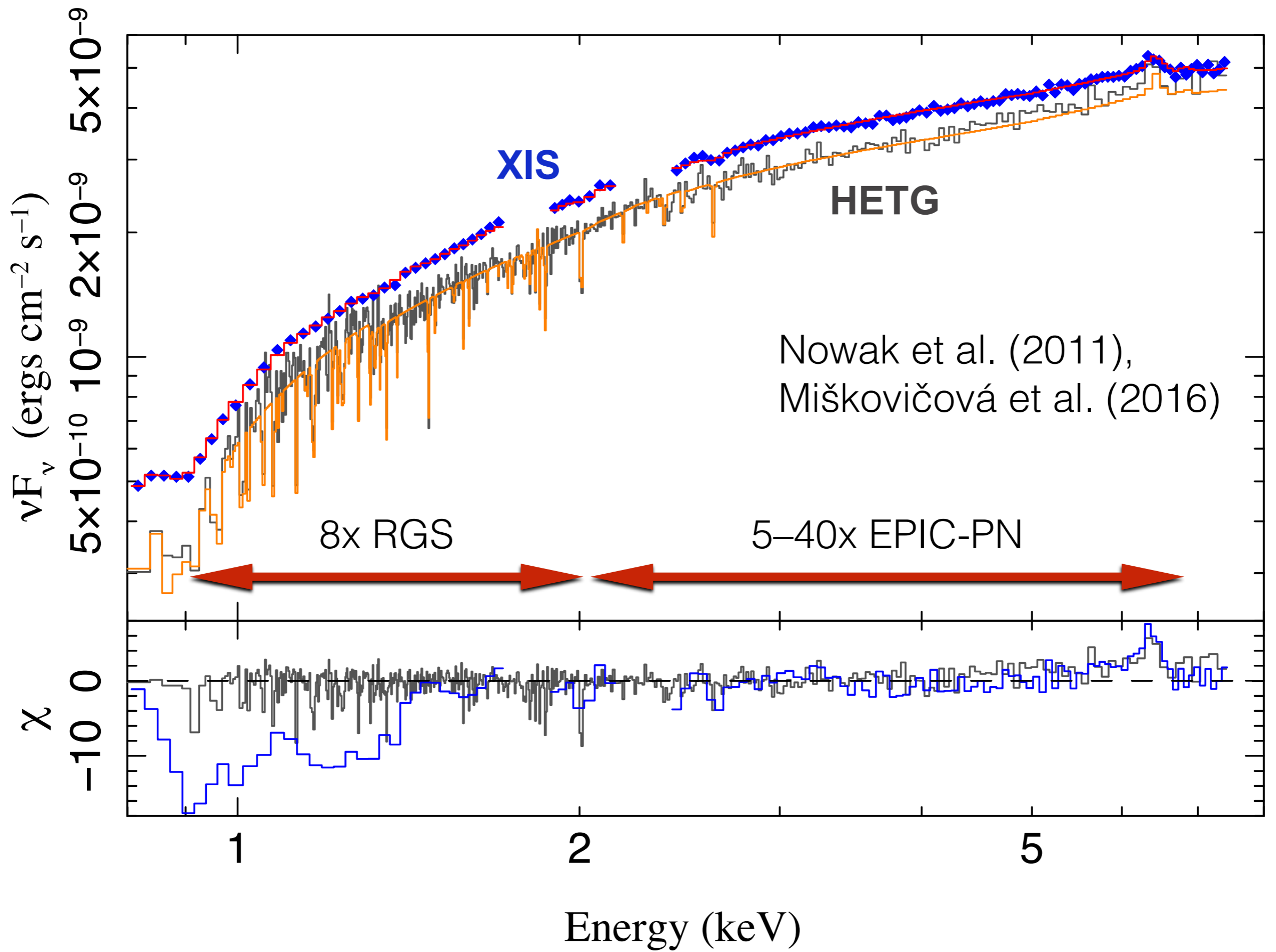
# The Campaigns:

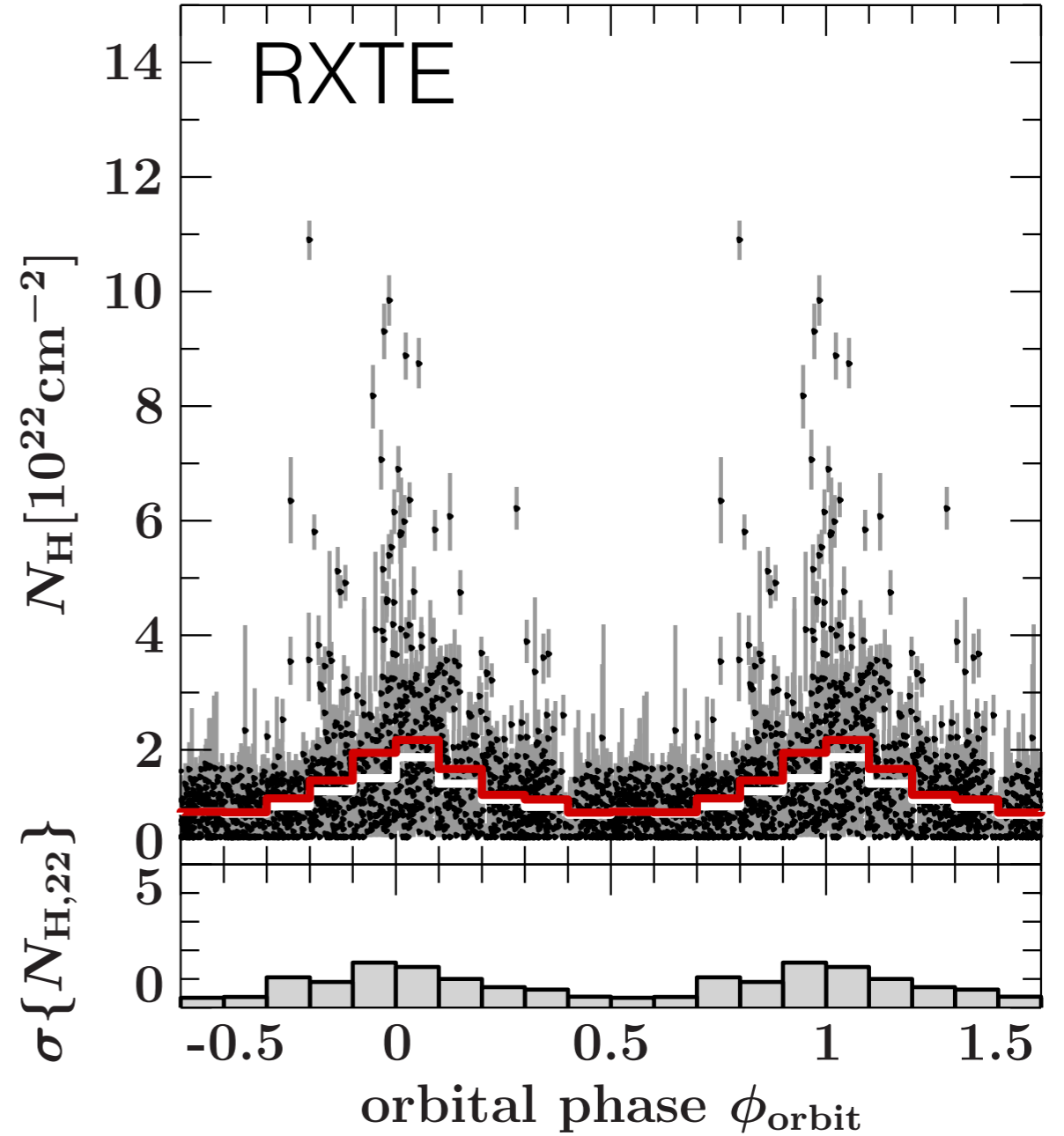
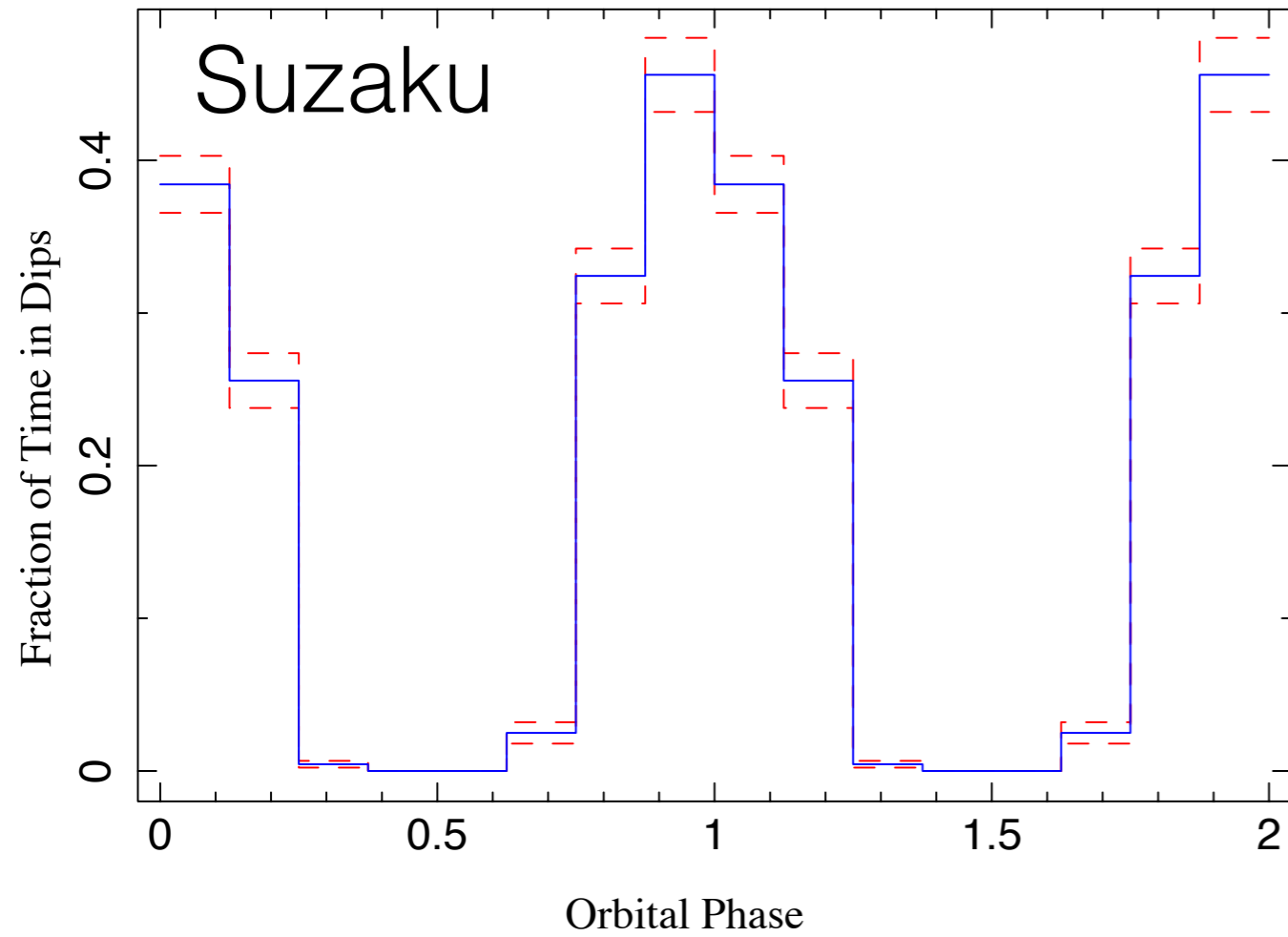
- Two Campaigns – Pointed Observation(s) & Monitoring
  - Wilms & Nowak: April 2008, Orbital Phase 0, *All X-ray Satellites*
  - J. Miller: 24 Suzaku Observations, *All Orbital Phases*
  - *Spectrally Hard States Throughout*
- Suzaku: Best CCD Resolution & Broad Band, 0.5 — 600 keV



Miškovičová et al. (2016),  
Chandra-HETG,  
Hard & Intermediate  
States Mixed

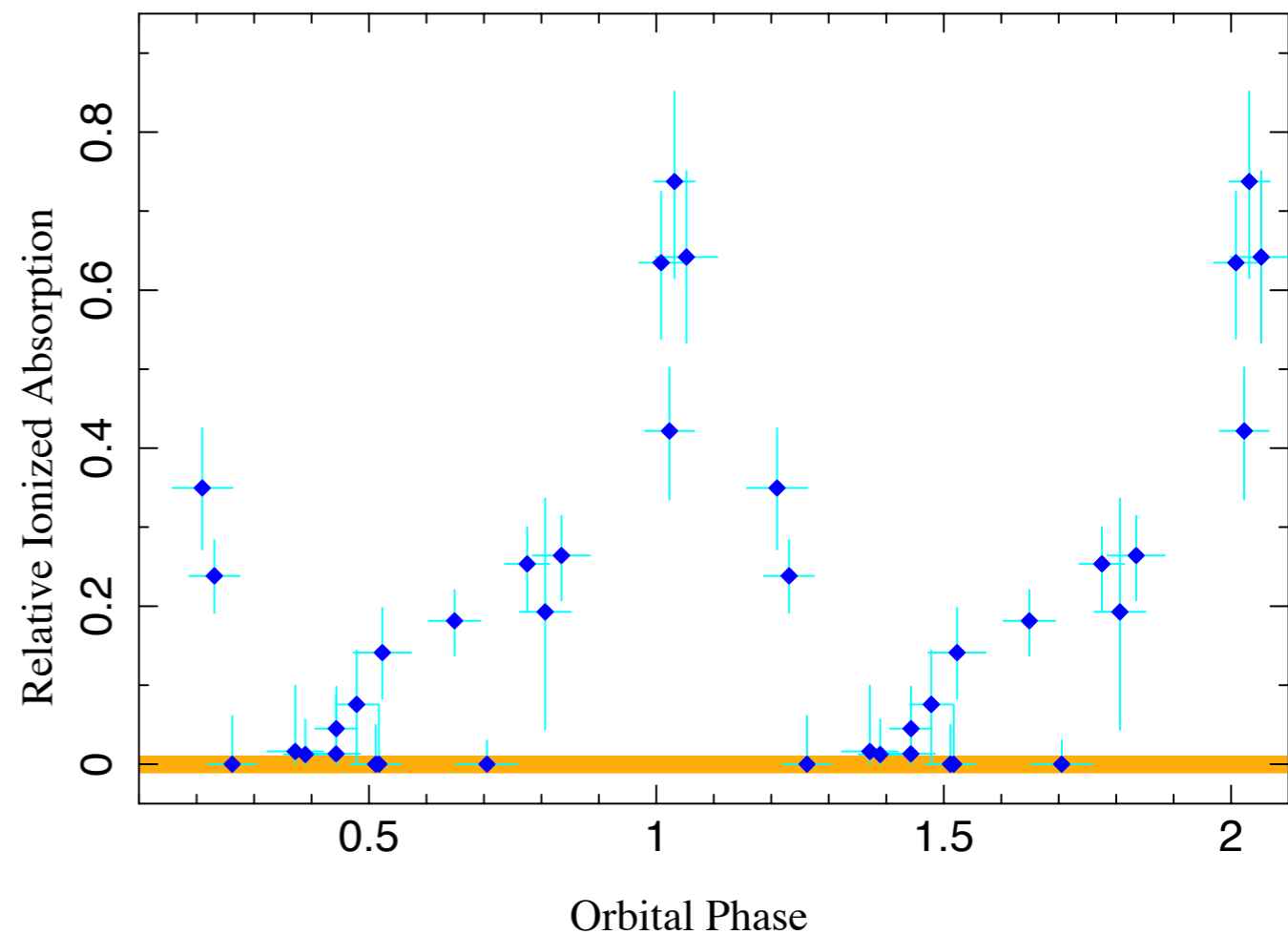
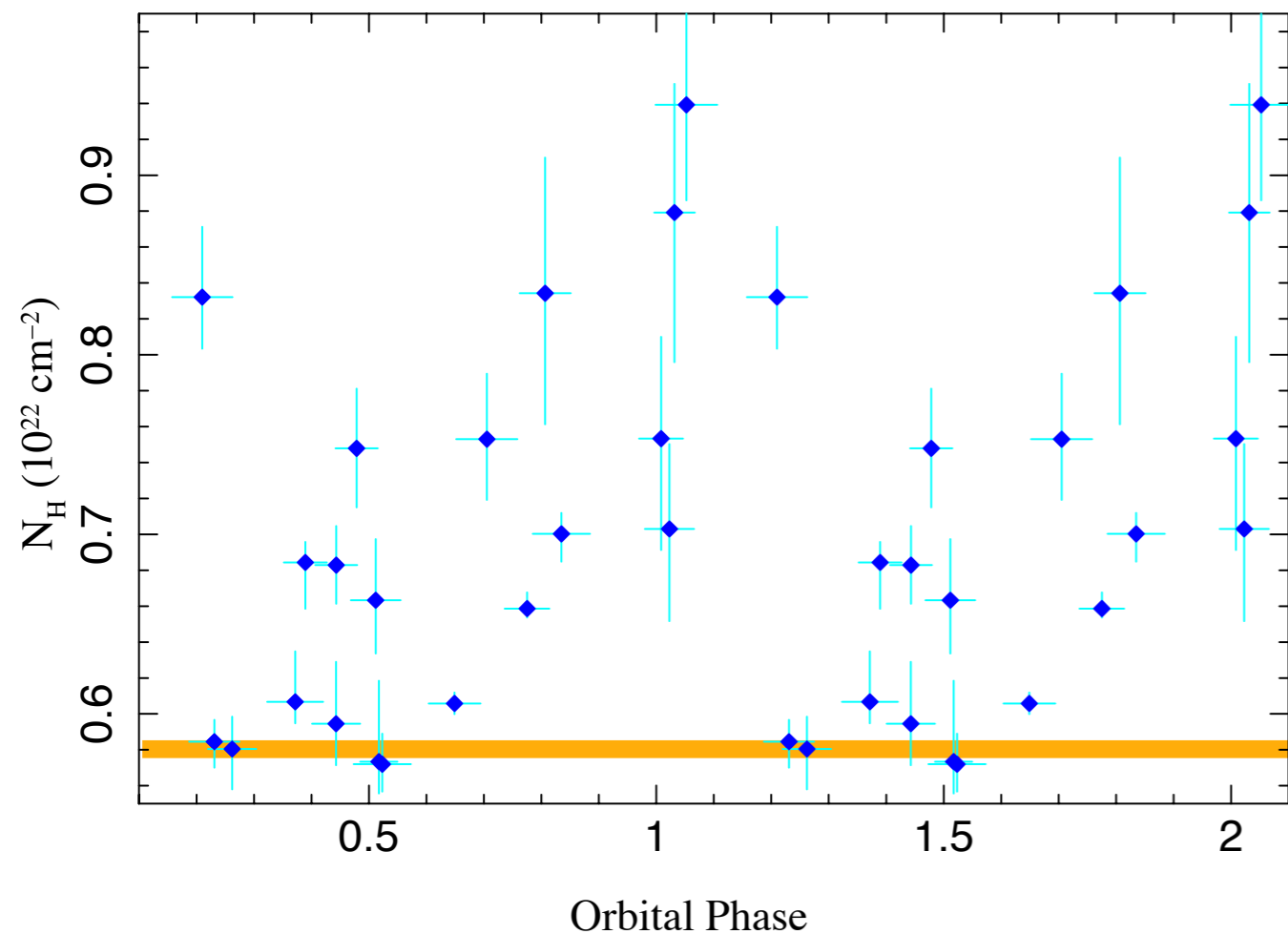






Nowak et al. in prep.

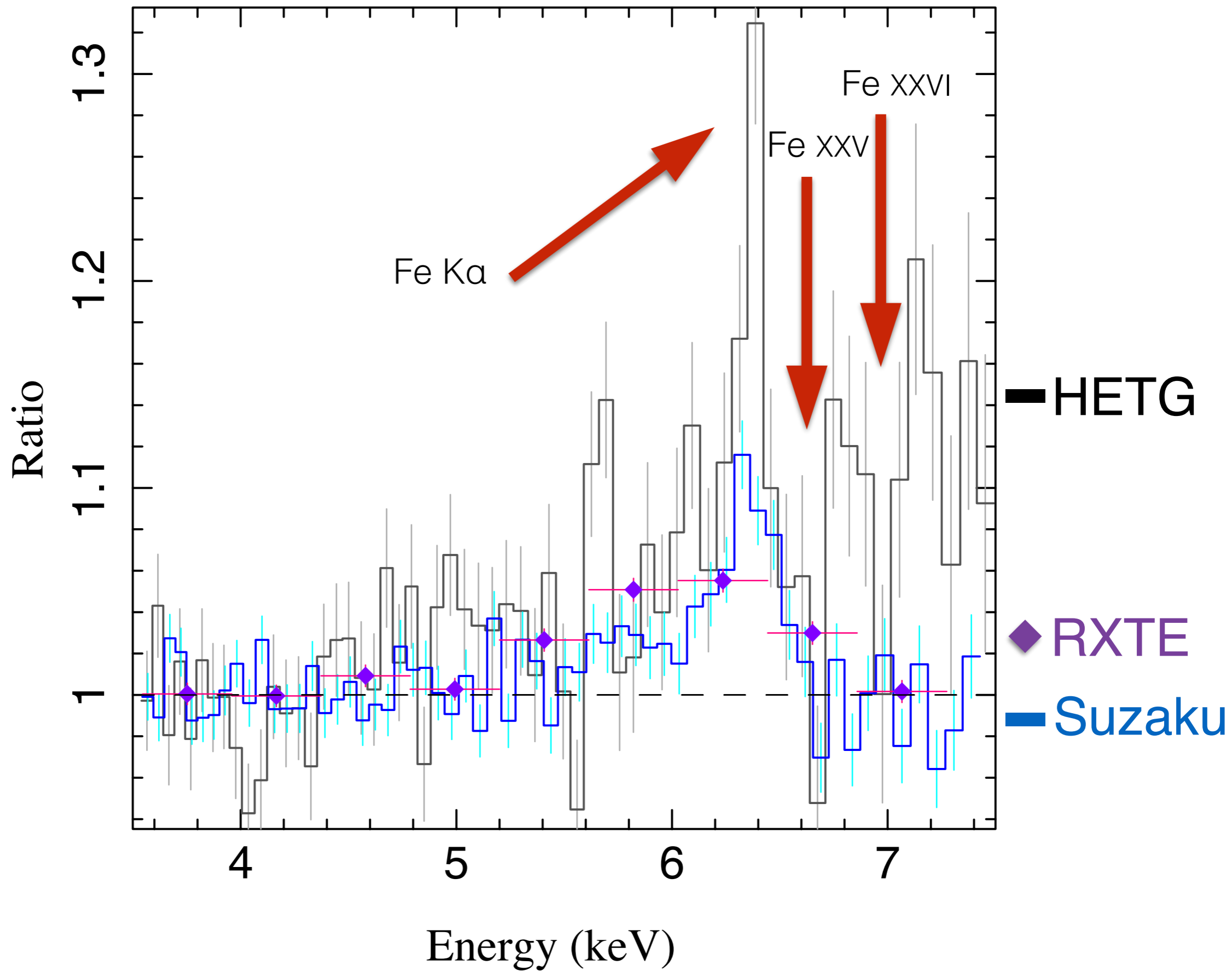
Poster: D03, V. Grinberg,  
Grinberg et al. (2016)



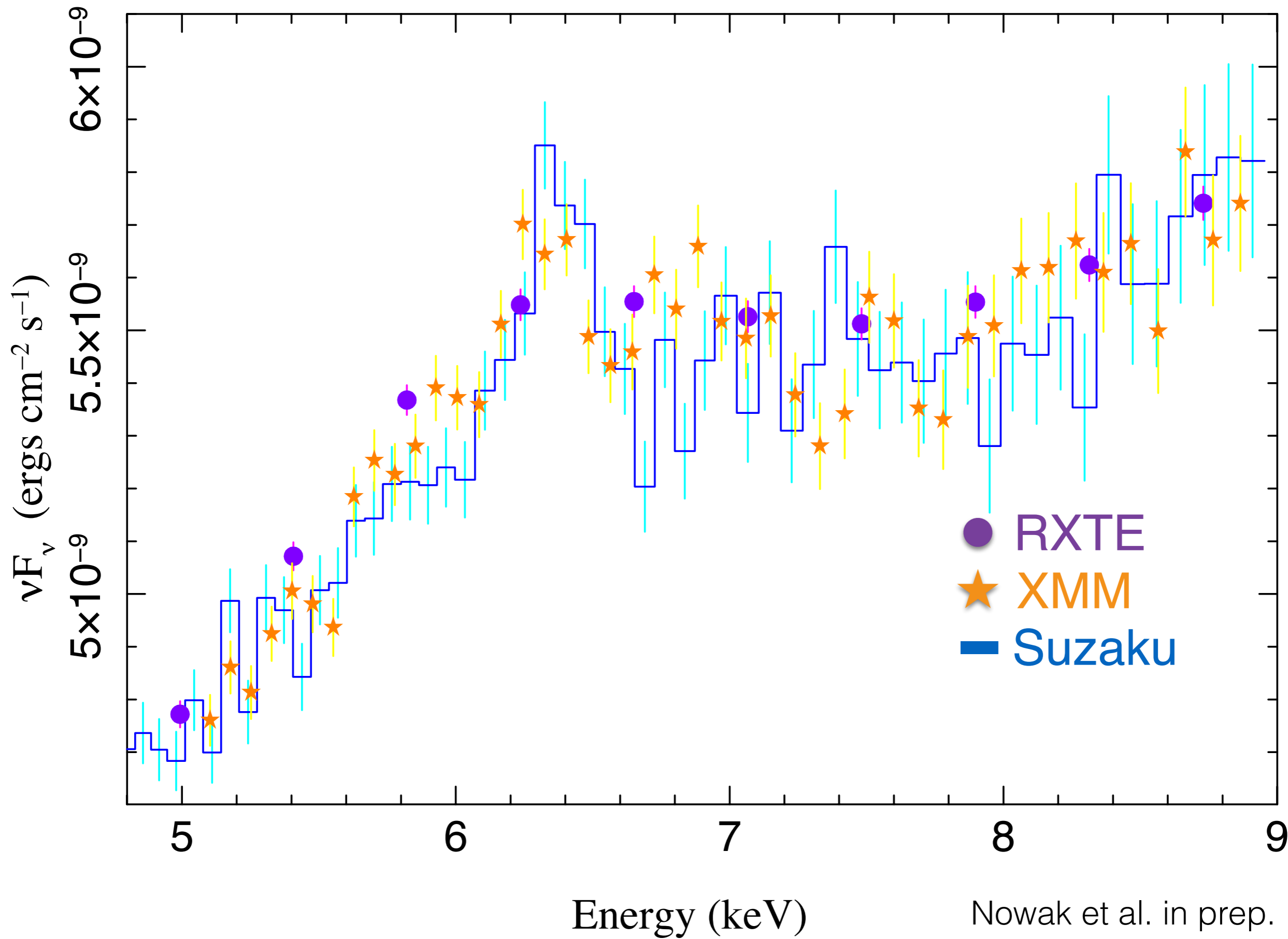
Nowak et al. in prep.

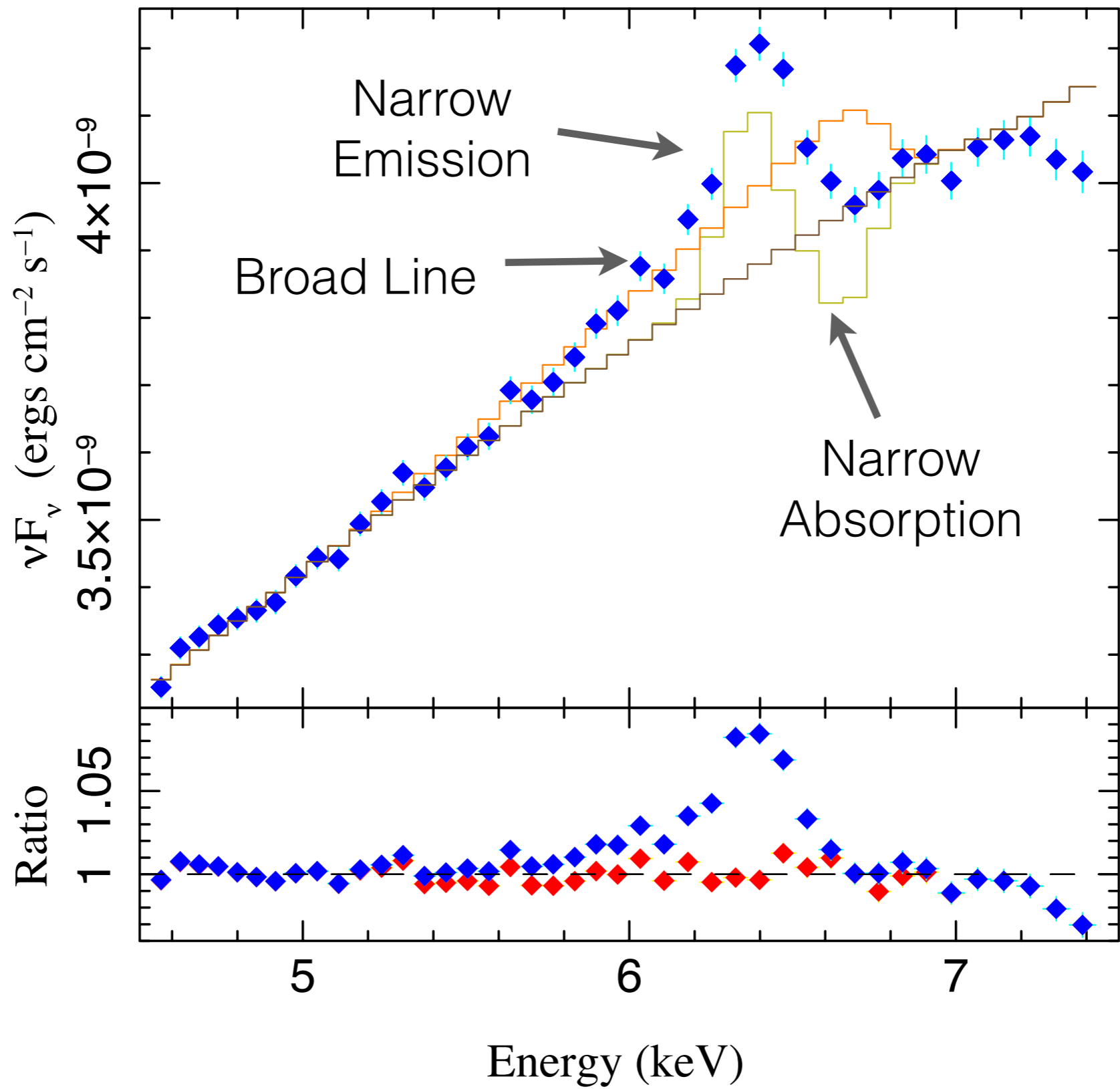
- *Dipping events have been filtered*
- Ionized absorption scaled relative to phase 0
- Recently finished Chandra-HETG observations of orbital phases in Cygnus X-1 hard state



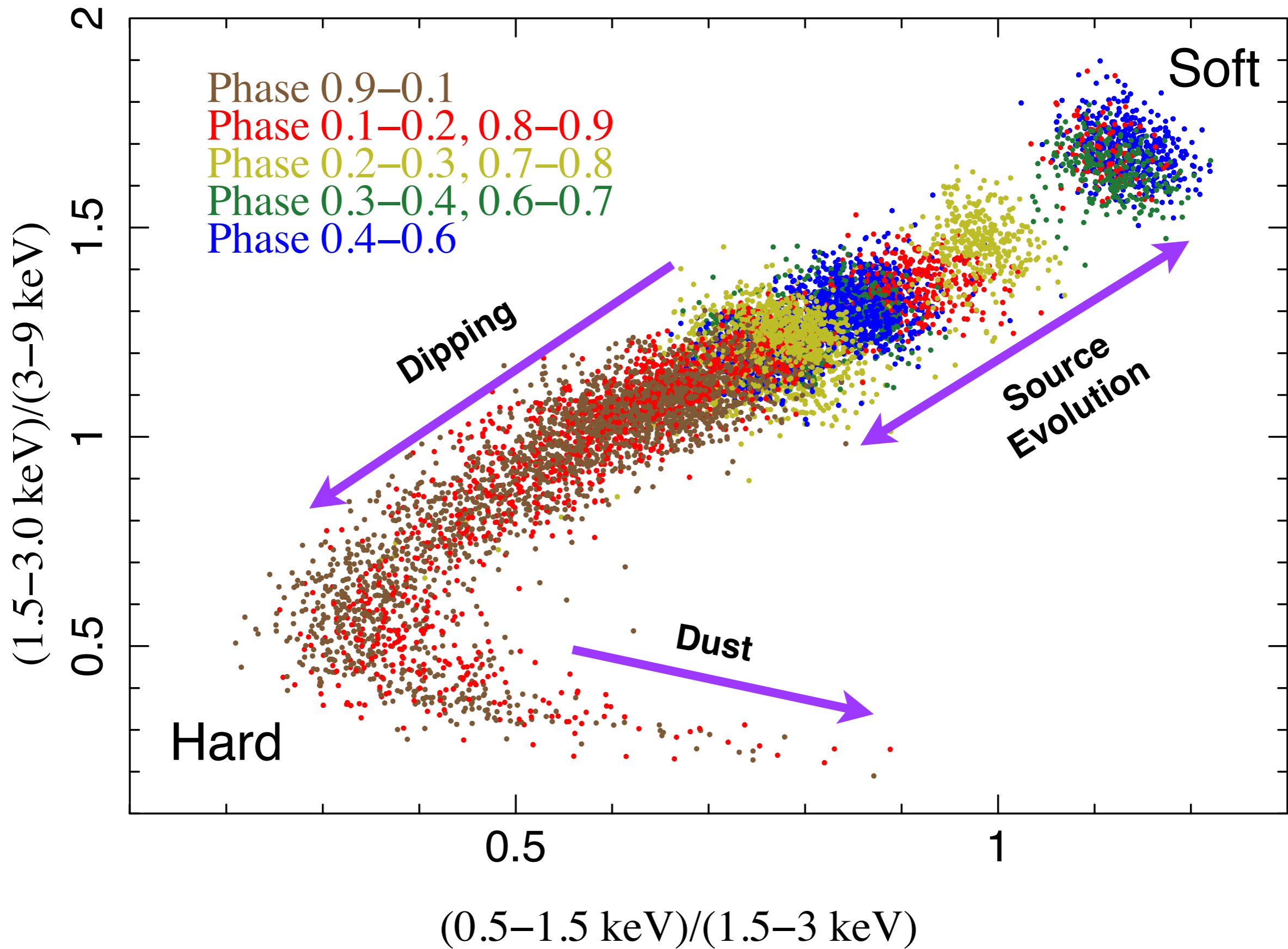


Nowak et al. (2011)

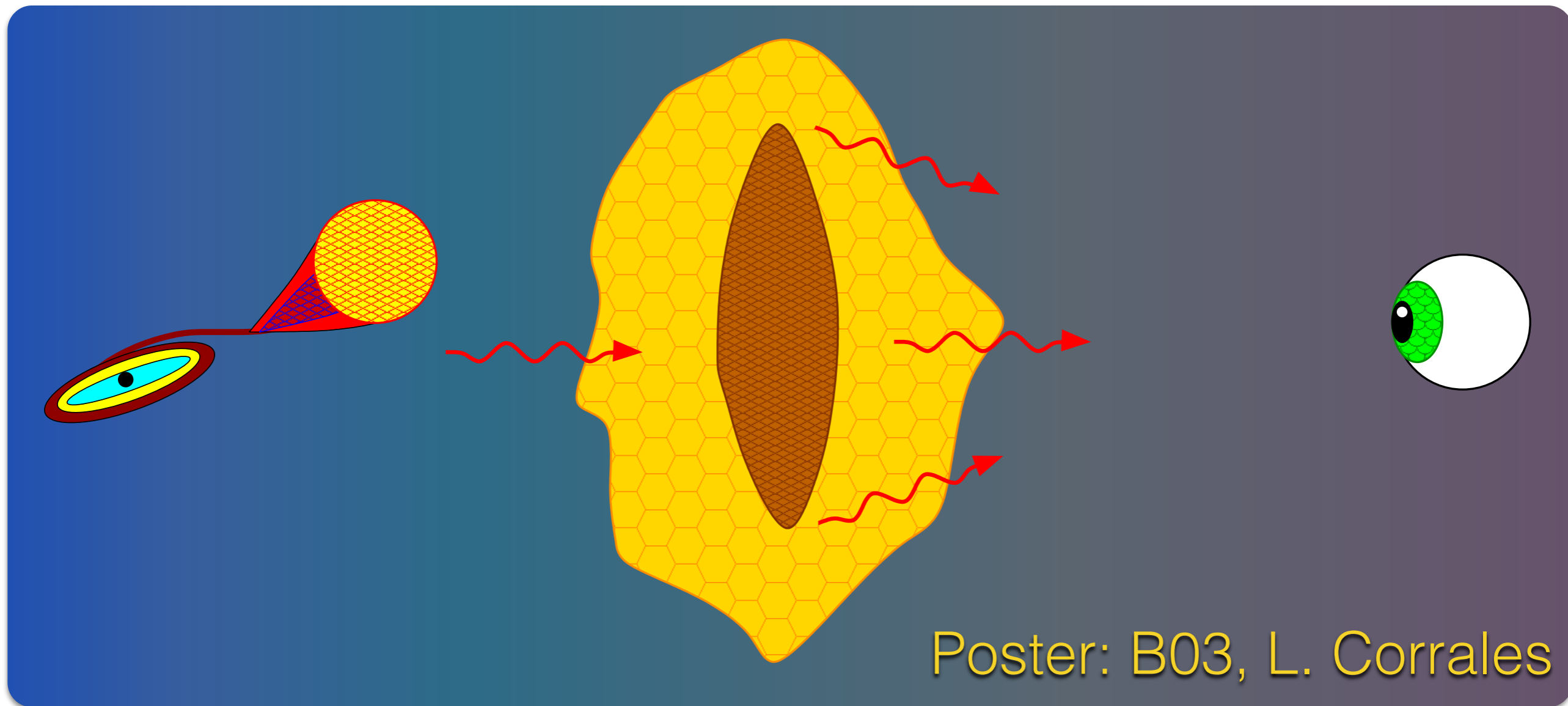




Nowak et al. (2011)



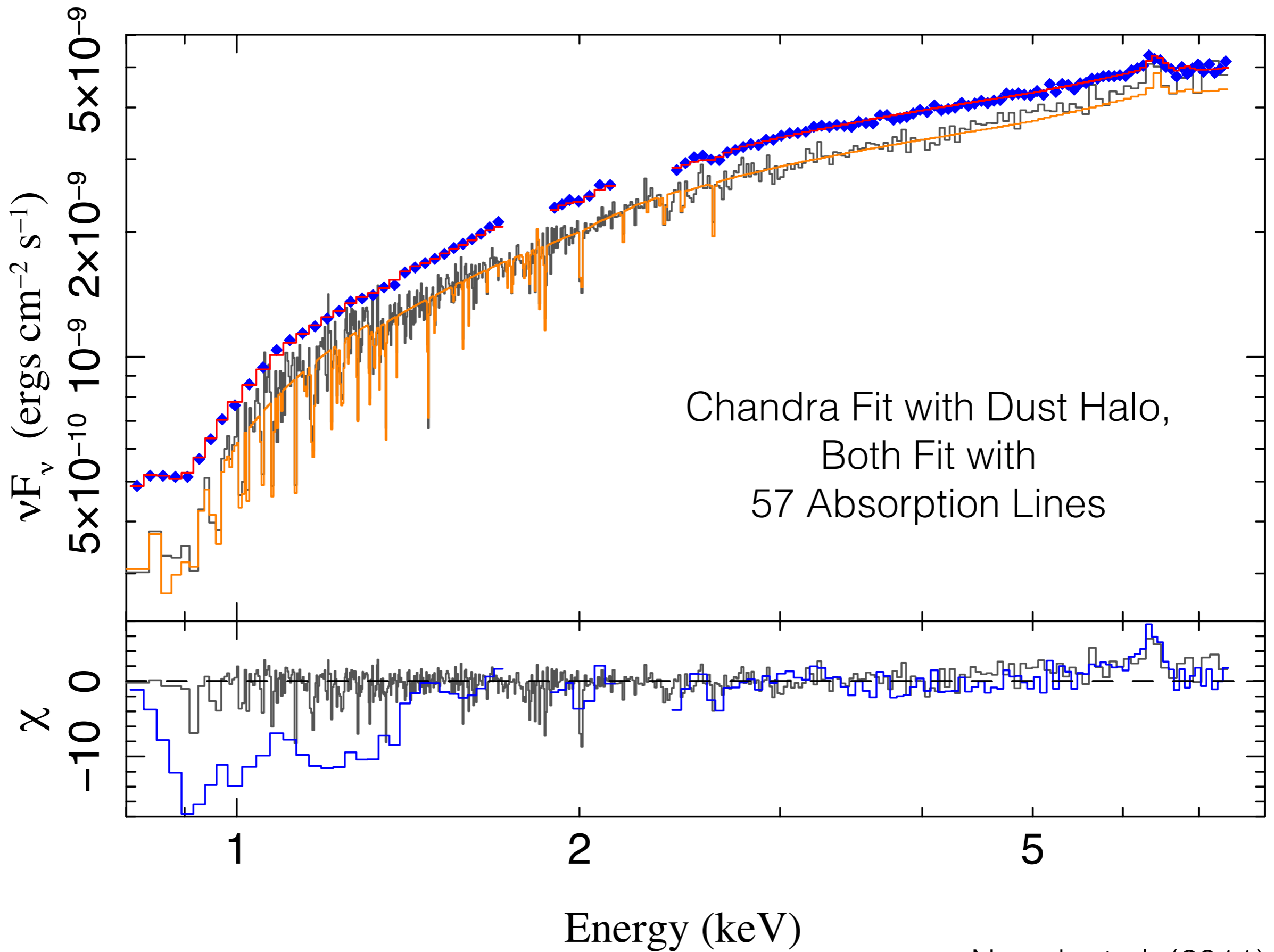
# The Dust Halo



Loss Term: Chandra, Swift, XMM-Newton

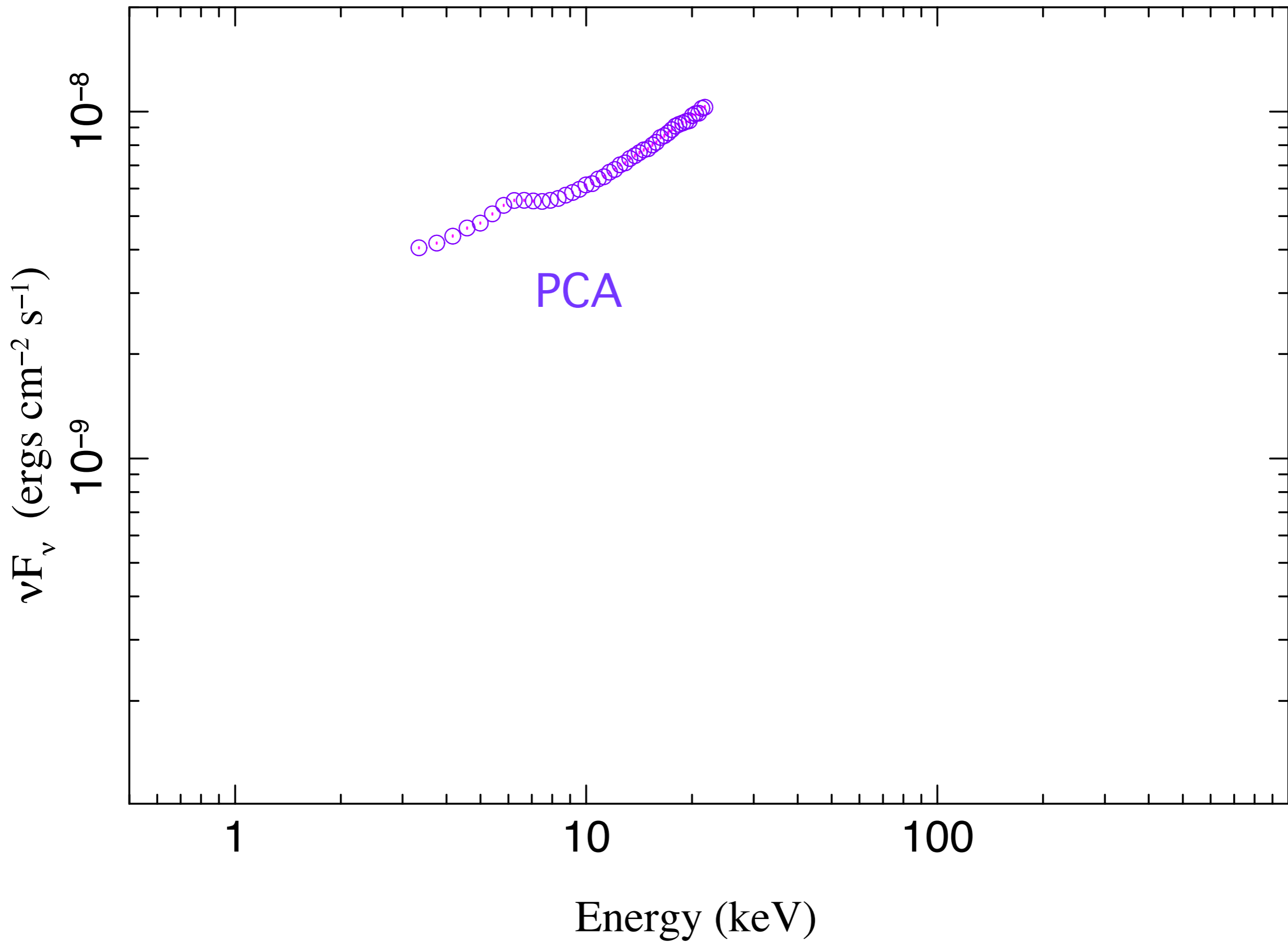
A "Wash": RXTE-PCA, Suzaku-XIS

Unimportant: Suzaku-HXD, RXTE-HEXTE, INTEGRAL

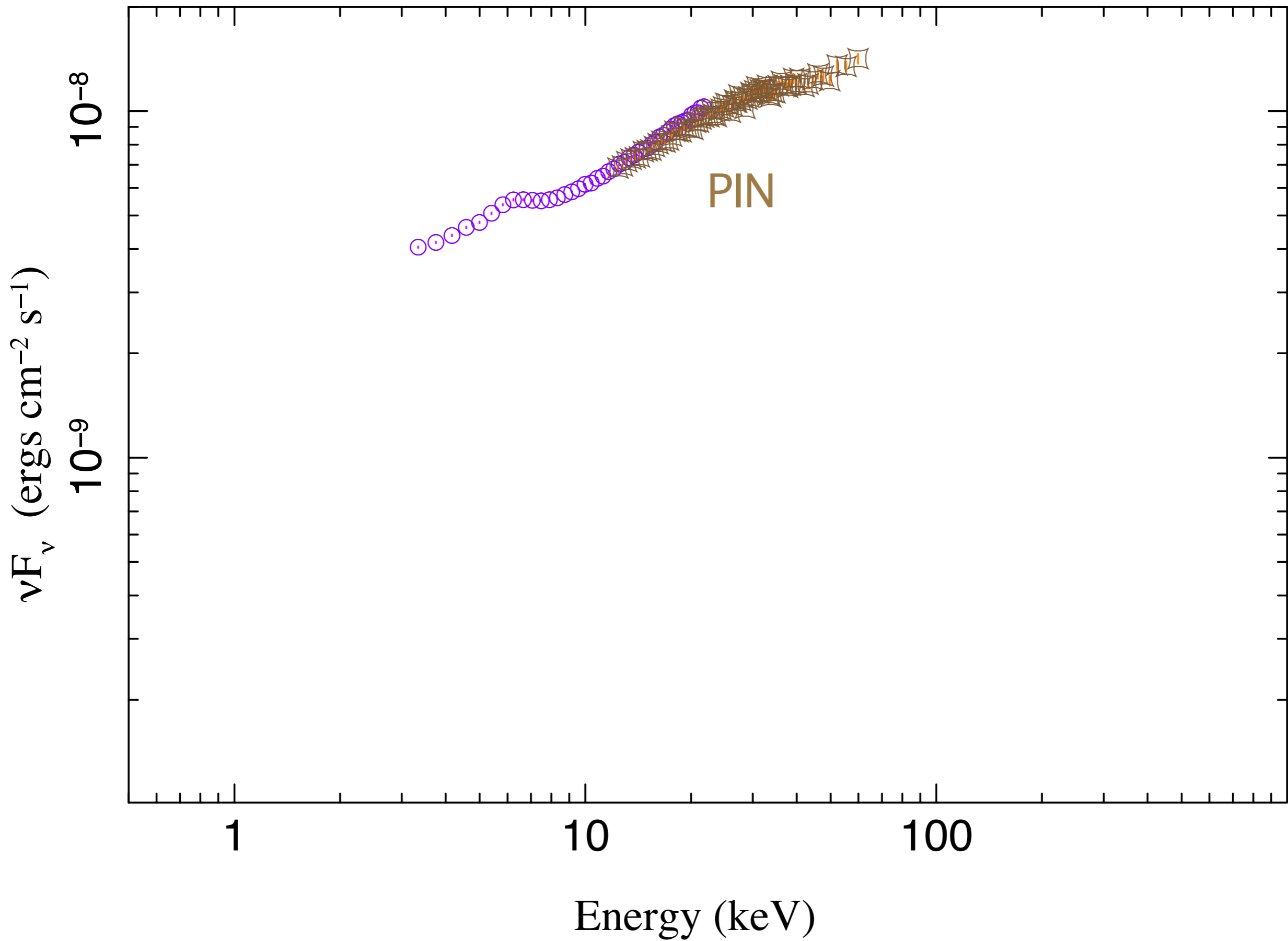


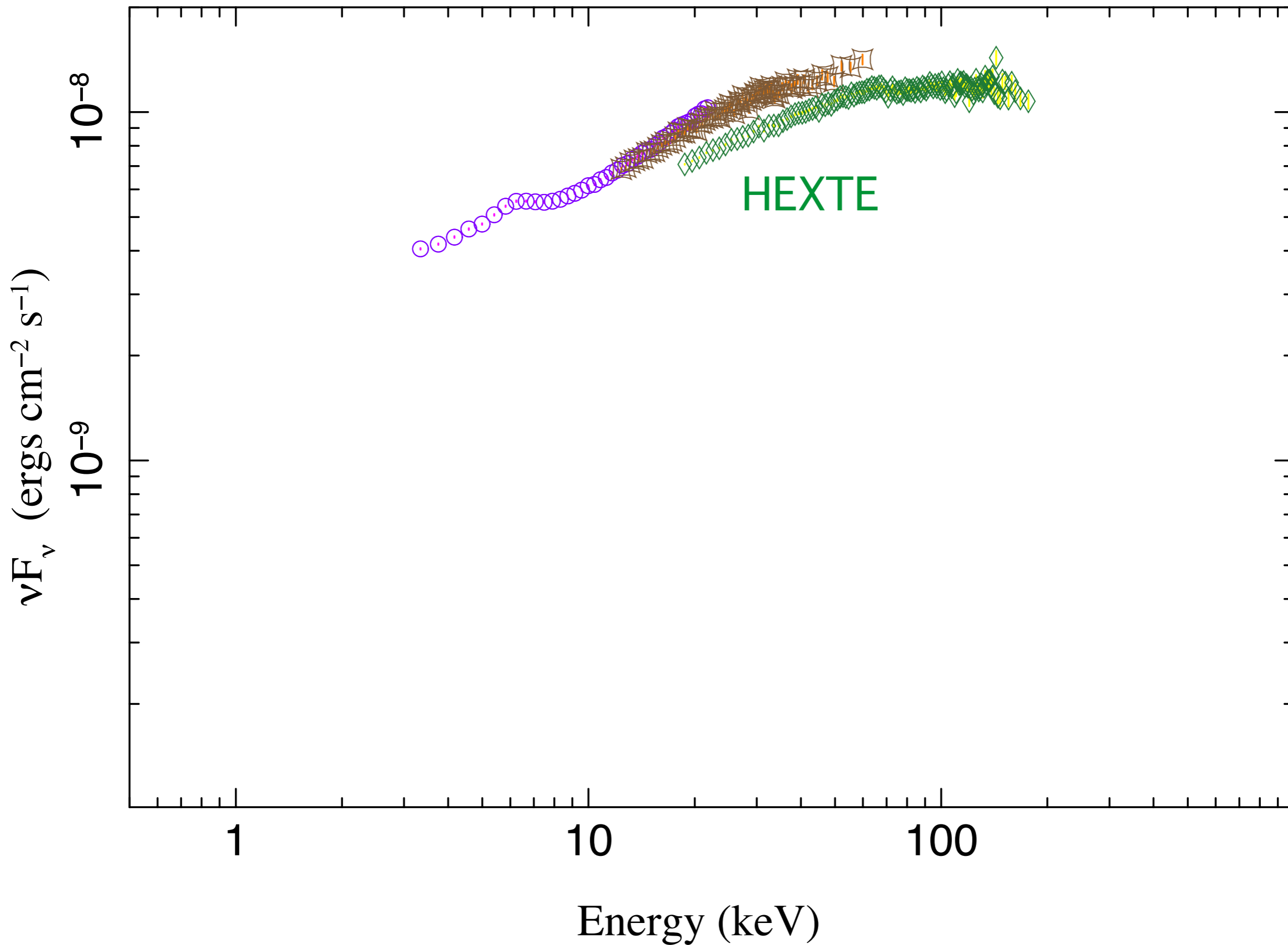
Nowak et al. (2011)

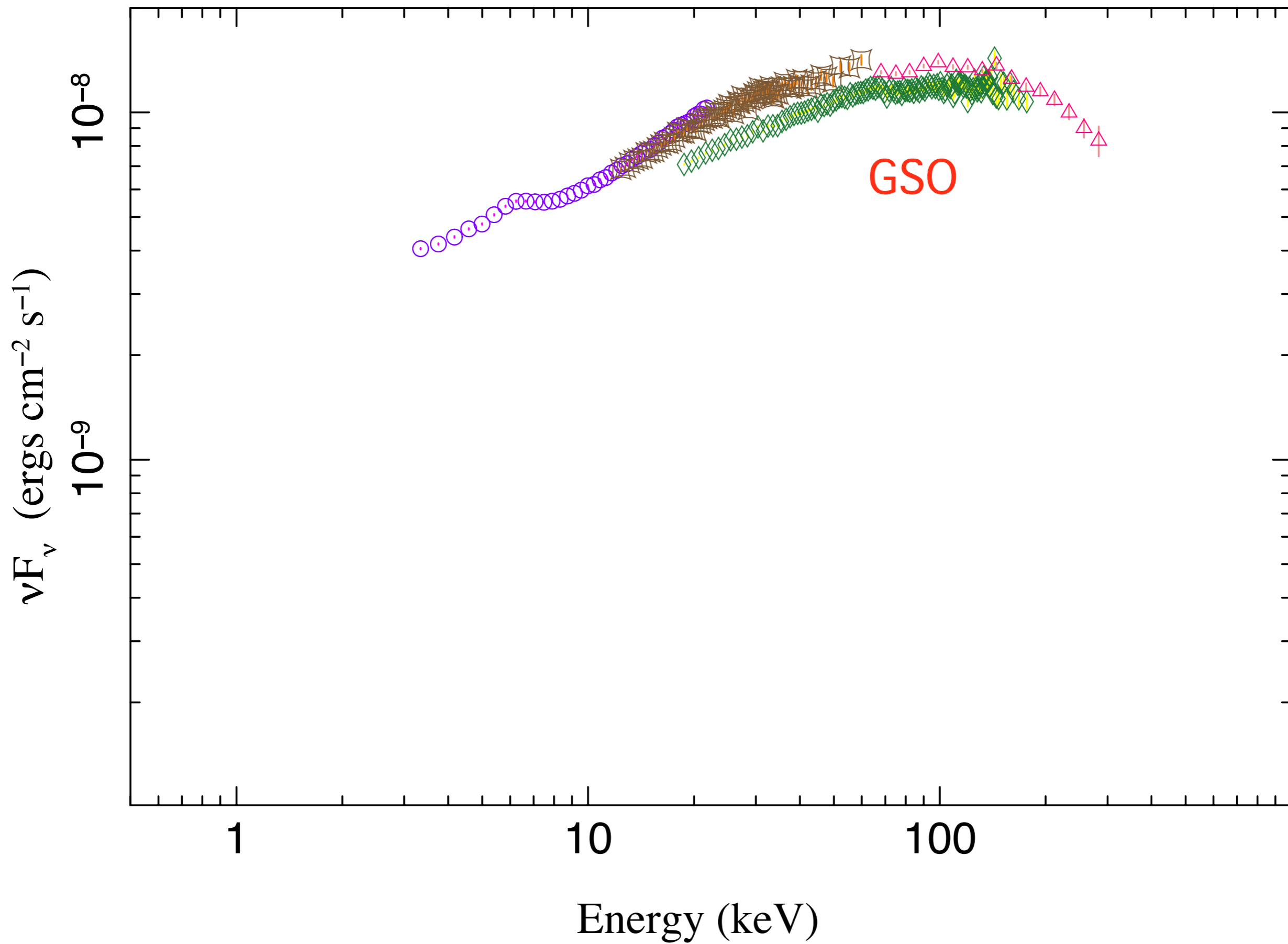
– Messy Instrumentation –

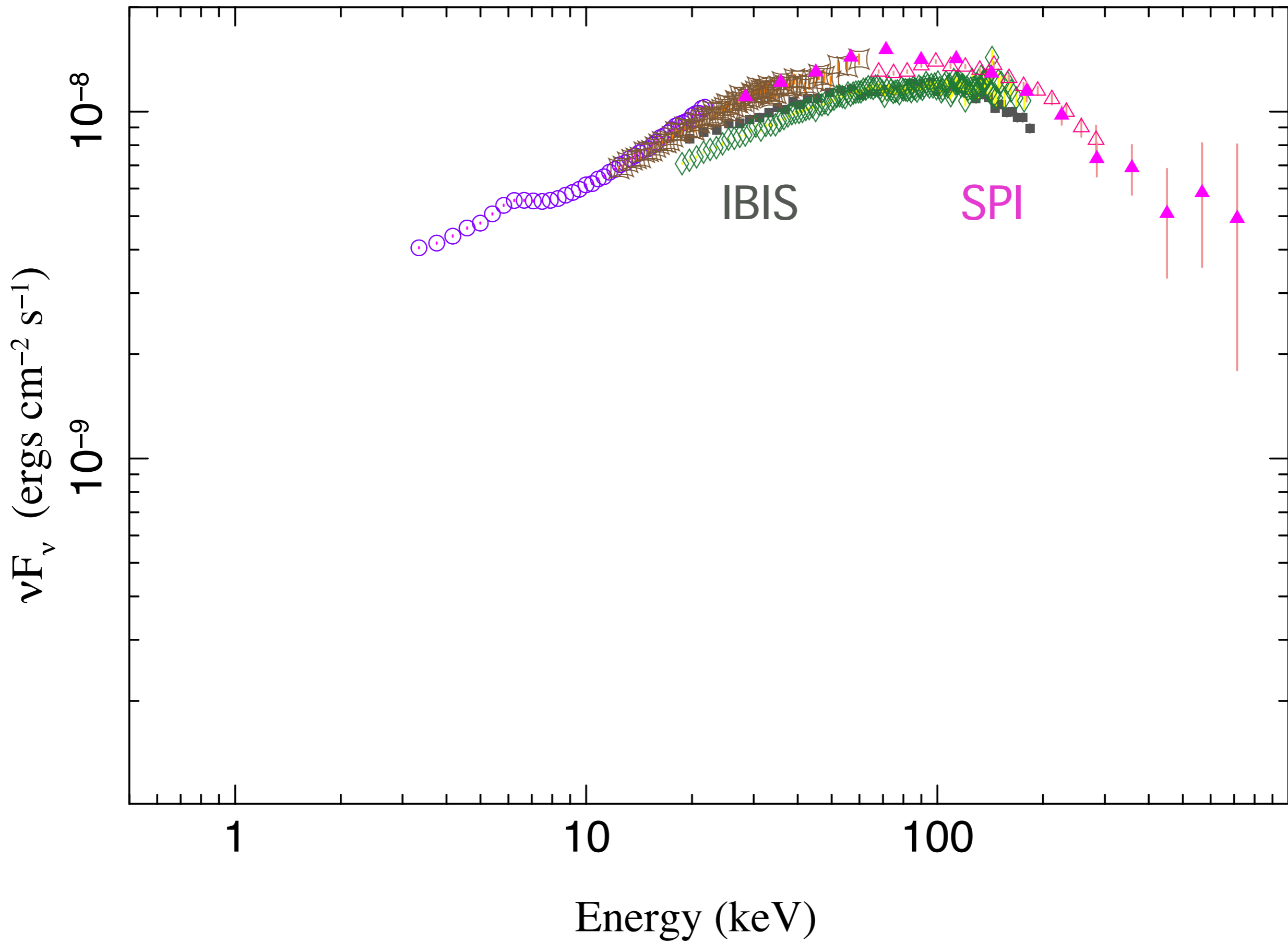


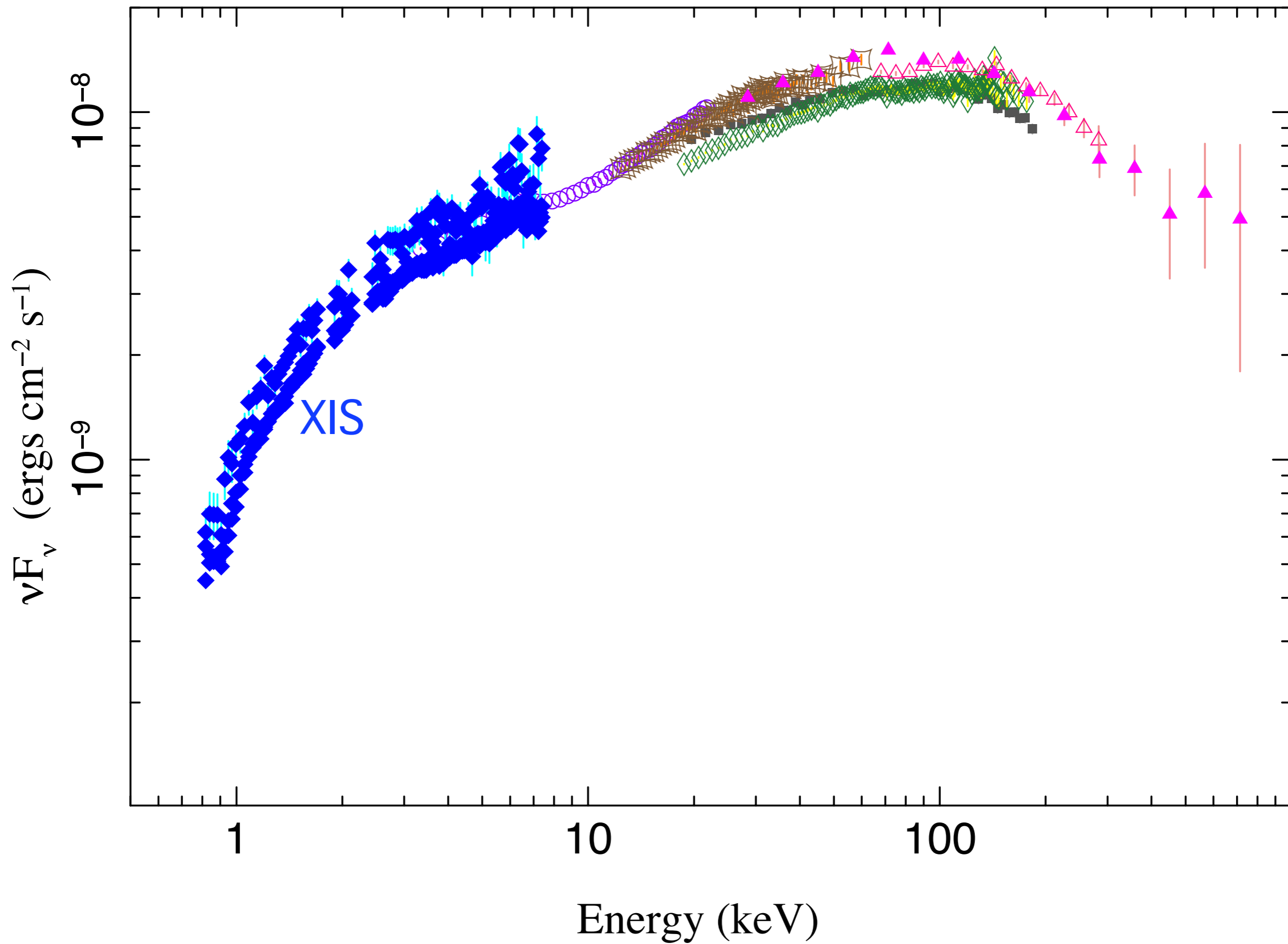


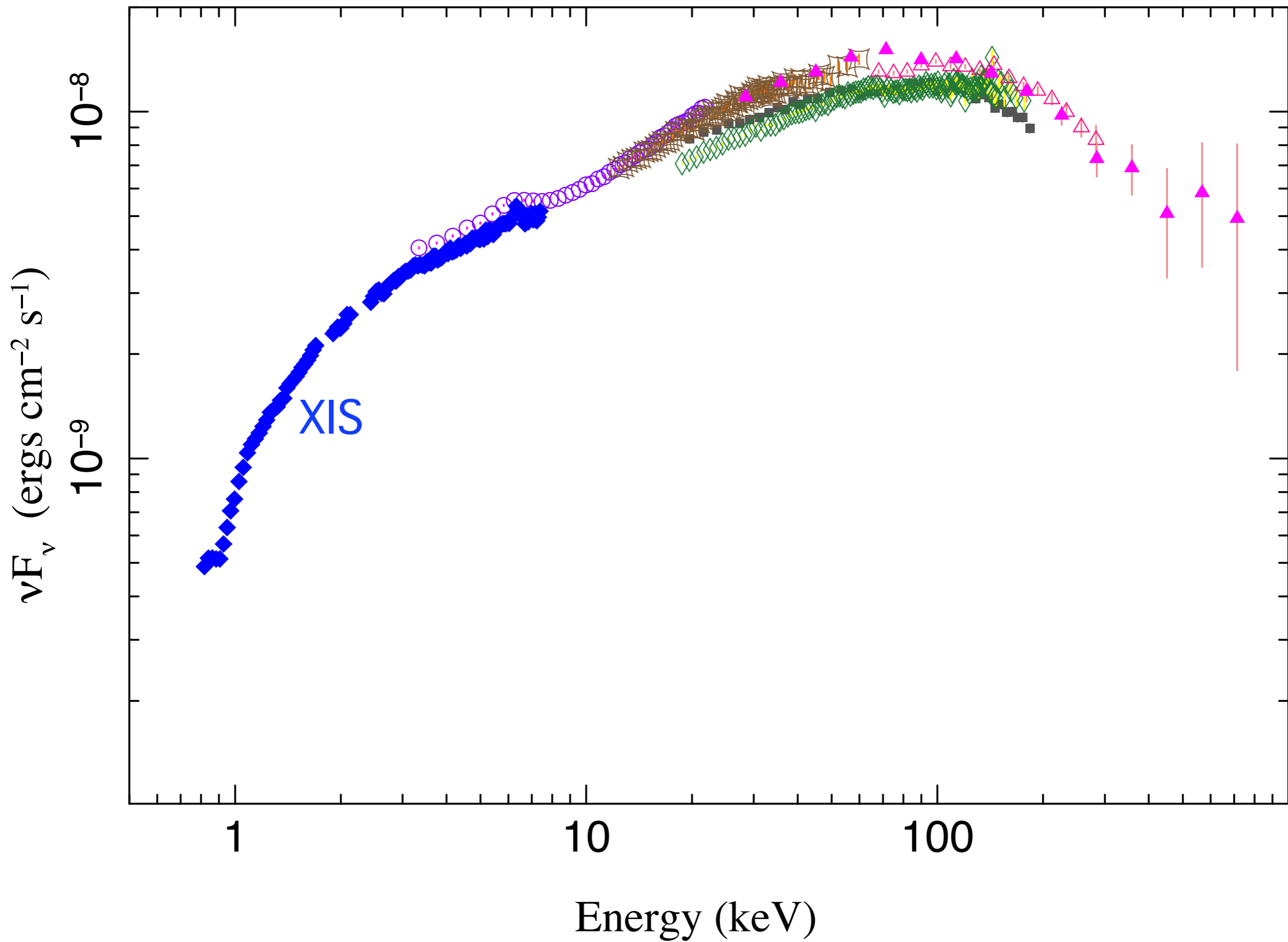


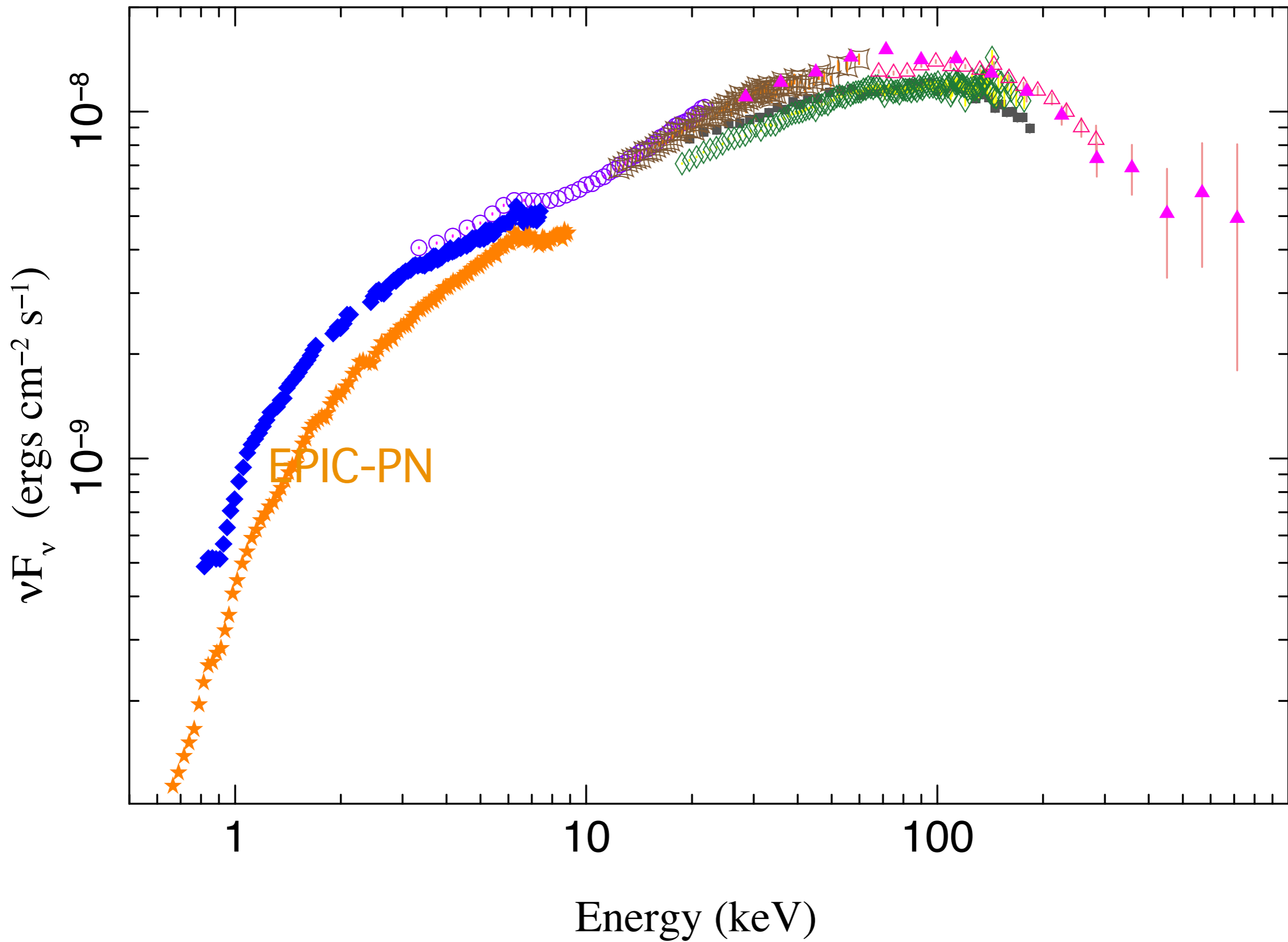


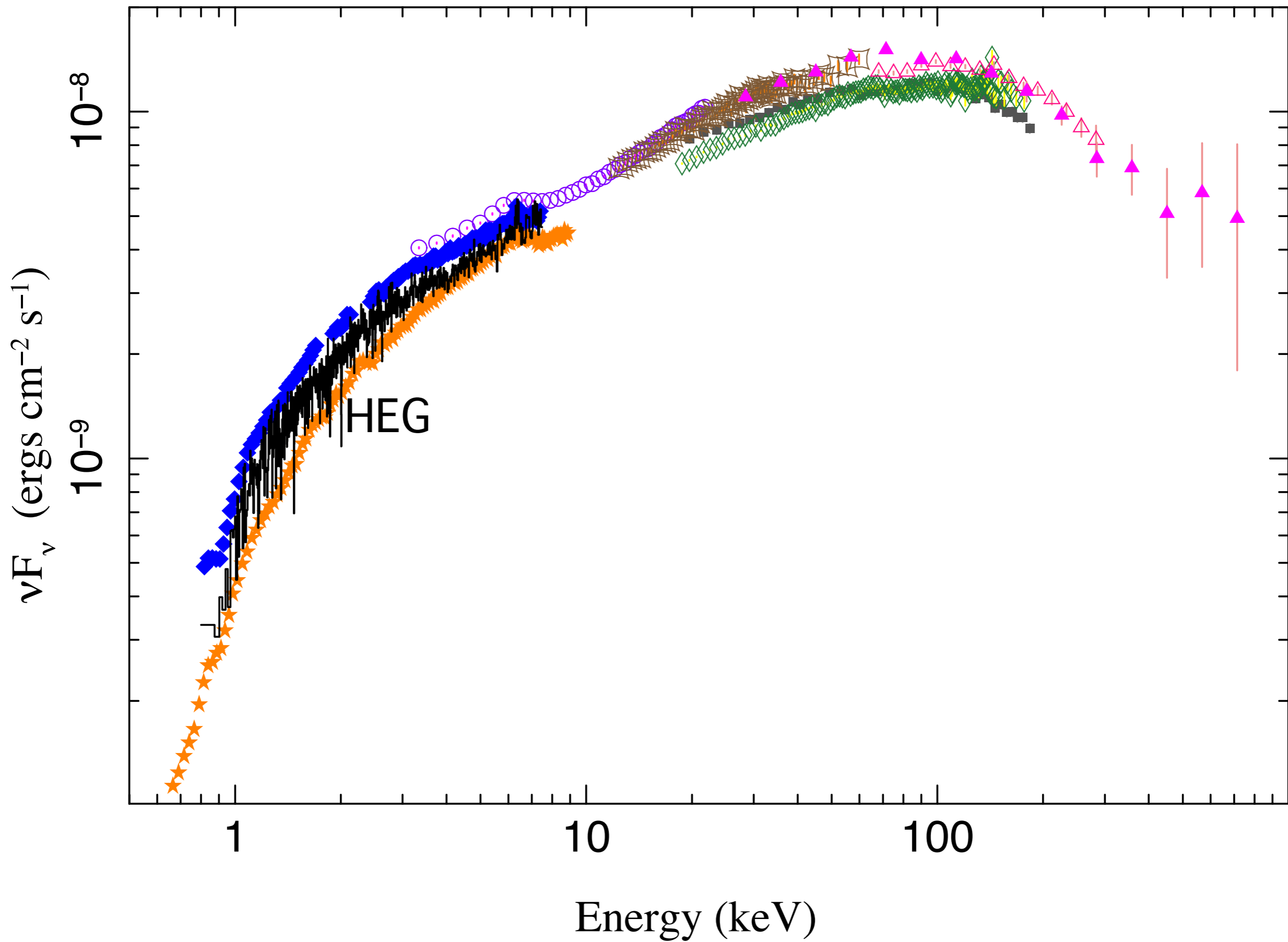




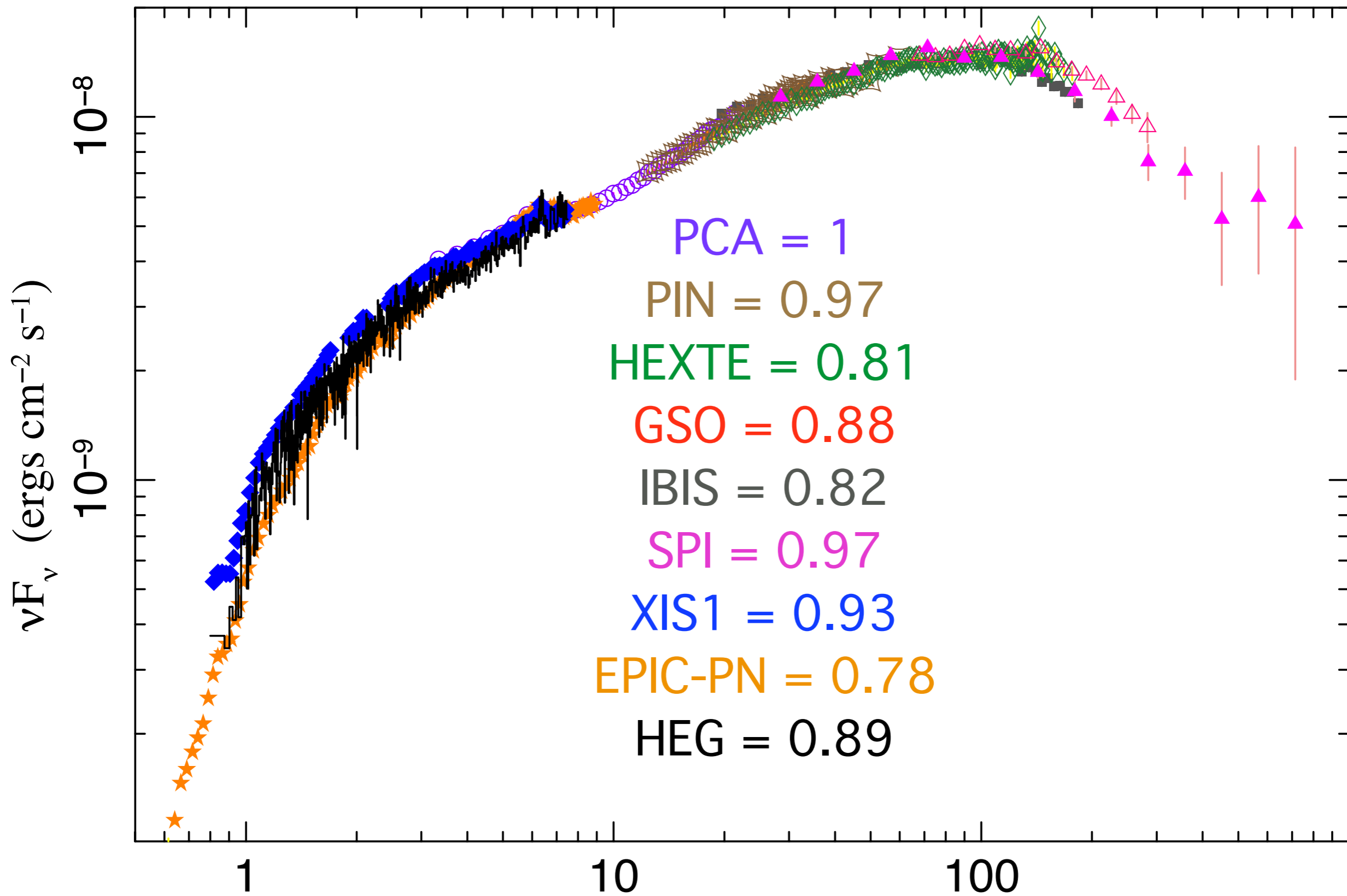






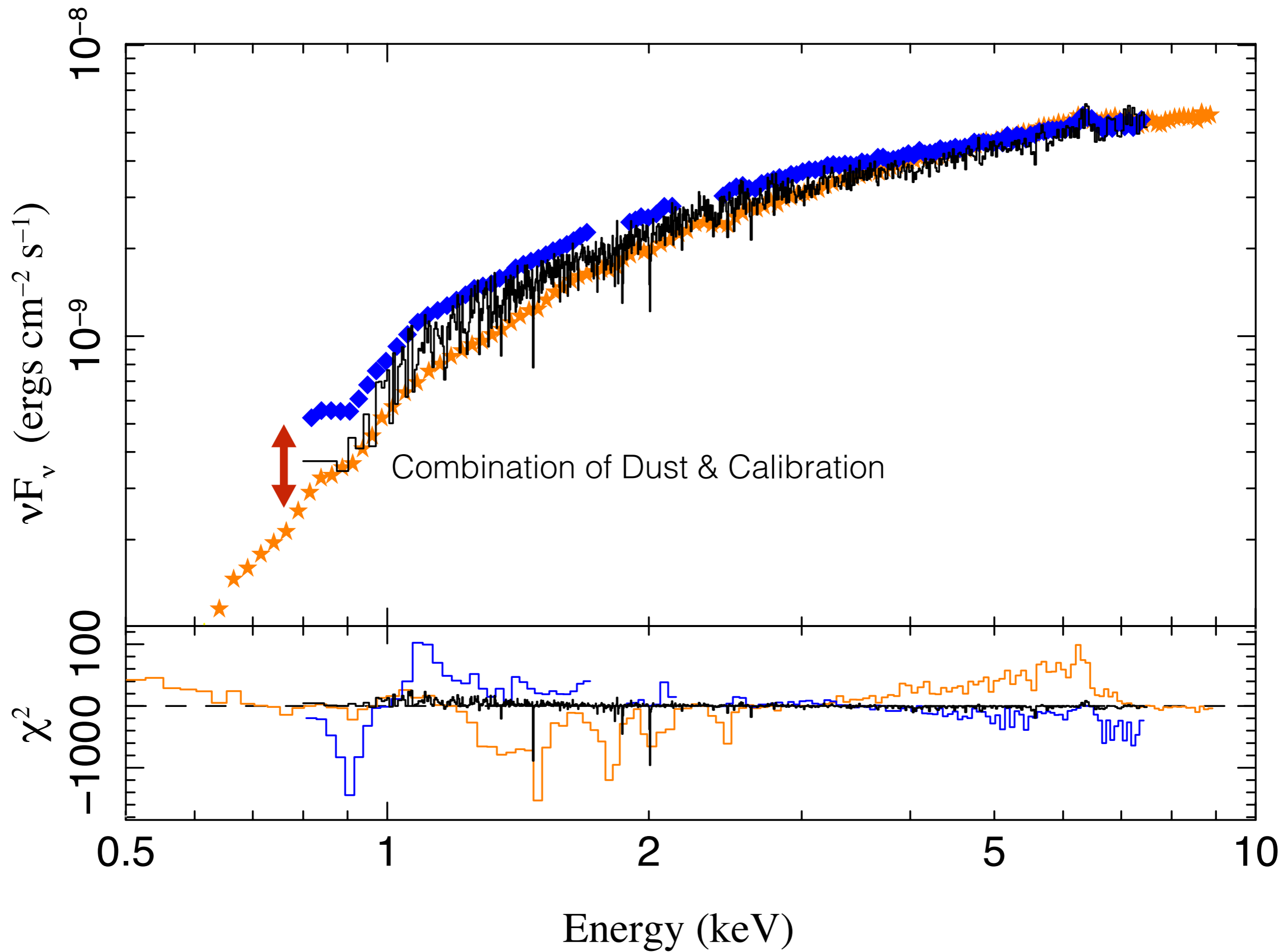


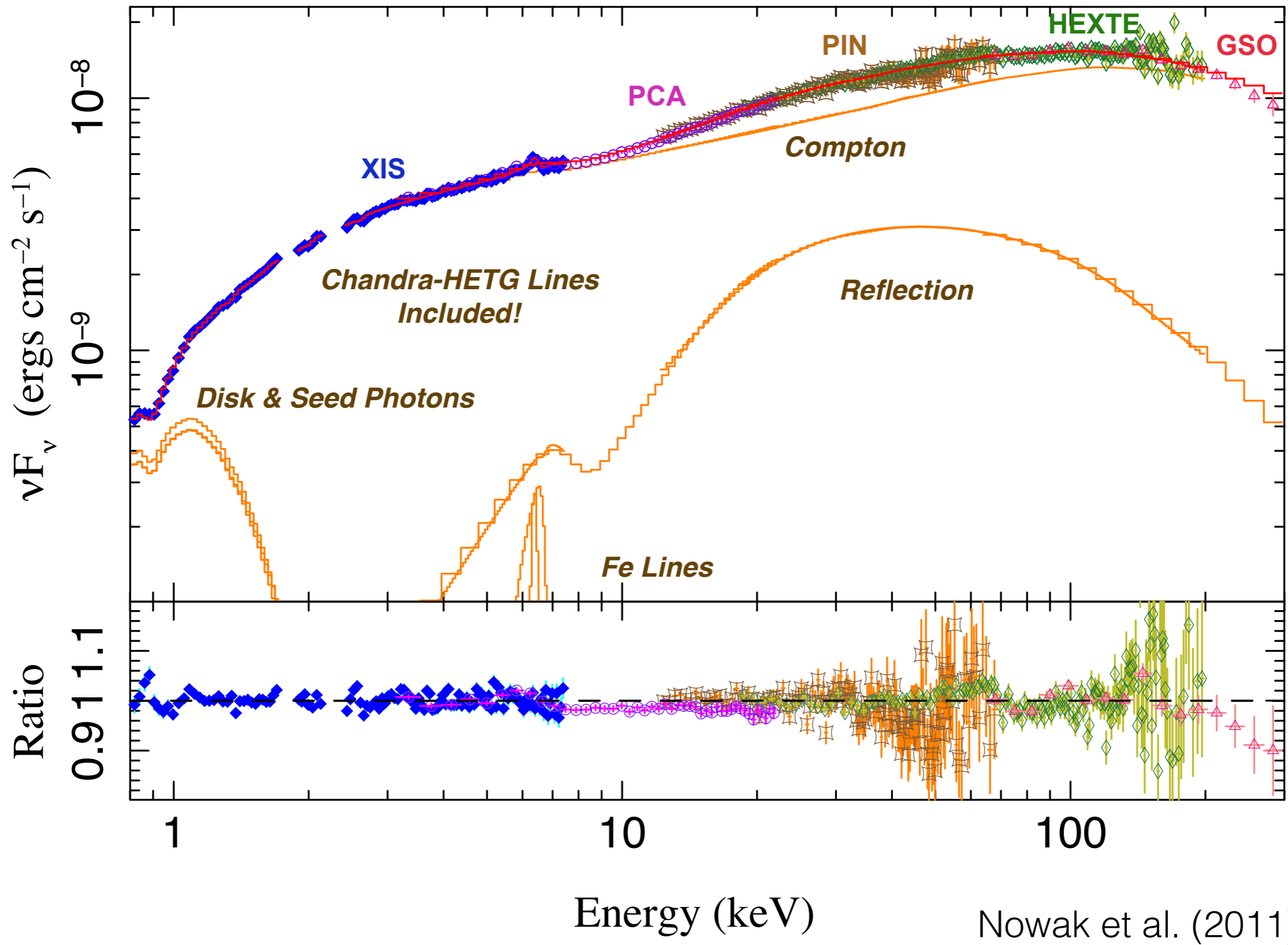




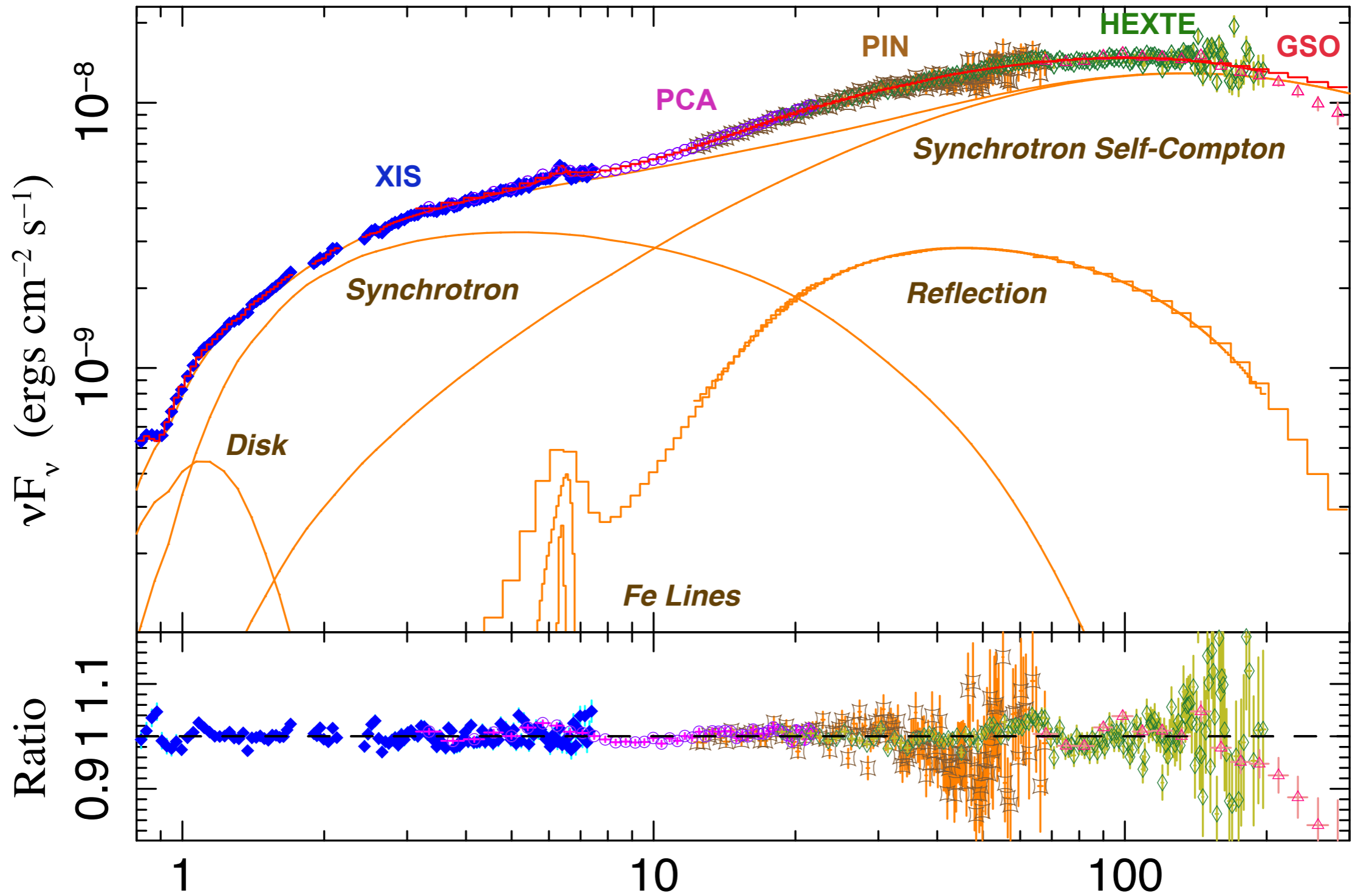
Energy (keV)

Nowak et al. in prep.





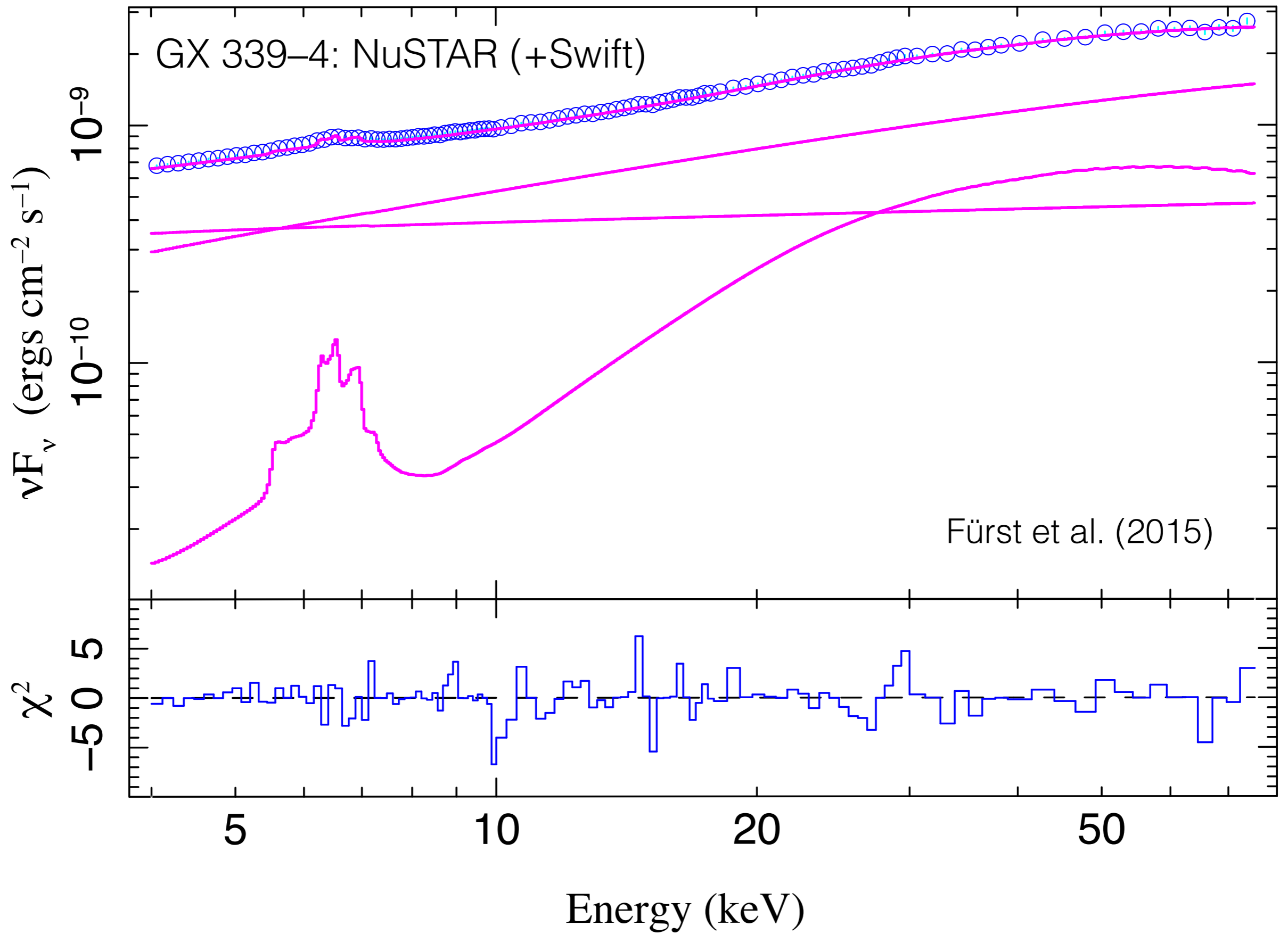
Non-Thermal Corona, Low kT Seed Photons



Energy (keV)

Nowak et al. (2011)

Jet Model



# Some Thoughts:

- There are important pieces to the model in HMXB that are sometimes forgotten & not incorporated
- Multi-instrument is *enormously* useful ...
  - But you have to be careful about tweaking the modeling on an instrument-by-instrument basis
  - Means of “tweaking” the calibration would be useful
- Have we been aggressive enough in pursuing multi-mission spectroscopy? With NuSTAR:
  - XMM – 1+Msec/400 ksec, Chandra – 155 ksec/ 400 ksec