NuSTAR and Obscured AGN

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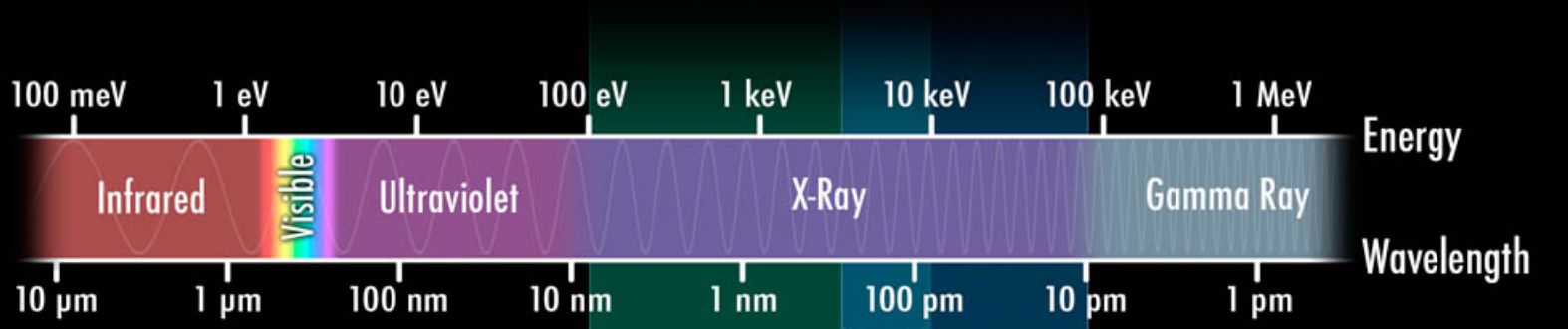
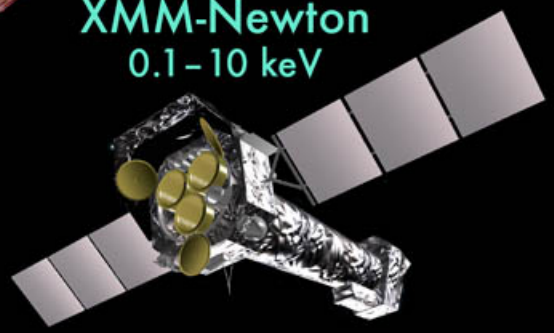
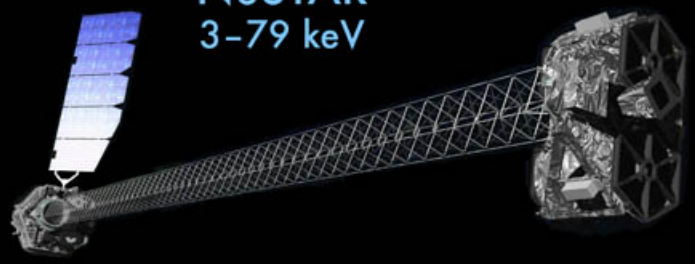
X-Ray Telescopes & the Electromagnetic Spectrum



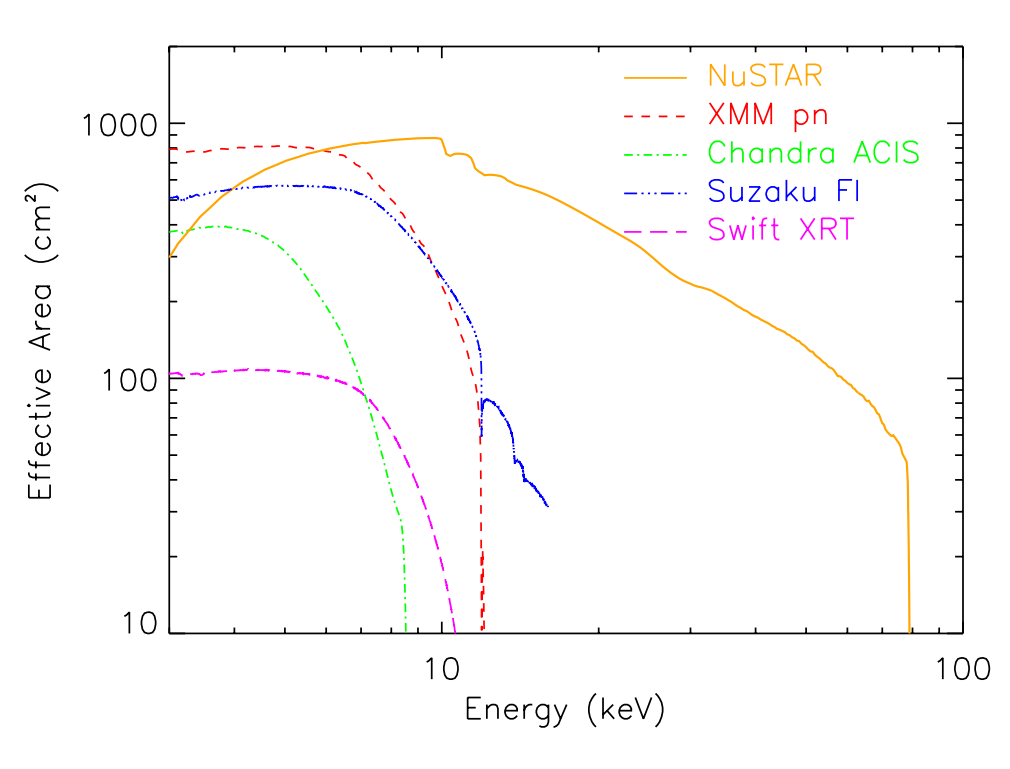
Chandra &
XMM-Newton
0.1–10 keV



NuSTAR
3–79 keV



Sensitivity

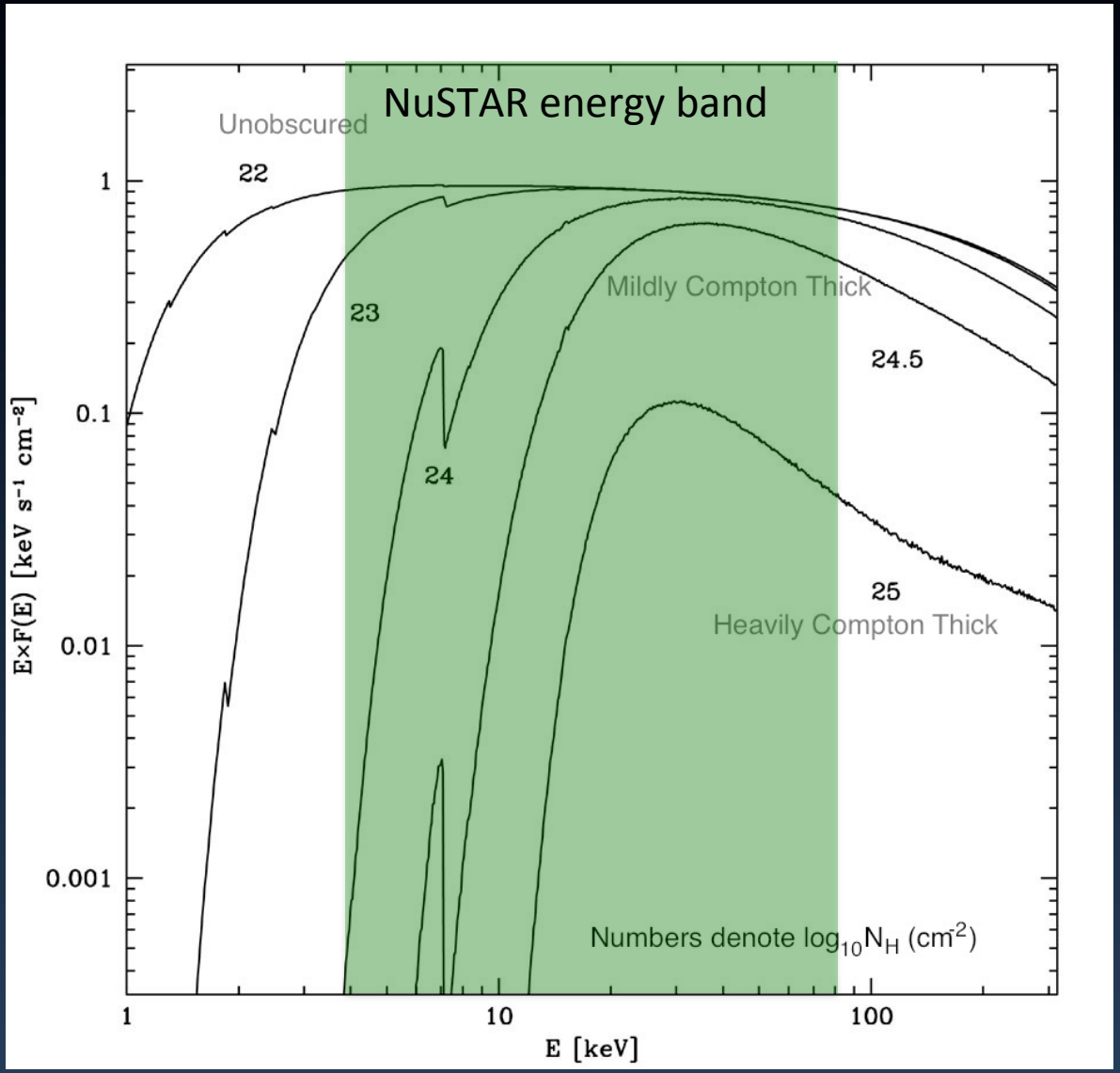


NuSTAR two-telescope total collecting area

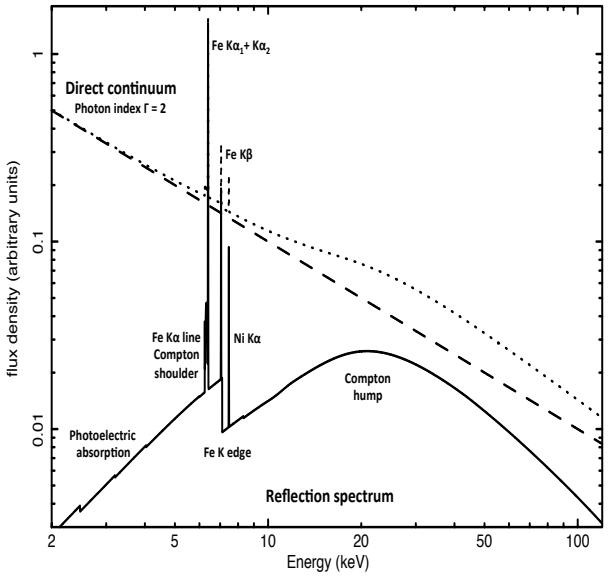
Satellite (instrument)	Sensitivity
INTEGRAL (ISGRI)	~0.5 mCrab (20-100 keV) with >Ms exposures
Swift (BAT)	~0.8 mCrab (15-150 keV) with >Ms exposures
NuSTAR	1 μCrab (10-40 keV) in 1 Ms

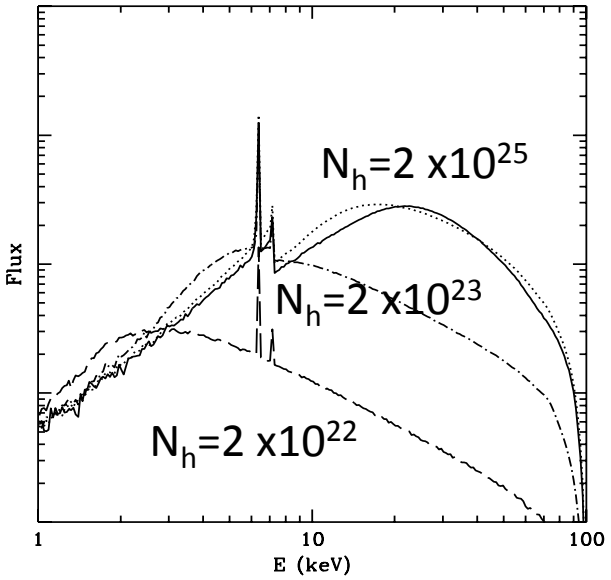
Sensitivity comparison

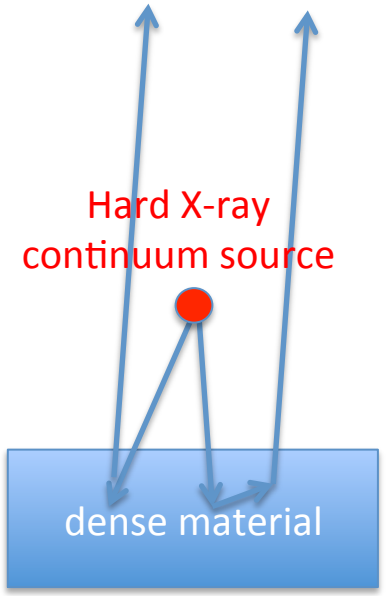
Obscured Sources



Compton Reflection







From Ponti (2012), Matt (2003)

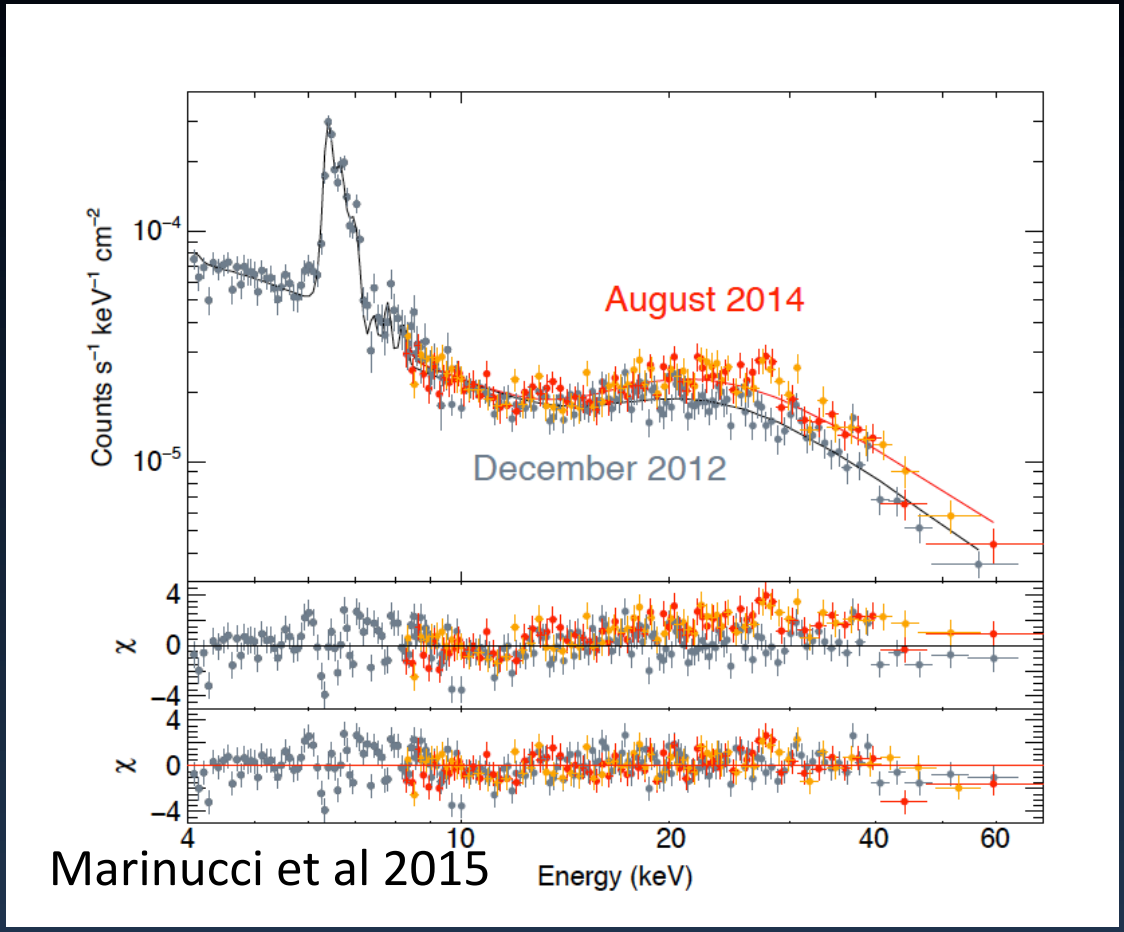
Famous Nearby Prototypes

- NGC 1365 – changing look Seyfert 1.9
  - » Risaliti et al 2013, Walton et al 2014, Kara et al 2015, Rivers et al 2015
- NGC 1068 – nearby Compton thick AGN
  - » Bauer et al 2015, Marinucci et al. submitted
- NGC 4945 – Seyfert 2 hard X-ray variability
- Circinus – nearby Compton thick AGN
  - » Aravelo et al 2014
- Mrk 231 – nearest BALQSO+ULIRG

Obscured Population Samples

- SLOAN Type-2 QSOs
  - » Lansbury et al 2015 – SDSS type 2 quasars
  - » Stern et al 2014: Wise selected type-2 quasars
- BAL QSO sample
  - » Luo et al 2014
  - » Teng et al. 2014
- ULIRGs
  - » Teng et al 2014
  - » Teng et al. 2015 in press

NGC 1068 and the Clumpy Torus

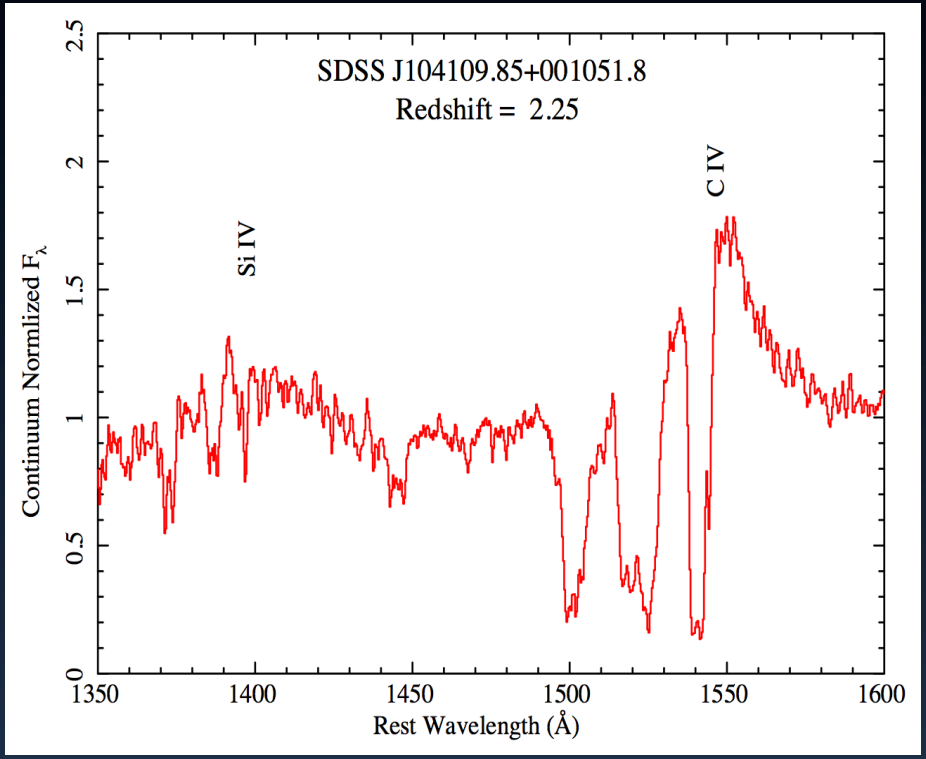


Marinucci et al 2015

The Receding Torus

- NuSTAR observations of WISE-selected sample of luminous ($L_{bol} \sim 10^{14} L_{sun}$) QSOs
  - » Expectations would be these are bright in the X-ray/ hard X-ray
- Observations with XMM+NuSTAR show they are X-ray weak or heavily obscured
  - » Contradicts the receeding torus model at the bright end

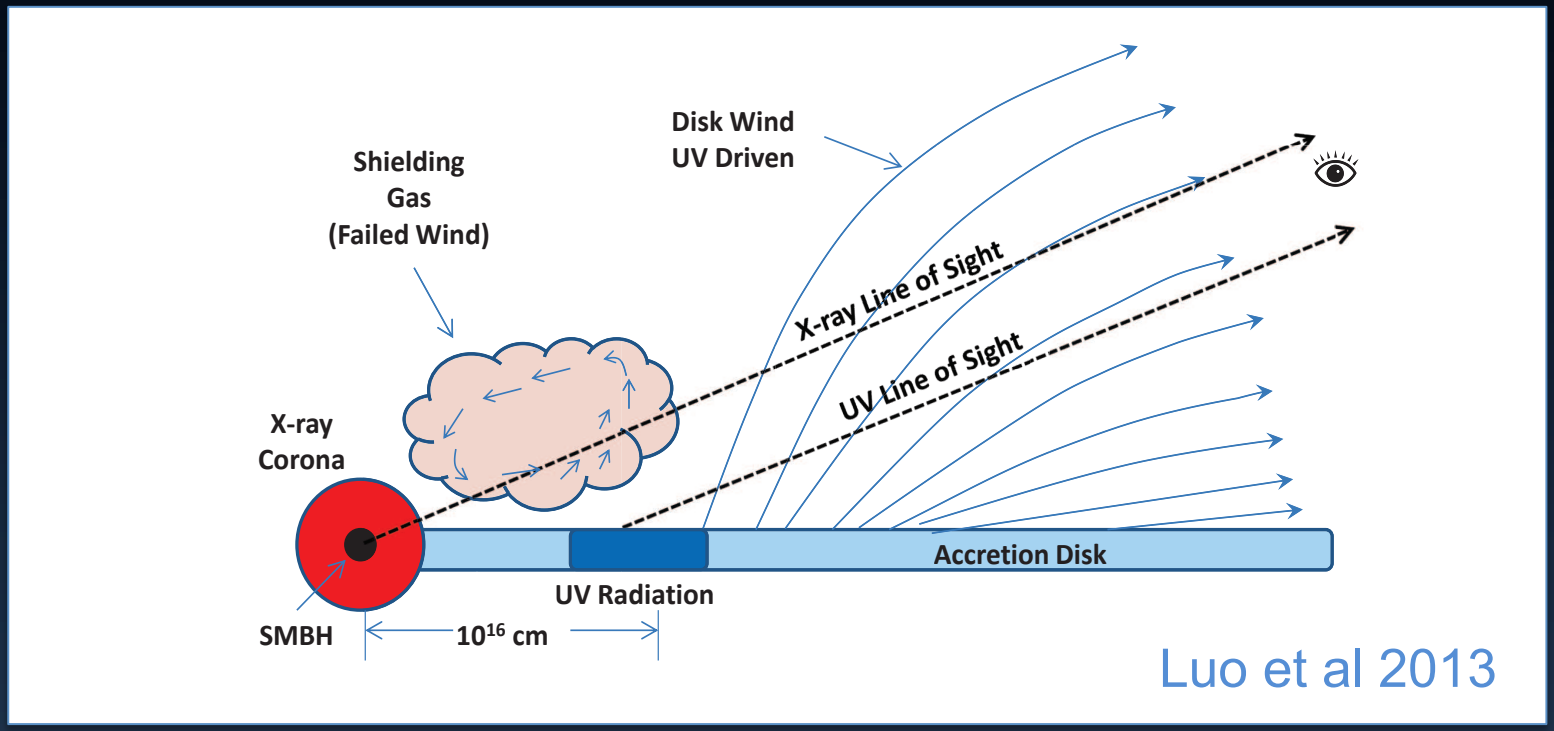
Unified Model for BAL QSOs



blueshifted transitions of, e.g., C IV, Si IV, Mg II, Al III.

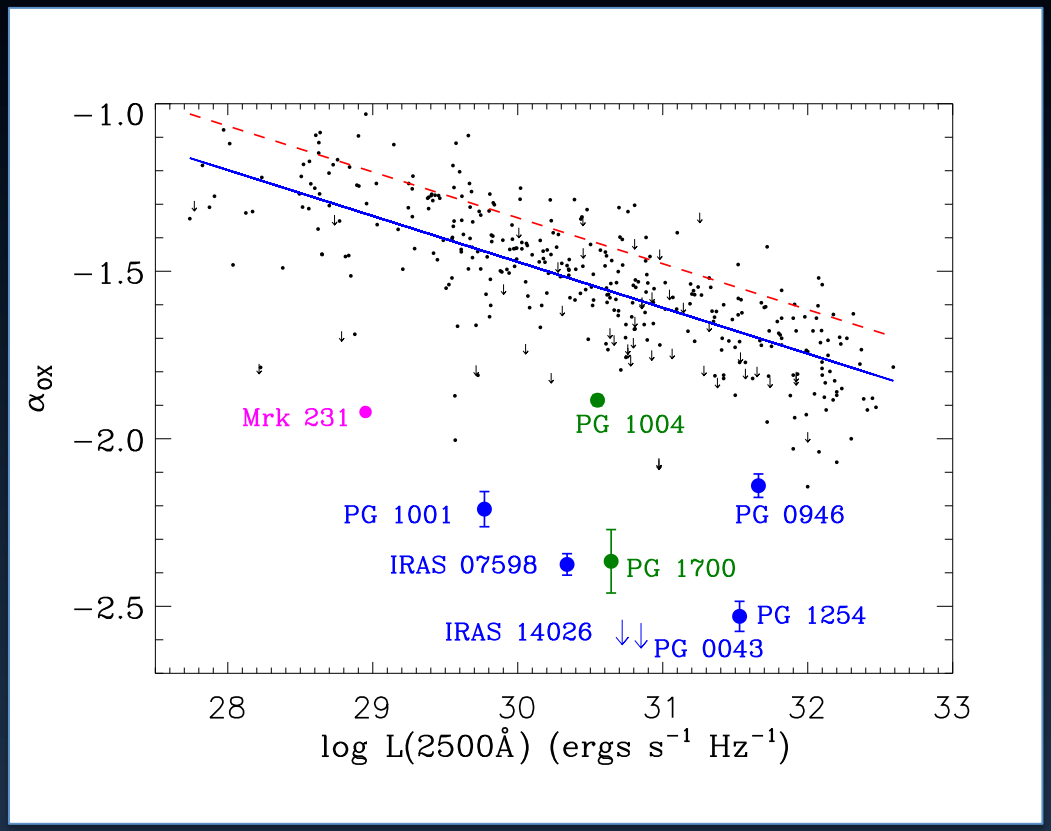
- V=1000-30,000 km/s - 15% of optically-selected QSOs
- Important on galactic scales? Angles and launch radius not well known

BAL Quasar Model

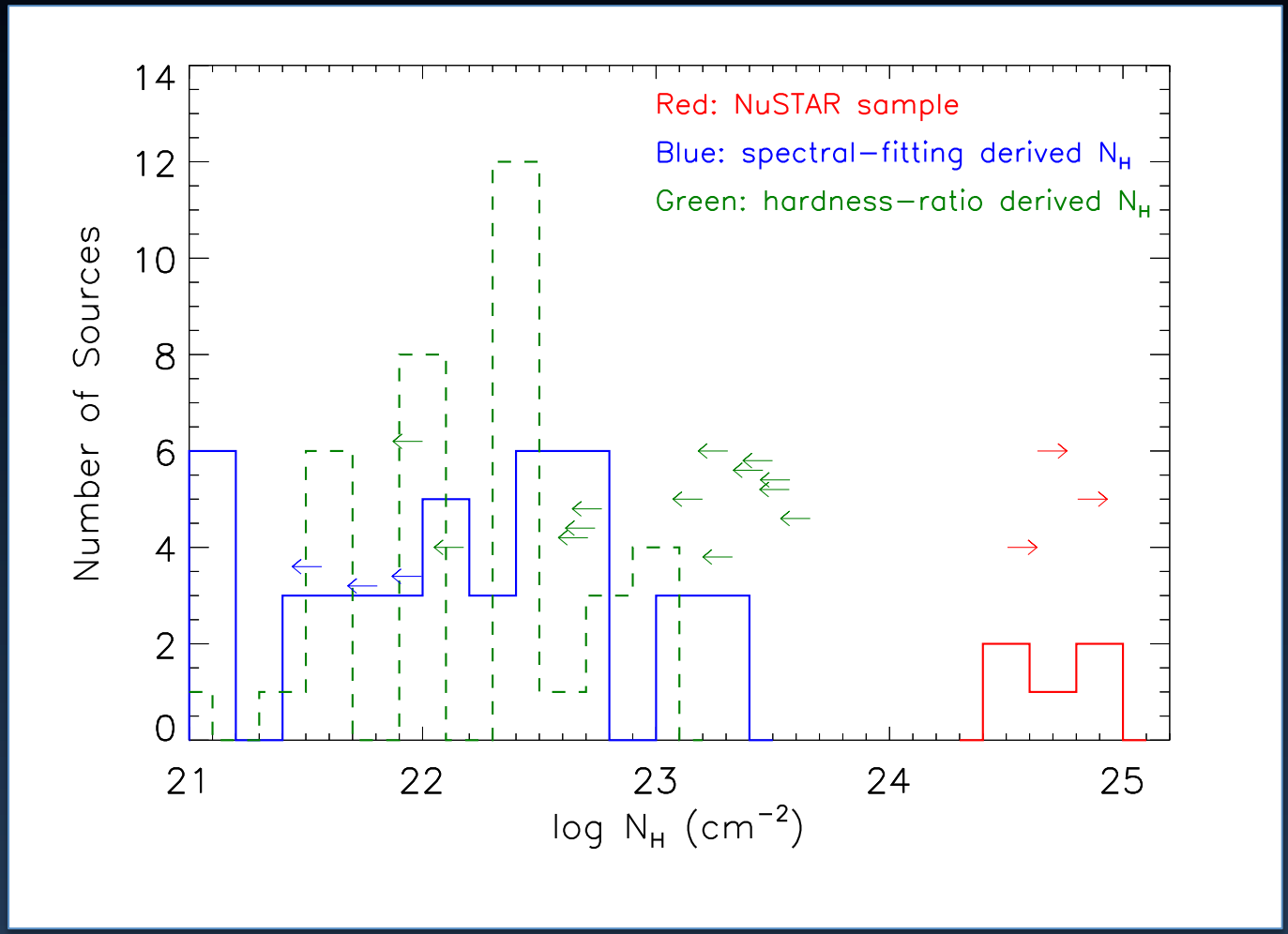


- All QSOs may have such outflows – seen in BAL QSOs due to geometry

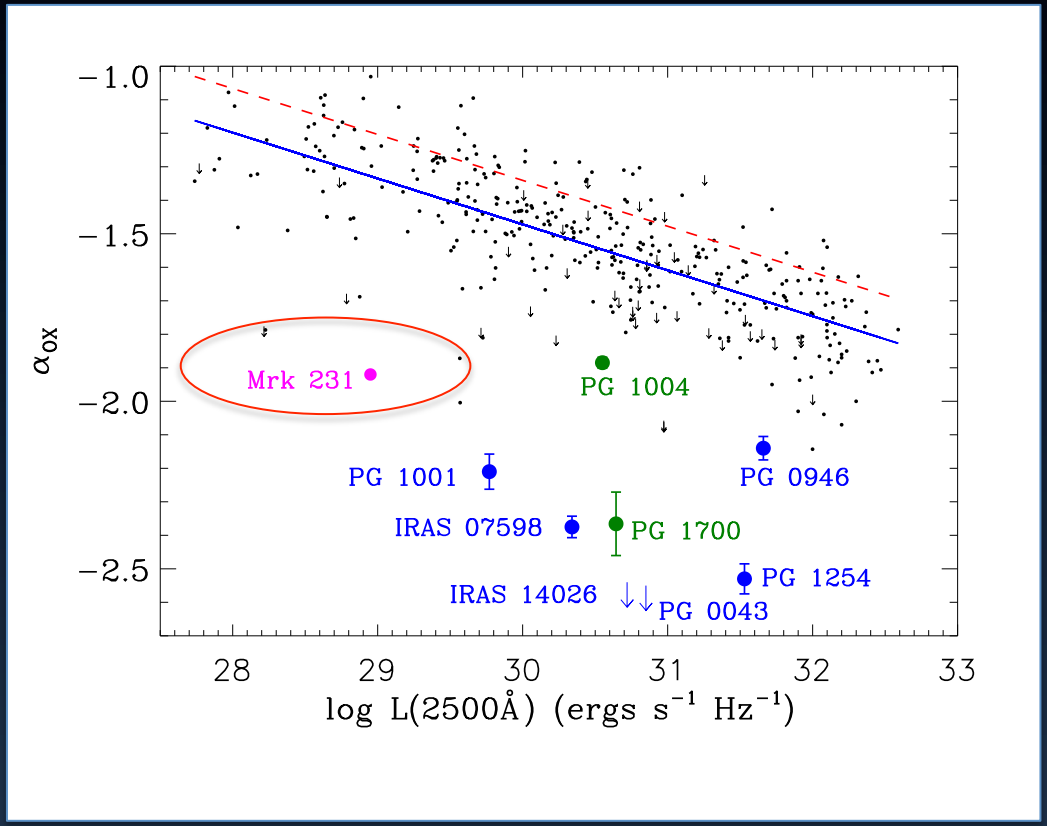
BAL QSO Sample



Testing Absorption



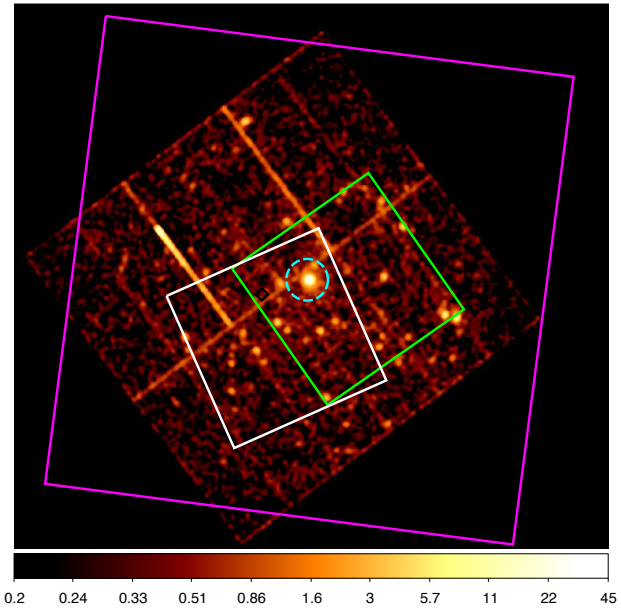
Mrk 231

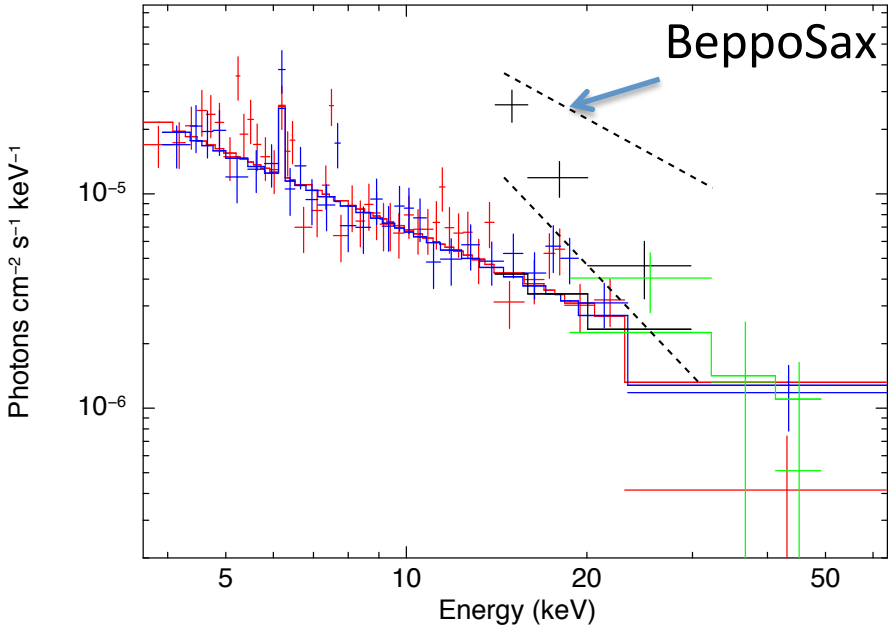


Mkn 231 – targeted as ULIRG

- BALQSO (nearest quasar, d=187 Mpc)
- Luminous starburst and AGN (L~1.5 x 10^{46} erg/s)

Mkn 231





Teng et al 2013

Other NuSTAR Results

- Bolokovic – Sample of BAT obscured AGN
- Murray Brightman – torus covering factor
- Liz Rivers – NGC 7582 (poster)
- Ady Annuar – Local CT sample