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X-ray Reprocessing in Local AGNs

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Objective

X-ray Unification

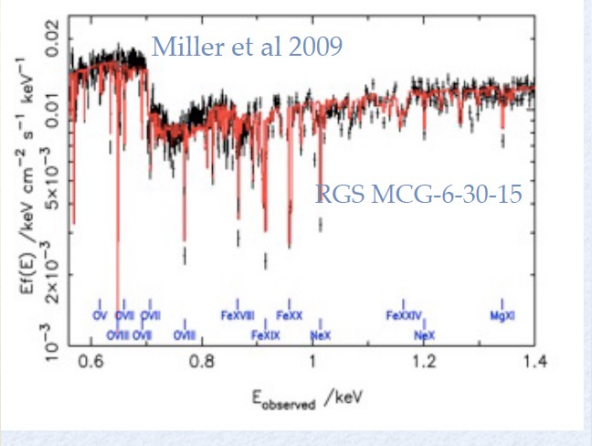
Test whether we may explain the gross X-ray spectral properties of the local AGN population with a simple, but physically self-consistent, model of reprocessing by circumnuclear material

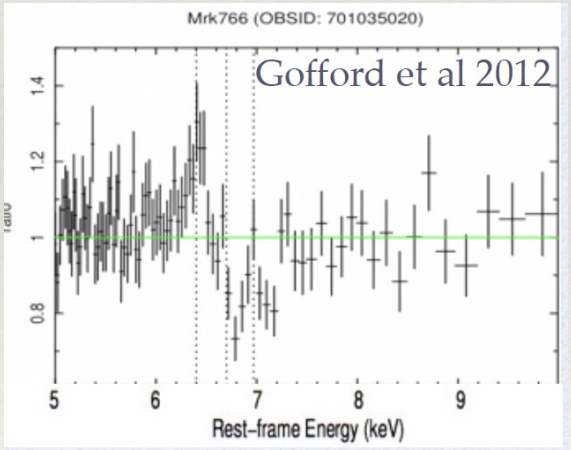
X-ray signatures: broad range of N_H, ξ

Outflow hundreds-thousands km/s, low ξ, N_H zones (e.g. Blustin et al 2005, McKernan et al 2007)

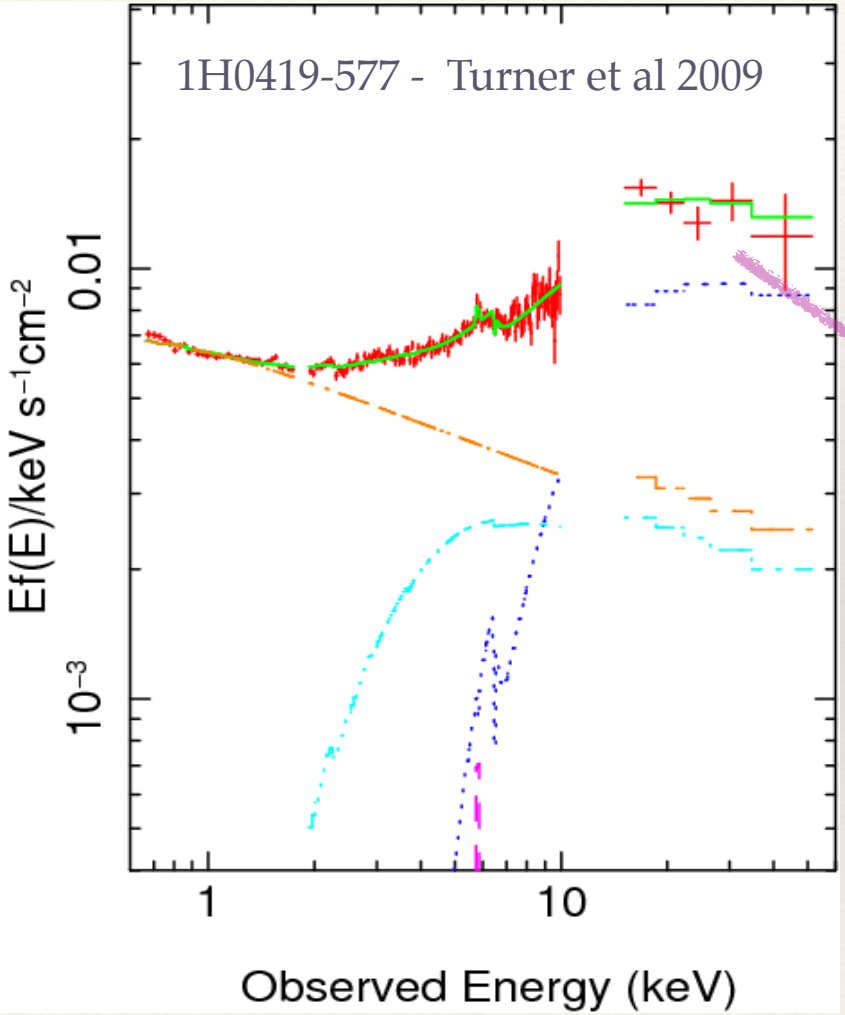
Tens of thousands km/s - fraction of c for high ξ N_H zones (Tombesi et al 2010)

Wind inevitable if accreting at high fraction of Eddington (King & Pounds 2003, King 2010)

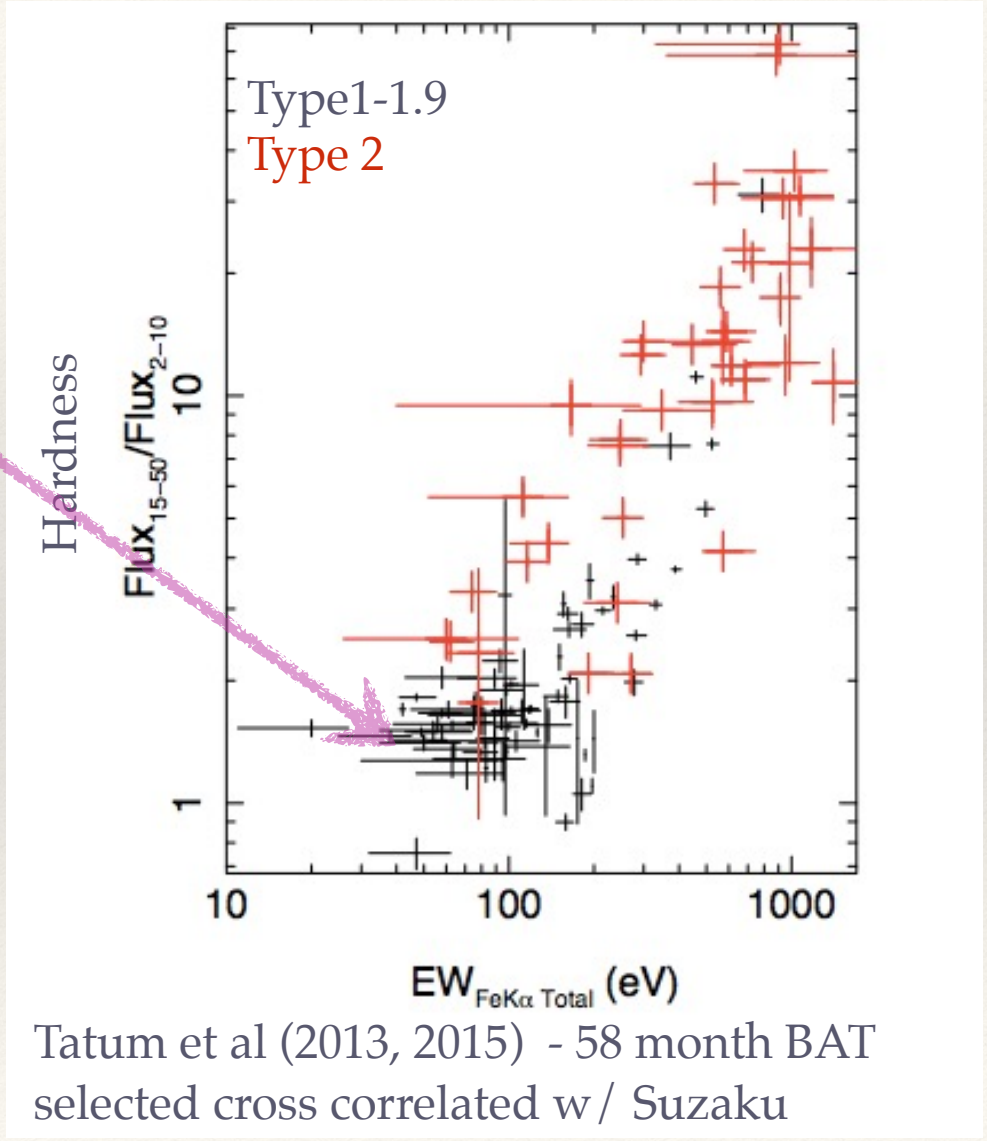




Suzaku study of local AGN



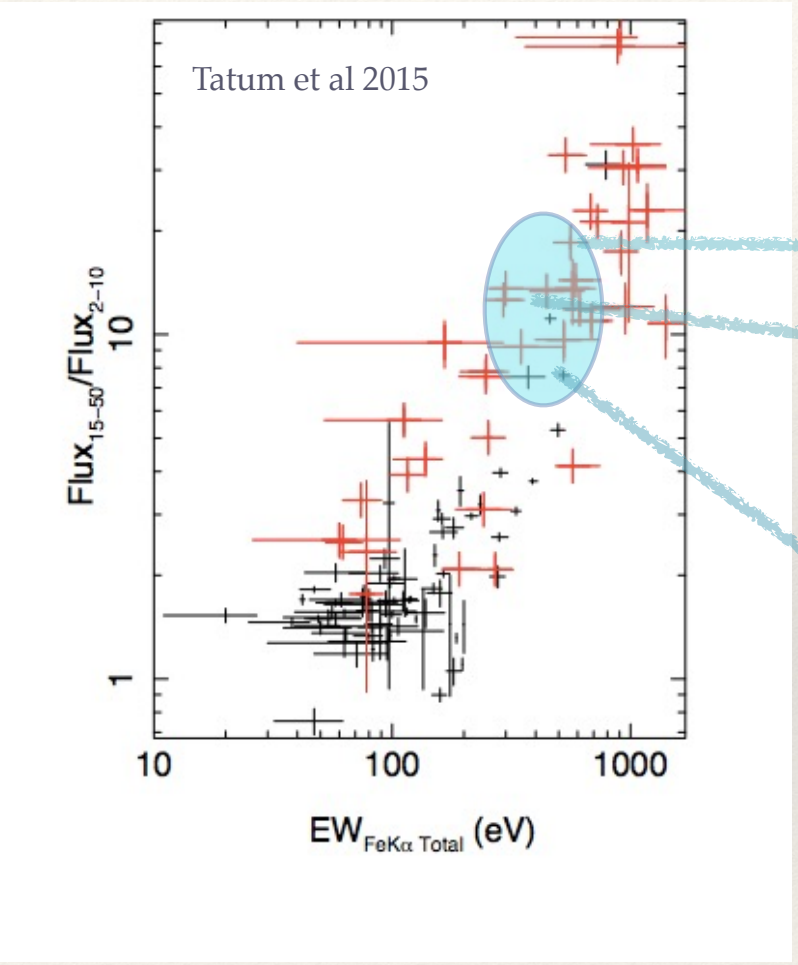
Hard component- partial-covering Compton-thick gas type I AGN



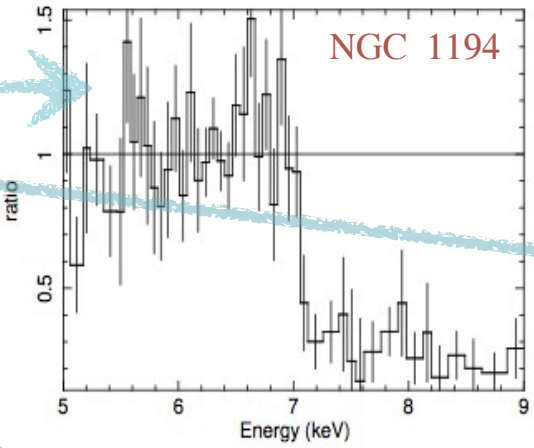
Tatum et al (2013, 2015) - 58 month BAT selected cross correlated w/ Suzaku

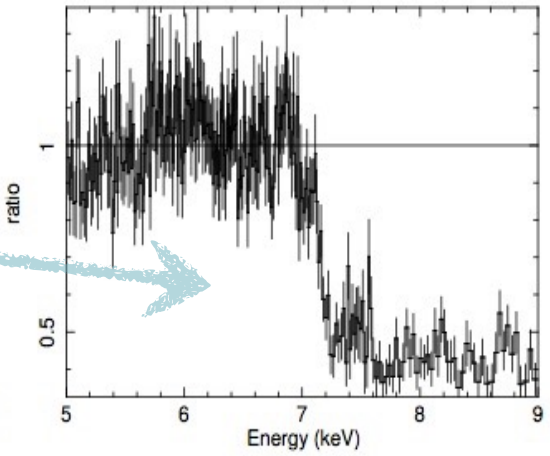
Hard excess ubiquitous in local Seyferts

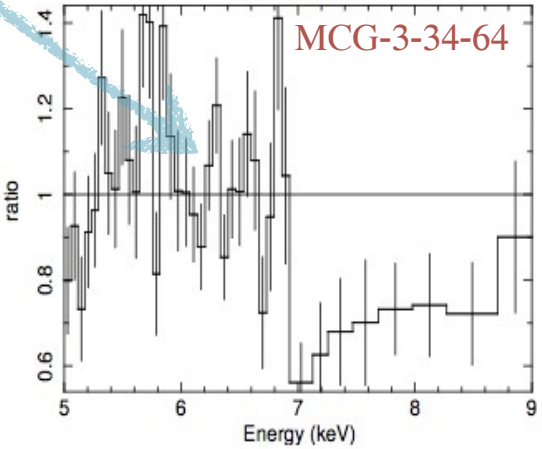
Sharp edges in hard sources



NGC 1365 2010 PIN data show very hard excess - absorption!







Sharp edges - hardness not predominantly from GR blurred component (Tatum et al 2012)

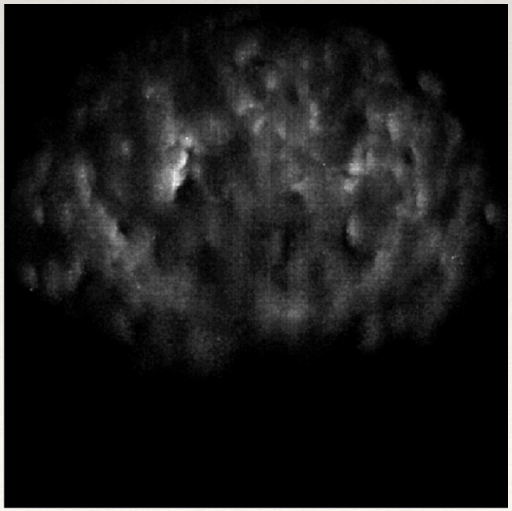
MCRT:Compton Thick Wind Model

High global covering, clumpy neutral gas atmosphere, partially covering source (cf Nandra & George '94)

Accounts for scattering of photons between clouds

System scale-free - i.e. scale can be set to anything, keeping N_H through each cloud invariant get same results - we never specify size of clouds in cm nor gas density in cm^{-3}

Instead specify shell inner (Rmin) and outer (Rmax) radii in terms of cloud radii



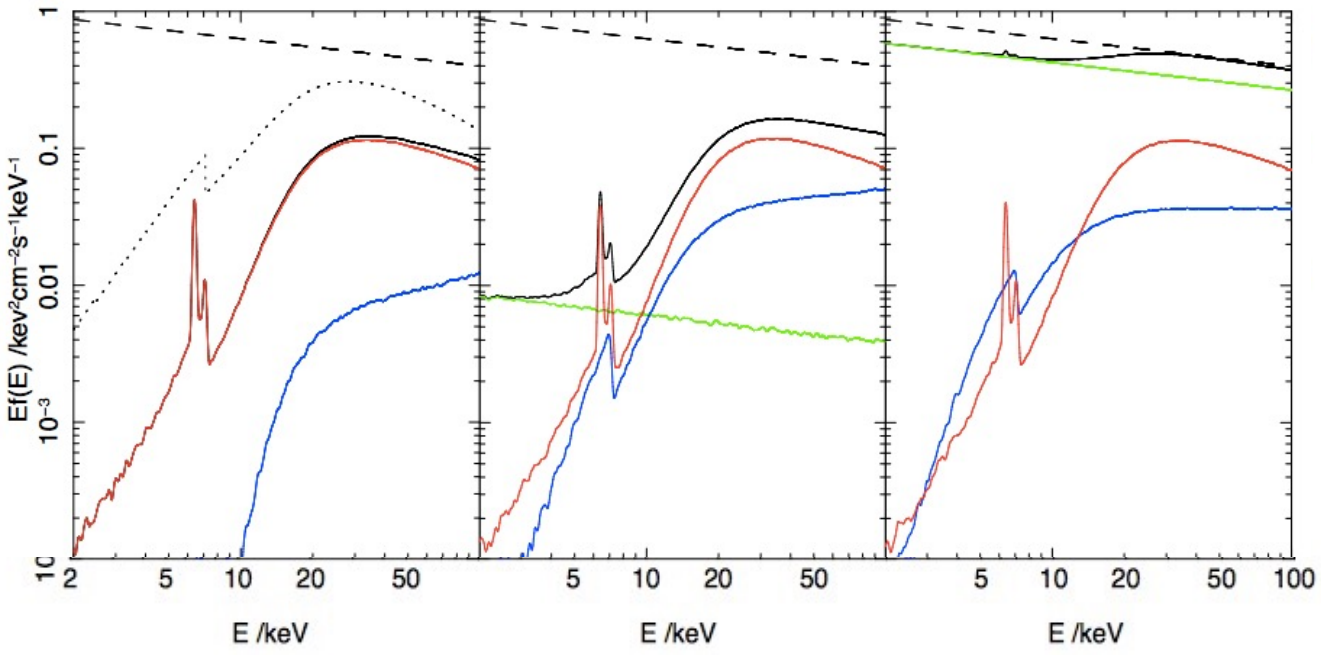
Rmin, Rmax control covering fraction of atmosphere

Initially, spectra for each atmosphere parameter averaged over large solid angle of sight-lines

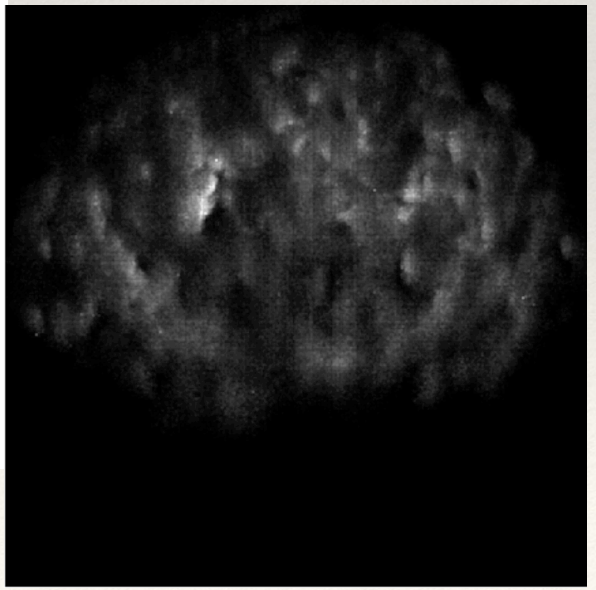
MCRT: spectral variability of a single AGN

Miller & Turner 2013 - accumulated spectra over small sets of sight-lines

$n_0 = 1.5 \times 10^{24}$ cm^{-2} mean column density through each cloud,
$\Gamma = 2.2$, shell 10-20 cloud radii,
polar distribution for cloud number density $\propto \sin \boldsymbol{\theta}$



incident continuum
unabsorbed continuum
scattered light
transmitted continuum

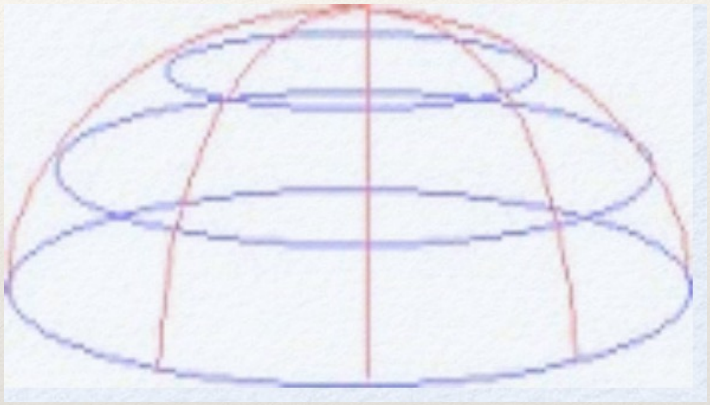


Spectral variations evident as a function of azimuthal angle, for a single atmosphere

MCRT: Unification of Local AGN

Extend Miller & Turner (2013) sims - test whether a single atmosphere can account for the local AGN population

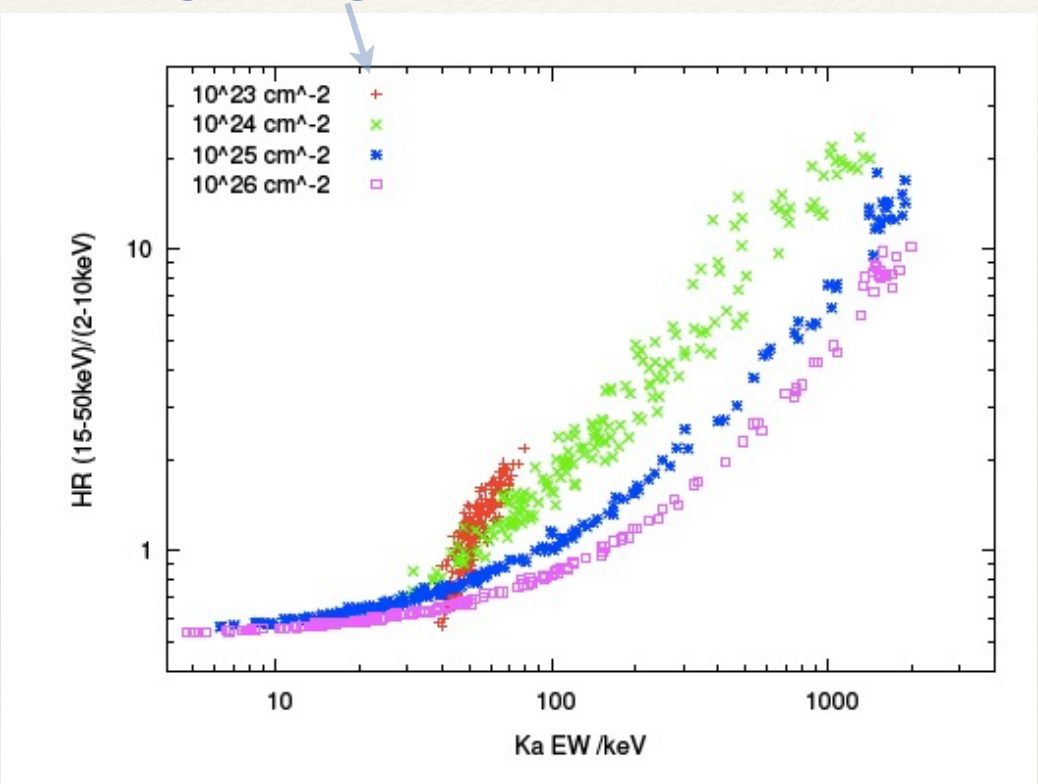
Used sinθ distribution with polar angle



Bin over azimuthal and polar angle in ~10^{o}x10^{o} segments - large enough to give partial covering in majority of sight-lines - small enough to get variations between sight-lines

Sampling a single atmosphere

mean column density
through a single cloud



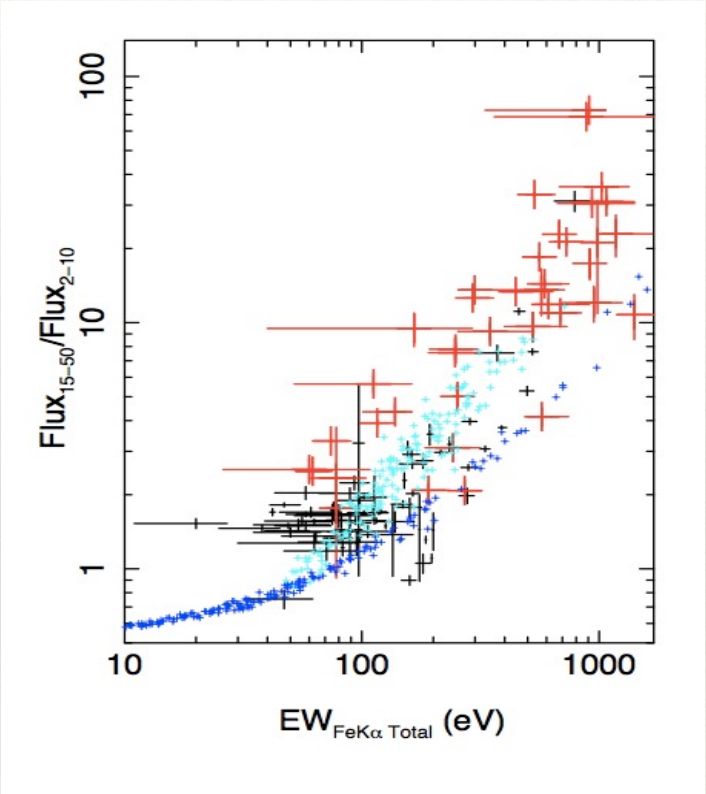
R=10-20, 1000 clouds, small samples of solid angle, cloud density constant

Clayton, p.comm

Single atmosphere

Tatum et al 2015

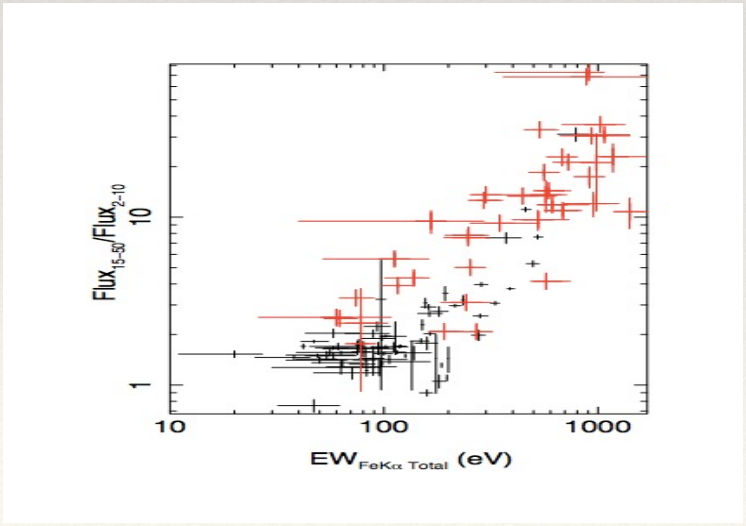
n_0=5x10^{23} cm^{-2}, 1x10^{25} cm^{-2}
Γ=2.2, 10 - 20 cloud radii
cloud density constant
sinθ

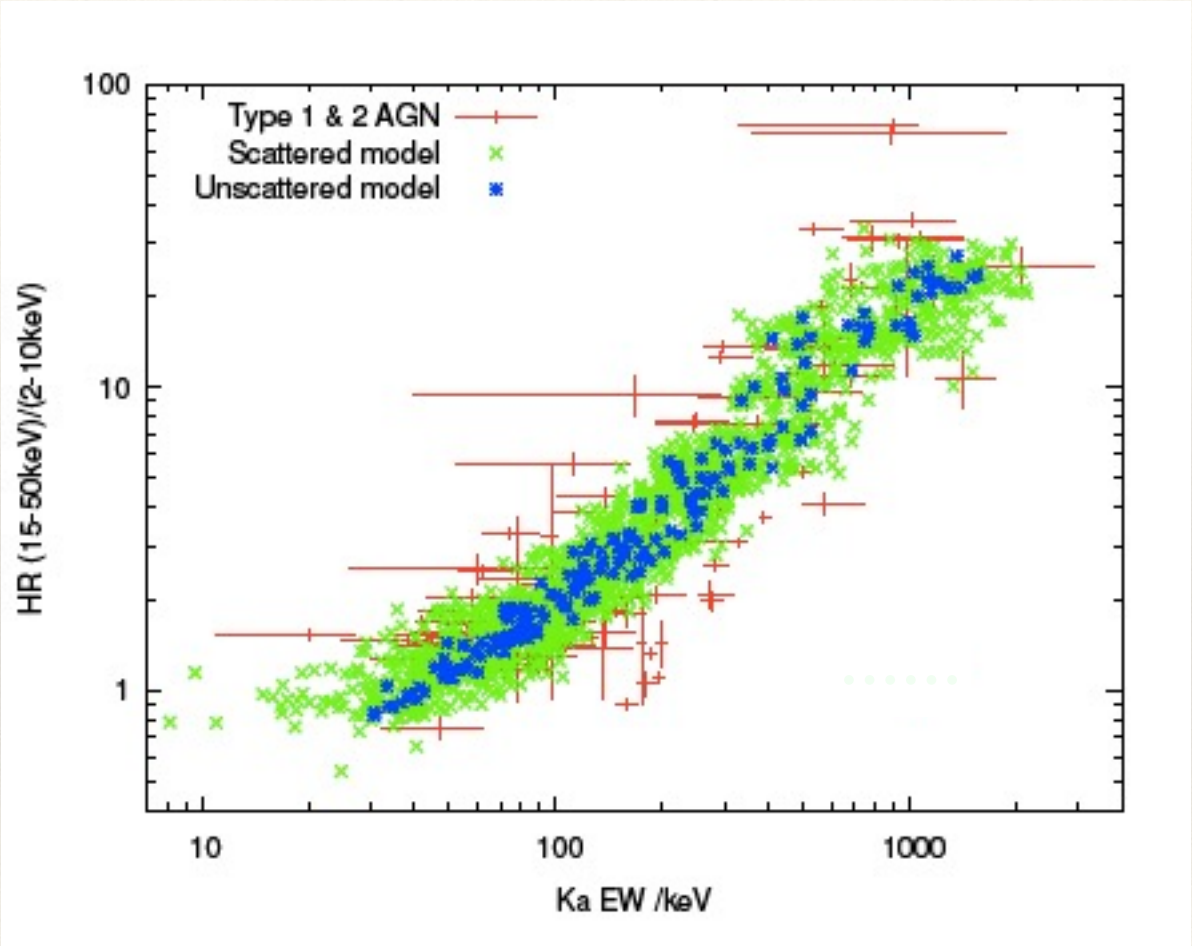


Model Uncertainties

- $n_0 = 10^{24}$ cm^{-2}
- ...including simulated experimental errors

Data consistent with model.
Type 1 and 2 explained by different sight-lines through ensemble with probability of obscuration a function of polar angle





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Summary

- Not seeing naked disk - X-rays reprocessed by wind with high N_H, global covering, part of massive clumpy outflow
- **A single Monte Carlo Radiative Transfer reprocessor model provides a *unified model* for the X-ray properties of the local AGN population - including spectral variability behavior**
- **The probability of a sight-line being obscured by a cloud is a function of polar angle**
- **Smooth distribution of absorber properties, rather than bimodal behavior**
- Compton-thick clumpy absorber not previously recognized as ubiquitous in AGN - crucial for understanding, accretion process, feedback, energy budget and CXRB