Obscured AGN in the local Universe: XMM-Newton legacy and future

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Why do we need X-rays to study the AGN physics?

- Central engine
- Accretion flow
- Birth and evolution of supermassive black holes
- Circumnuclear gas

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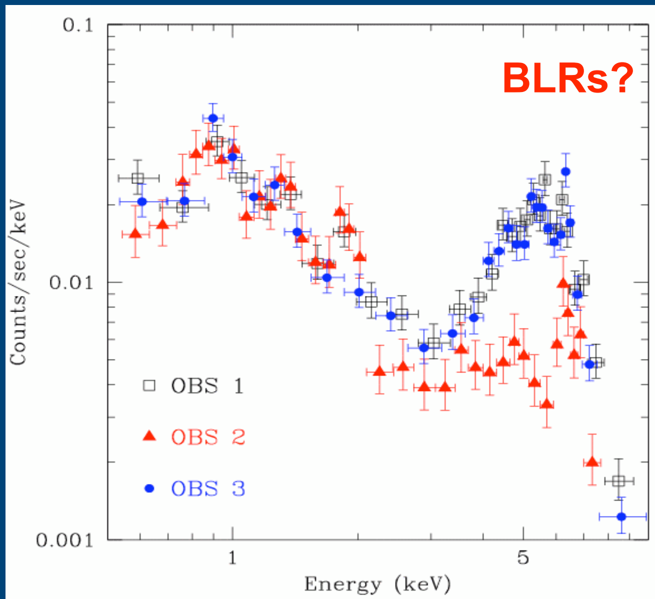
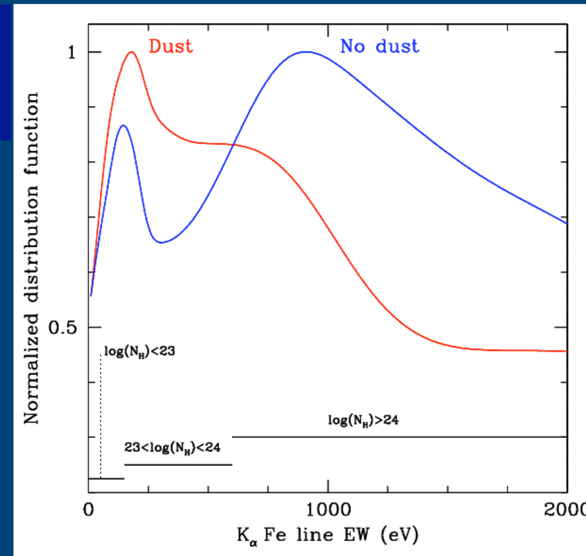
Quest for the location of the obscuring matter

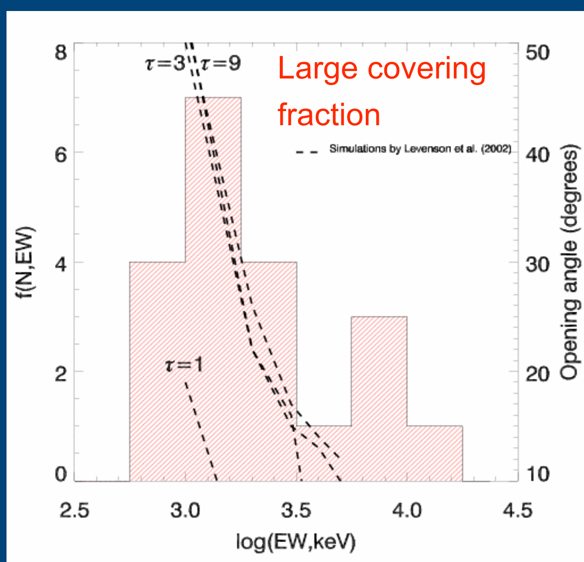
(NGC4388: Elvis et al. 2004; NGC4141: Puccetti et al. 2007
NGC1365: Risaliti et al. 2002, 2007)



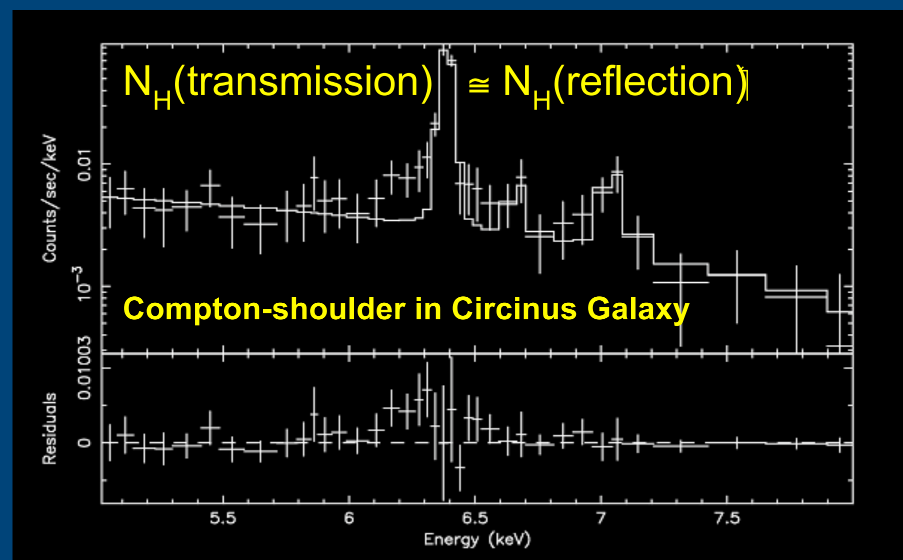
Host galaxy dust lanes?



(Guainazzi et al. 2005)



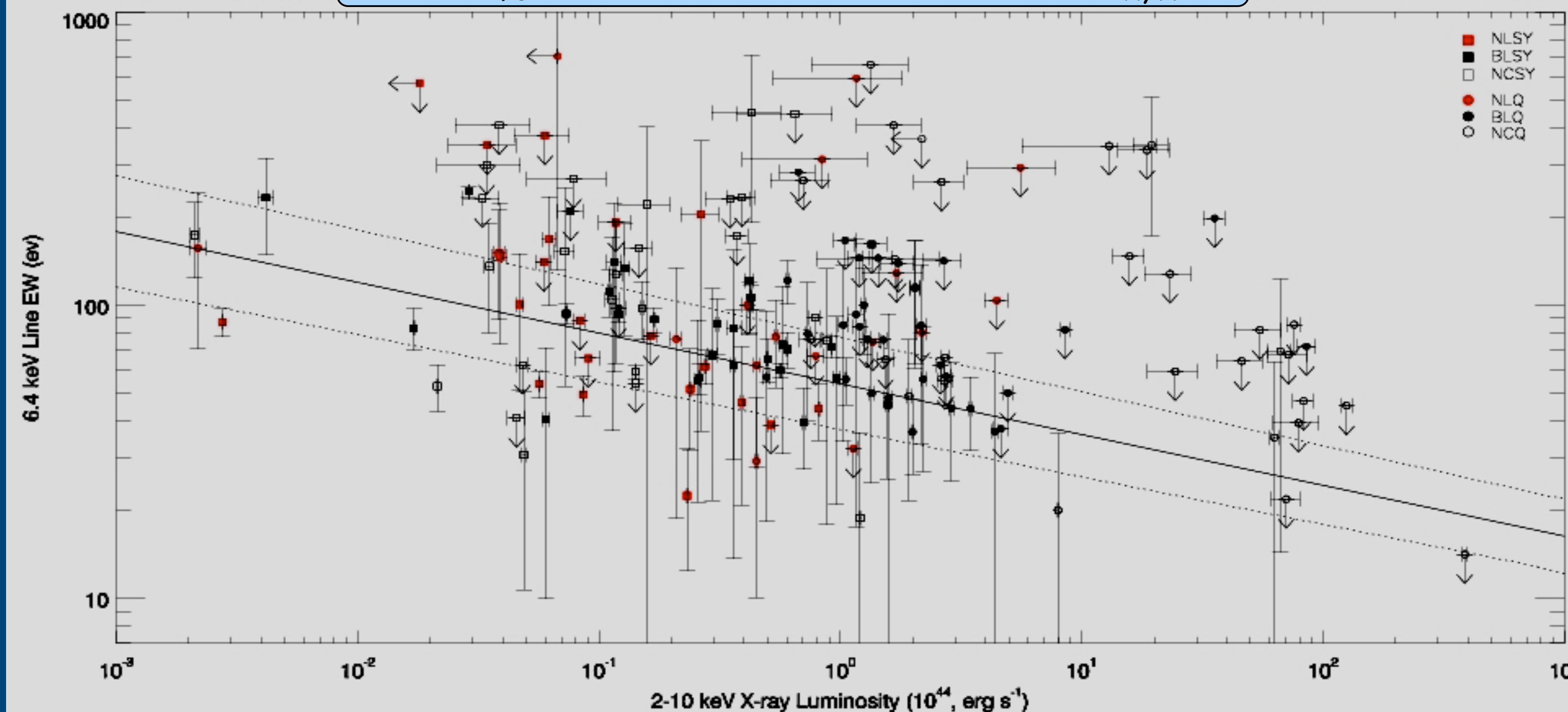
(Levenson et al. 2004, 2006, Krolik et al. 1994)



(Bianchi et al. 2002)

AGN-reflector feedback

$$\log(EW_{Fe})=(1.73\pm0.03) + (-0.17\pm0.03)\log(L_{X,44})$$



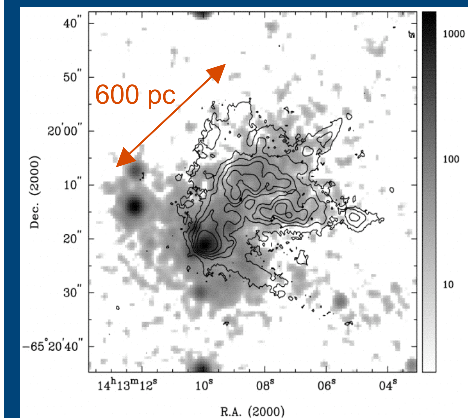
(Iwasawa & Taniguchi 1993; Page et al. 2004; Jimenéz-Bailón et al. 2005; Jiang et al. 2006; Bianchi et al. 2007)

- an anti-correlation between the EW of the Fe K_α fluorescent line (narrow component) and the X-ray luminosity (or accretion rate?) - ***Iwasawa-Taniguchi effect*** (Bianchi's poster)
- Best explained by a luminosity-dependent covering fraction of the Compton-thick reflector
- Quantitatively consistent with 5100 vs. 6.7 χορρελατιον ιν quasar (Maiolino et al. 2007)

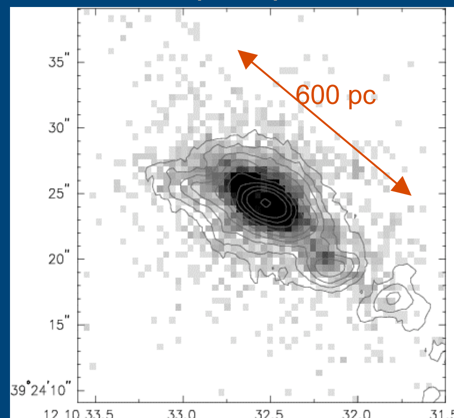
Soft X-ray Extended NLRs

Size of the NLRs according to Bennert et al. (2006)

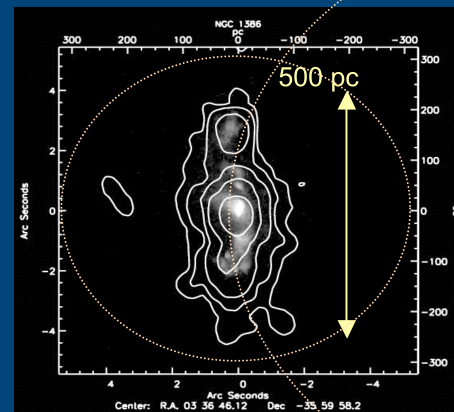
Images: O[III] – Contours: soft X-rays



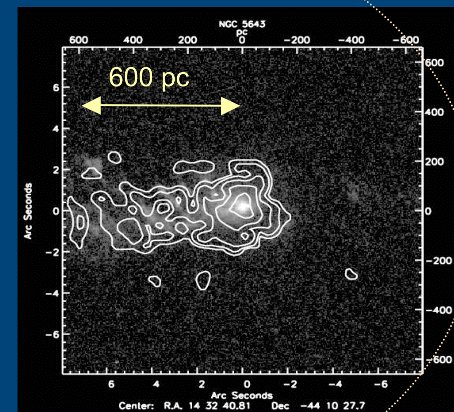
Circinus Galaxy
(Smith & Wilson 2001)



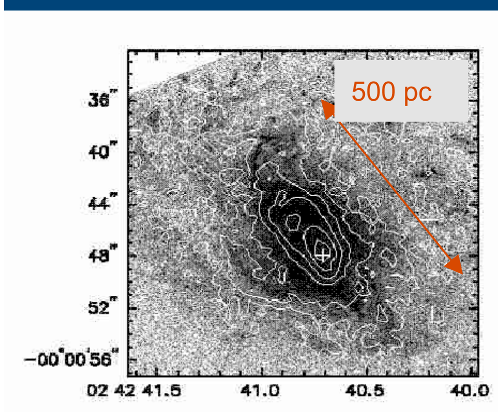
NGC4151
(Yang et al. 2001)



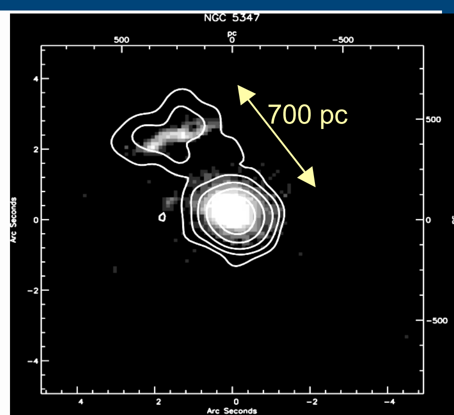
NGC1386
(Bianchi et al. 2006)



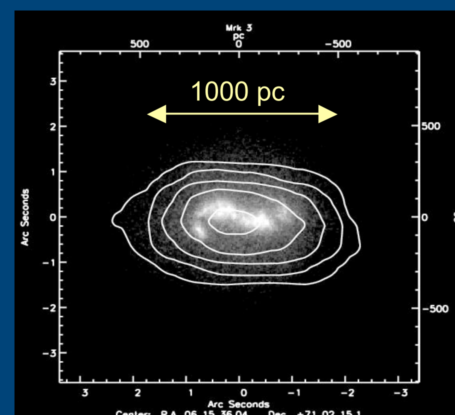
NGC5643
(Bianchi et al. 2006)



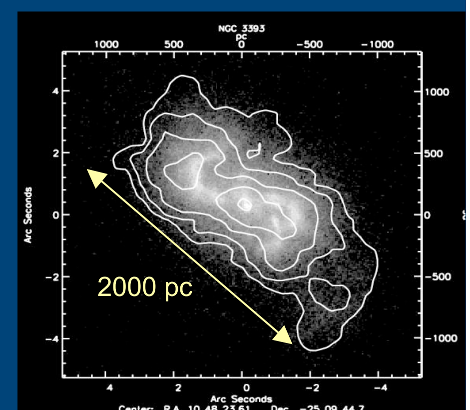
NGC1068
(Young et al. 2001)



NGC5347
(Bianchi et al. 2006)

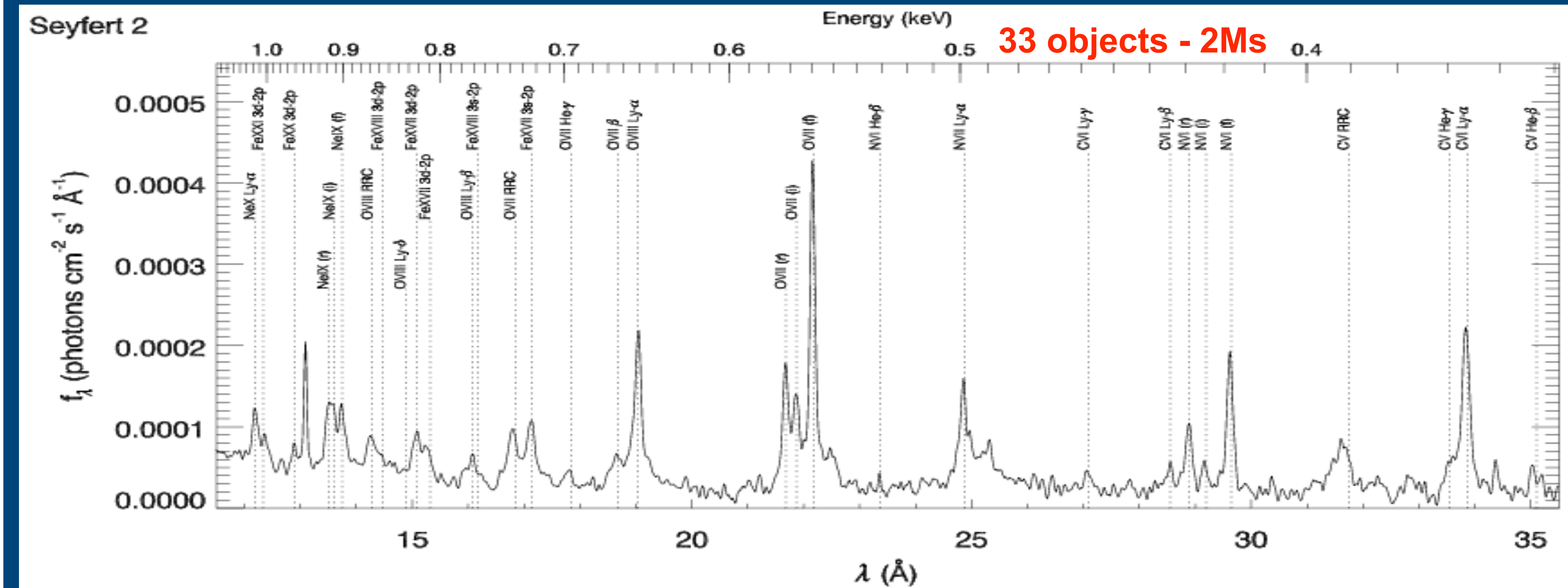


Mkn3
(Sako et al. 2000)



NGC3393
(Bianchi et al. 2006)

RGS spectroscopy

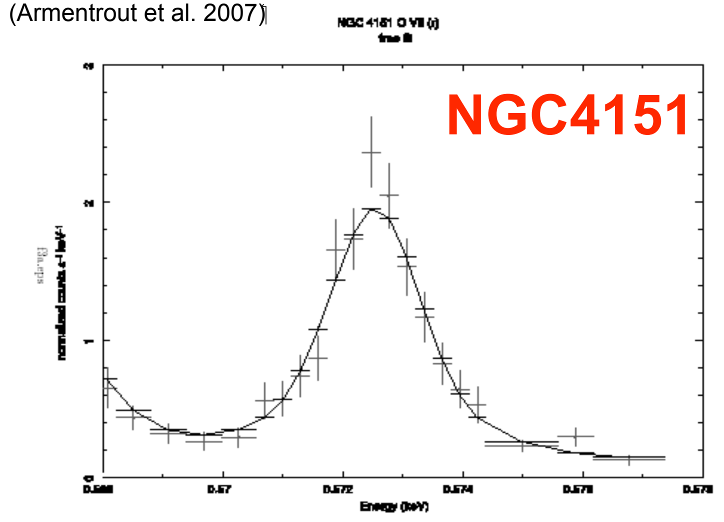


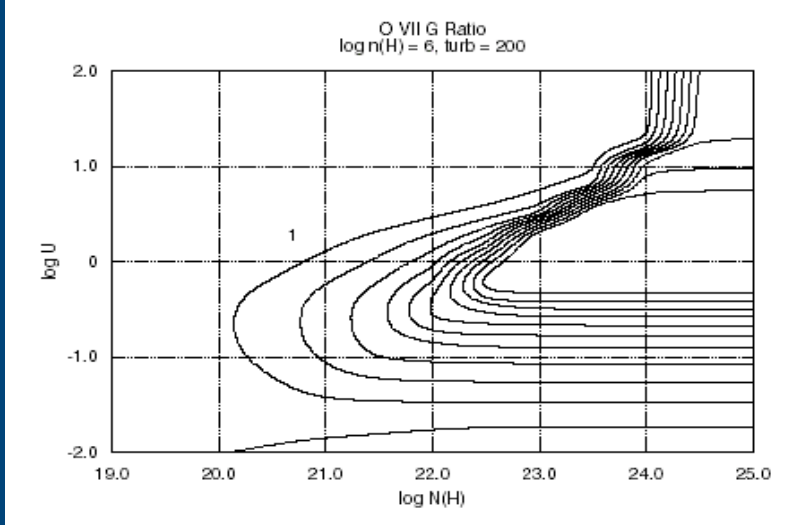
(XMM-Newton: NGC1068, Kinkhabwala et al. 2002; Mkn3: Bianchi et al. 2005; Pounds et al. 2005; NGC4151, Armentrout et al. 2007
Chandra: Mkn3, Sako et al. 2000; Circinus Galaxy, Sambruna et al. 2001)

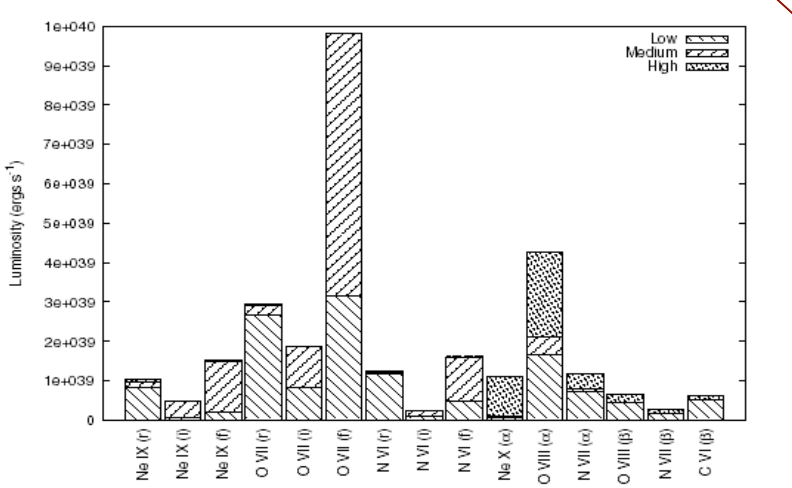
- **Line-dominated spectra – little or no continuum contribution**
- **3% in flux of the intrinsic AGN continuum see Bianchi's poster**
- **He- and H-like recombination transitions of Carbon, Oxygen, Neon and Fe-L “forest”**
- **He-like triplets dominated by the forbidden component – negligible intercombination**
- **Narrow Radiative Recombination Continua (RRC) are signature of photoionization**

Detailed photoionization calculations

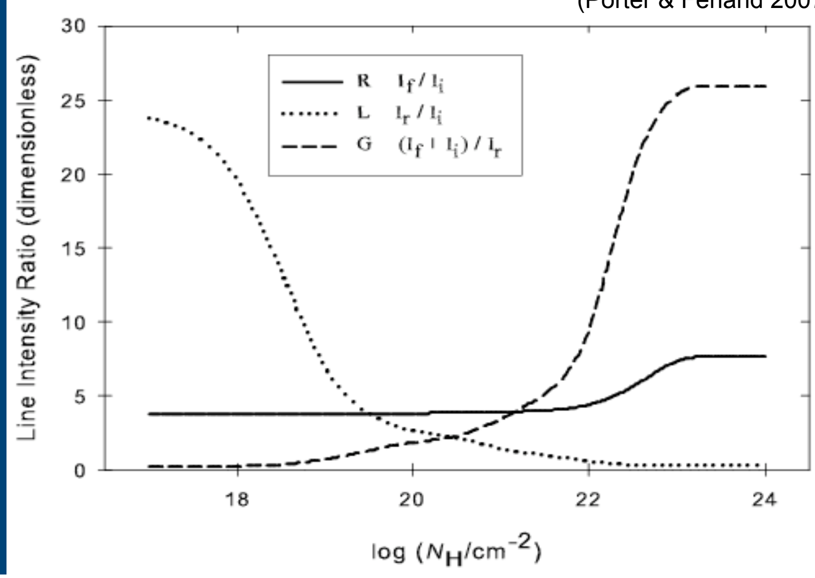
(Armentrout et al. 2007)







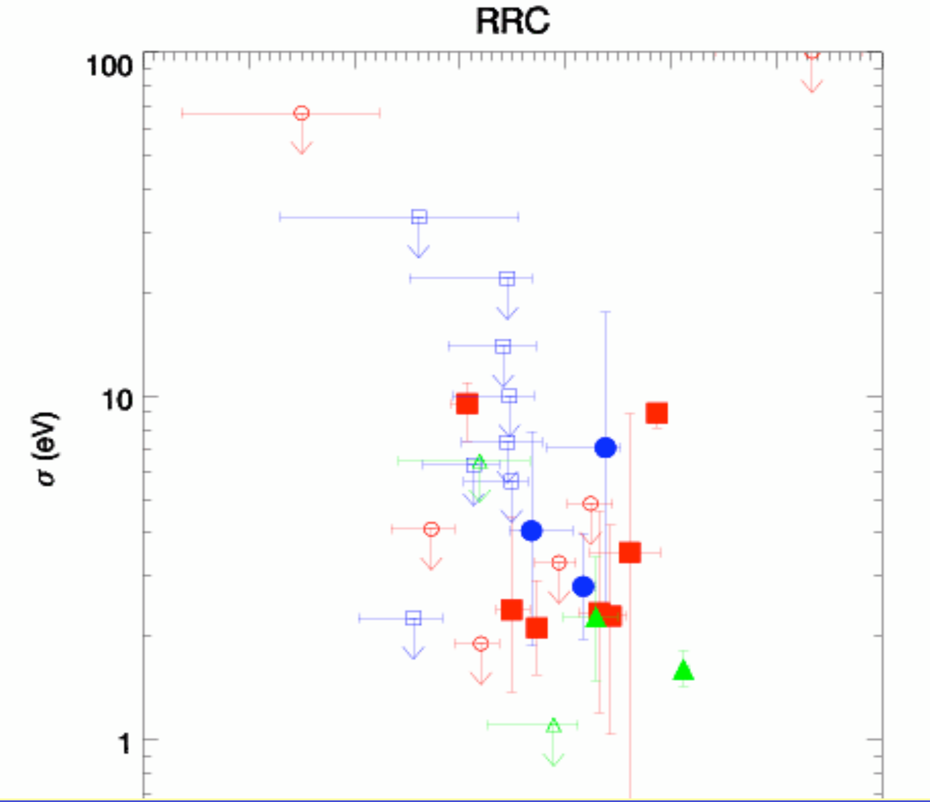
(Porter & Ferland 2007)

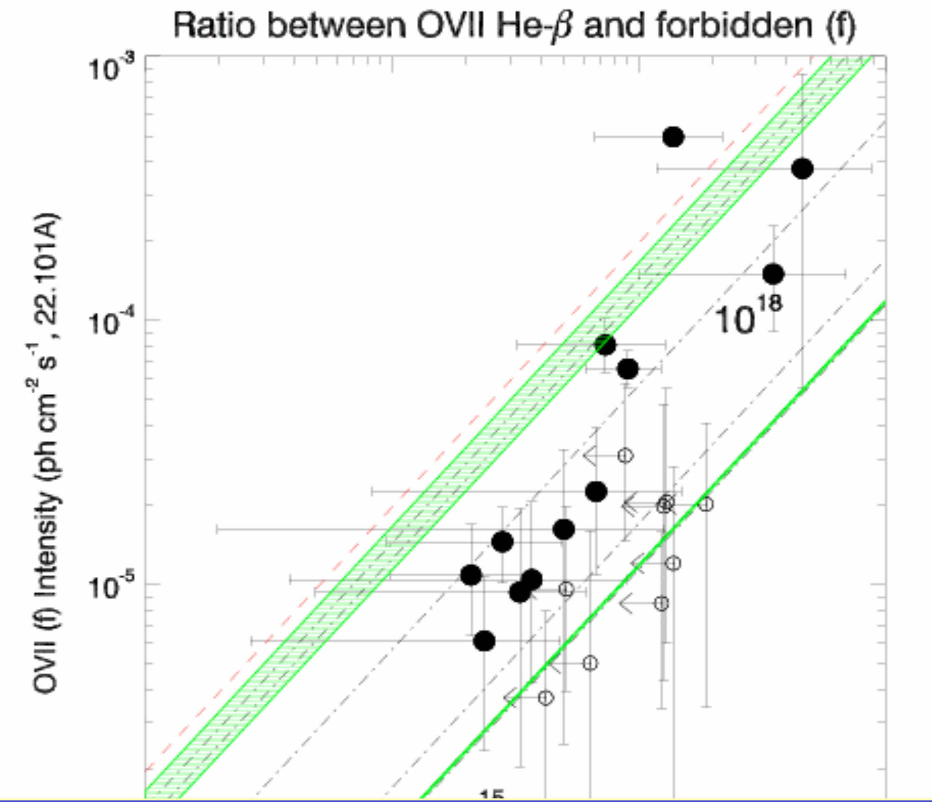


Sample of 69 RGS spe

CIELO

(Catalogue of Emission Line in Obscured AGN)





Large fraction (≥40%) of narrow *Radiative Recombination Continua*

Higher order resonance transitions (*np→1s*) larger then in pure photoionization

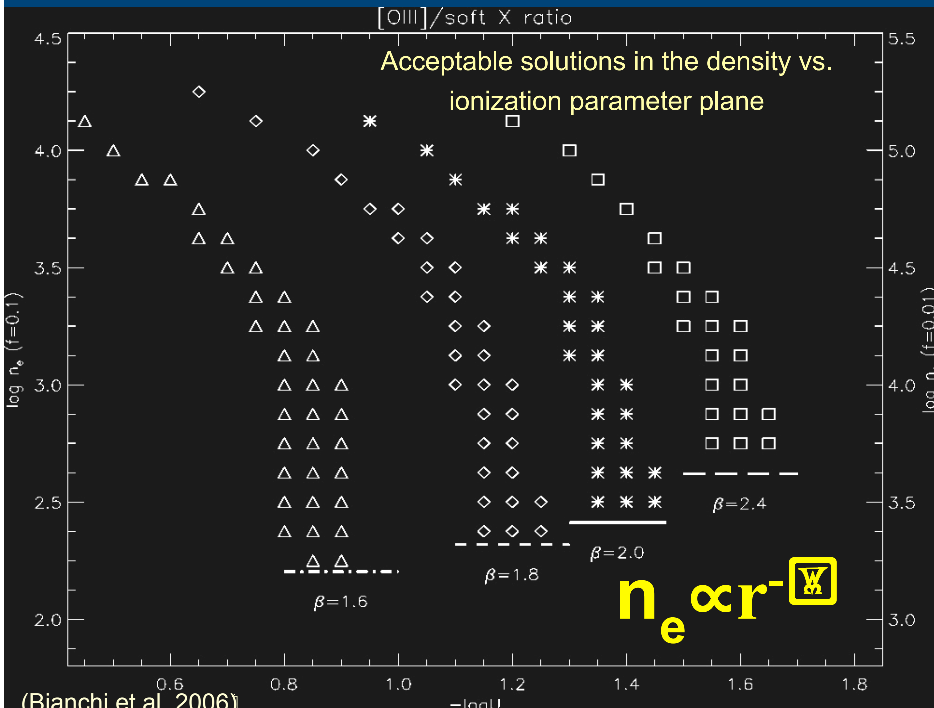
⇓

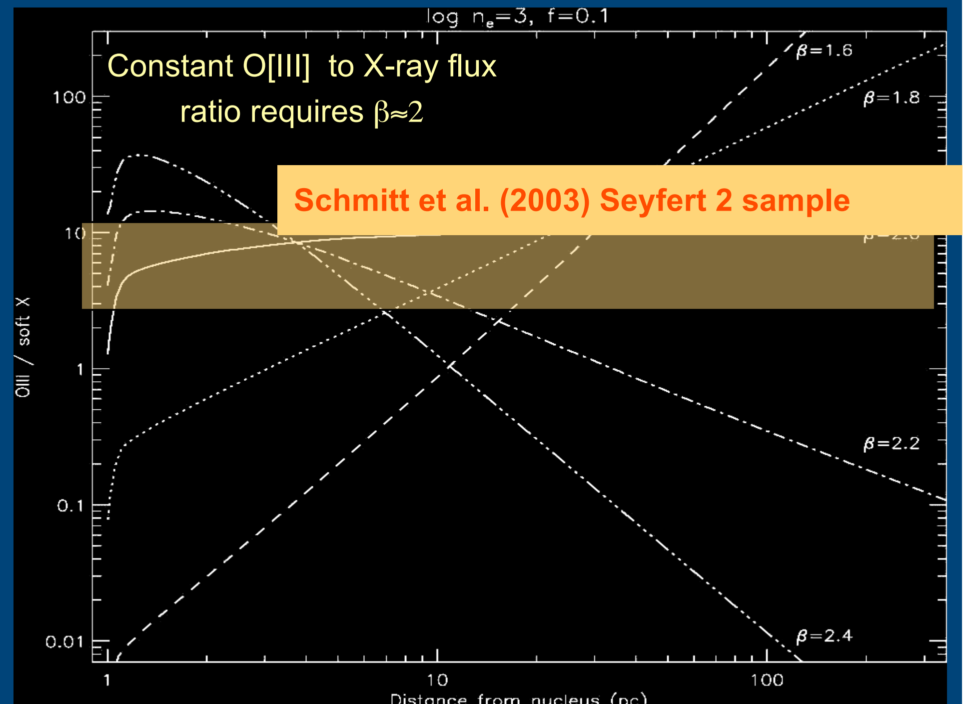
(Guainazzi & Bianchi, 2007)

AGN-photoionization (important role of resonant scattering ⇒ $N_H \cong 10^{17-18}$ cm^{-2})

Statistical discrimination vs. starburst-powered sources via OVII(f) diagnostics

X-ray to O[III] ratio versus photoionization codes





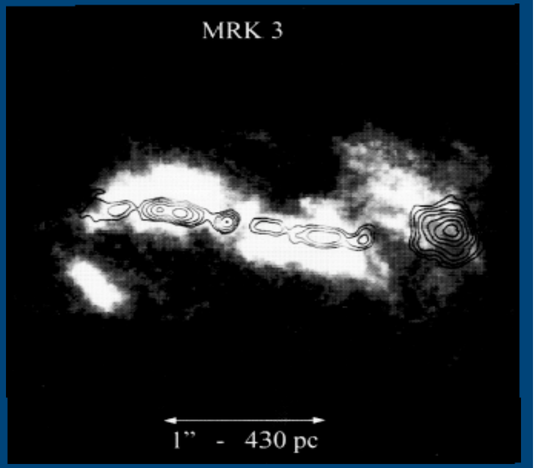
The comparison between the *Chandra* and the *HST* images shows that the [OIII]/soft X-ray ratio is fairly constant along with the radius, up to hundreds of pc. Photoionization models reproduce this behavior if $n_e \propto r^{\beta}$, with $\beta \approx 2$ (*i.e.* the ionization parameter is ≈ constant).

$n_e = n_e(r)$ *from NLR diagnostics*

- *Capetti et al. 1996:* $n_e \propto r^{-1}$ *(Mkn573)*
- *Kraemer et al. 2000, Kraemer & Crenshaw (2000):* $n_e \propto r^{-2}$ *(NGC1068)*
- *Bradley et al. (2004):* $n_e \propto r^{-2}$ *(M51)*
- *Bennert et al. (2006):* $n_e \propto r^{-[0.8-1.3]}$ *(IC5063, NGC7212, NGC3281, NGC5643, NGC1386)*

A shallower $n_e = n_e(r)$ is normally required

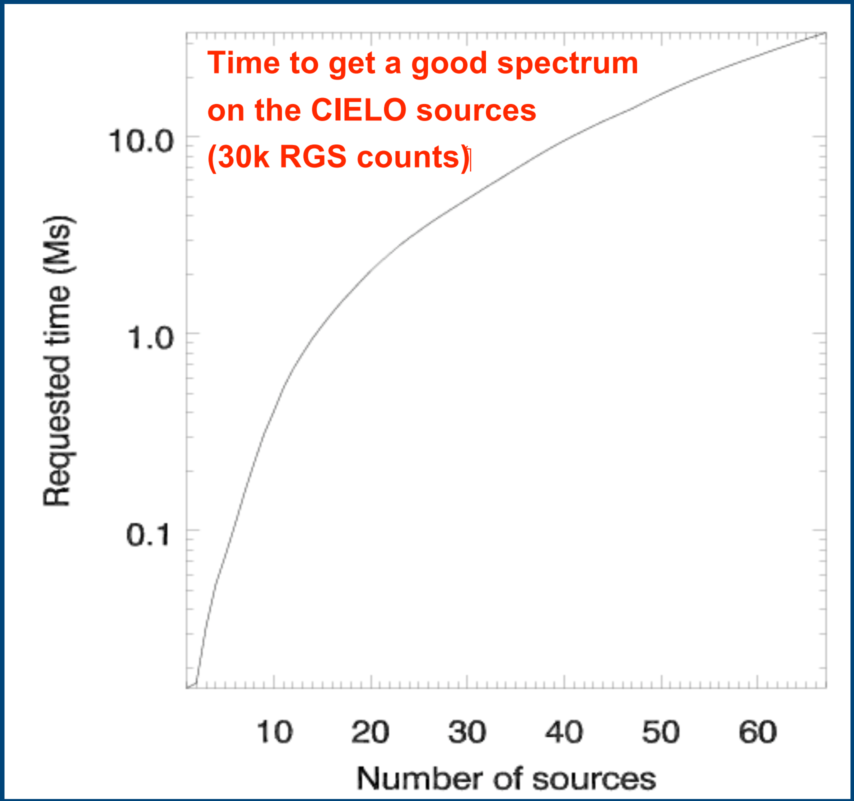
“Local” photoionization? Jet-ISM interactions

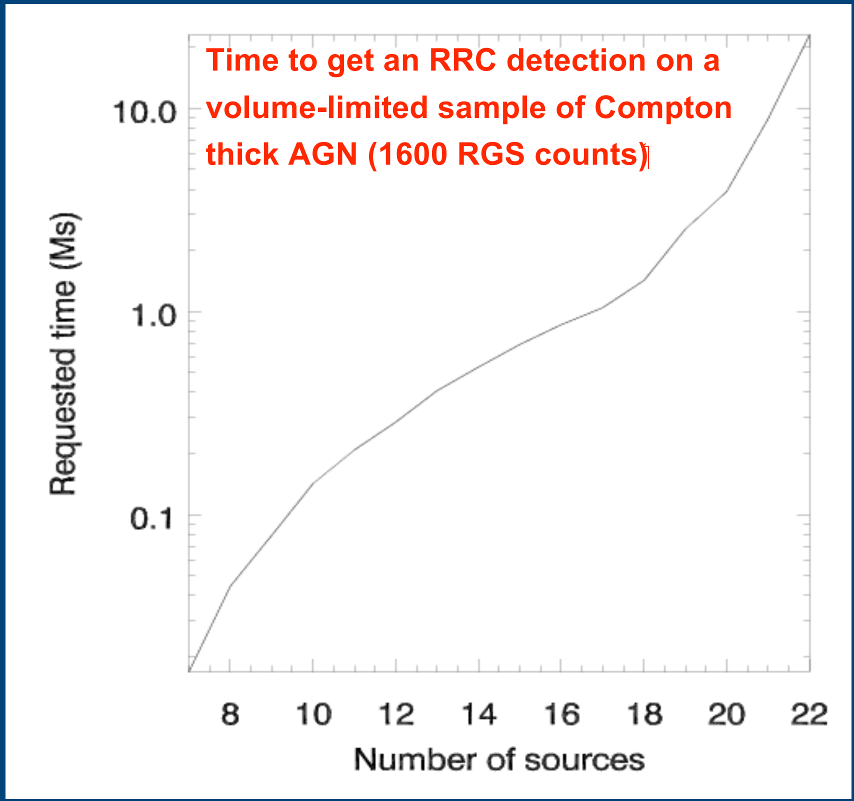


(Capetti et al. 1996)

Conclusions

- XMM-Newton has **ultimately solved** the issue on the nature of the soft excess emission in obscured AGN
- What's next?





To-rus or not to-rus

- Observational facts on the X-ray absorber/reflector:
  - Large covering factor in Compton-thick objects
    - almost invariably
  - Azimuthal symmetry when Compton-shoulder can be measured:
    - 1 object: the Circinus Galaxy
  - X-ray variability measurements suggests location at the BLRs
    - 3 objects: NGC4388, NGC4151, NGC1365
  - Statistical correlation between Compton-thin absorber and dust lanes
    - Large sample of nearby Seyferts
- Interpretation:
  - Compton-thick obscured AGN: a torus-like structure
  - Compton-thin obscured AGN: a mixed bag of torus, BLRs, disk winds, host galaxy, and starburst dusty region (why not?)