Modeling the Extreme X-ray Spectrum of IRAS 13224-3809

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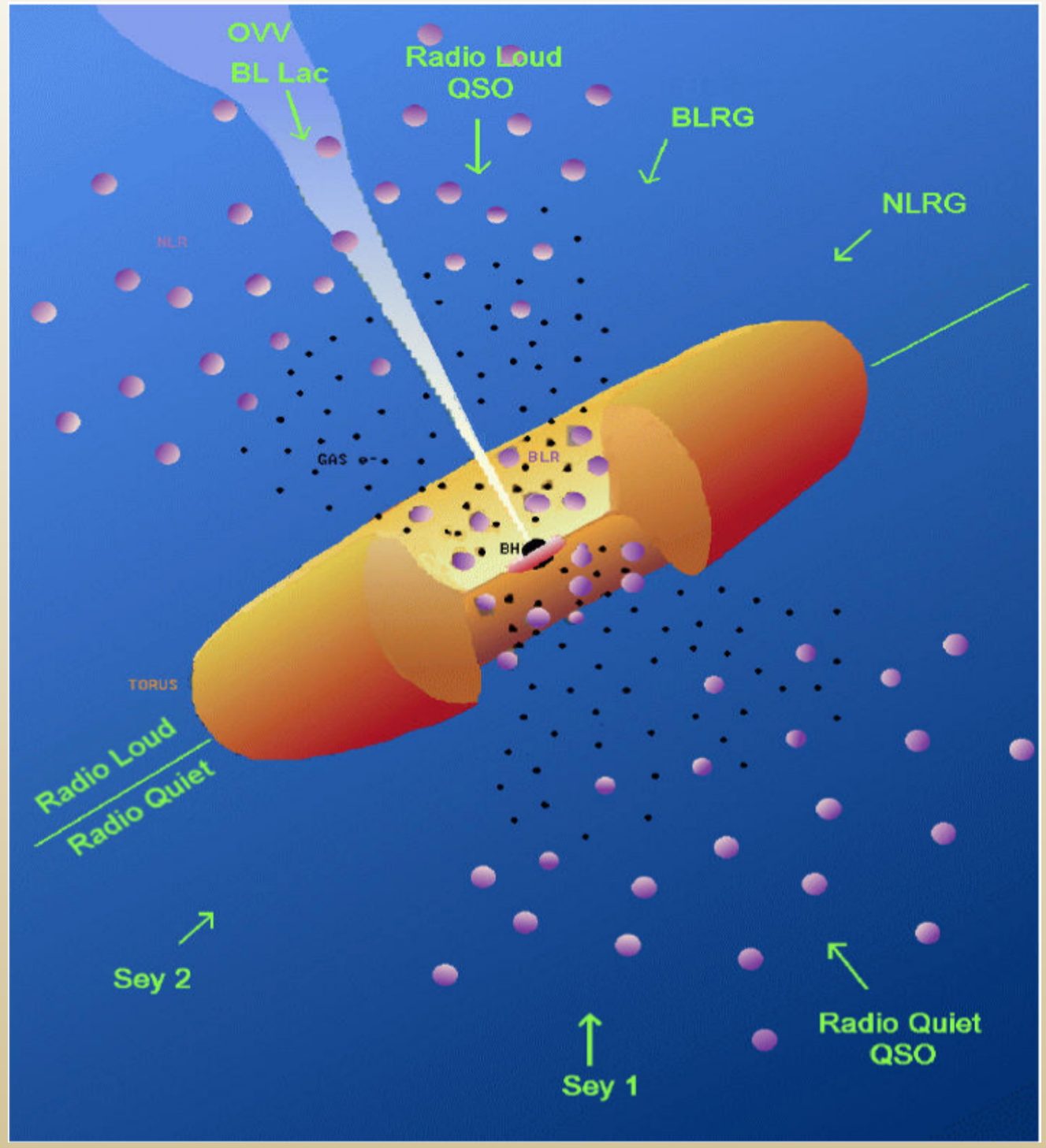
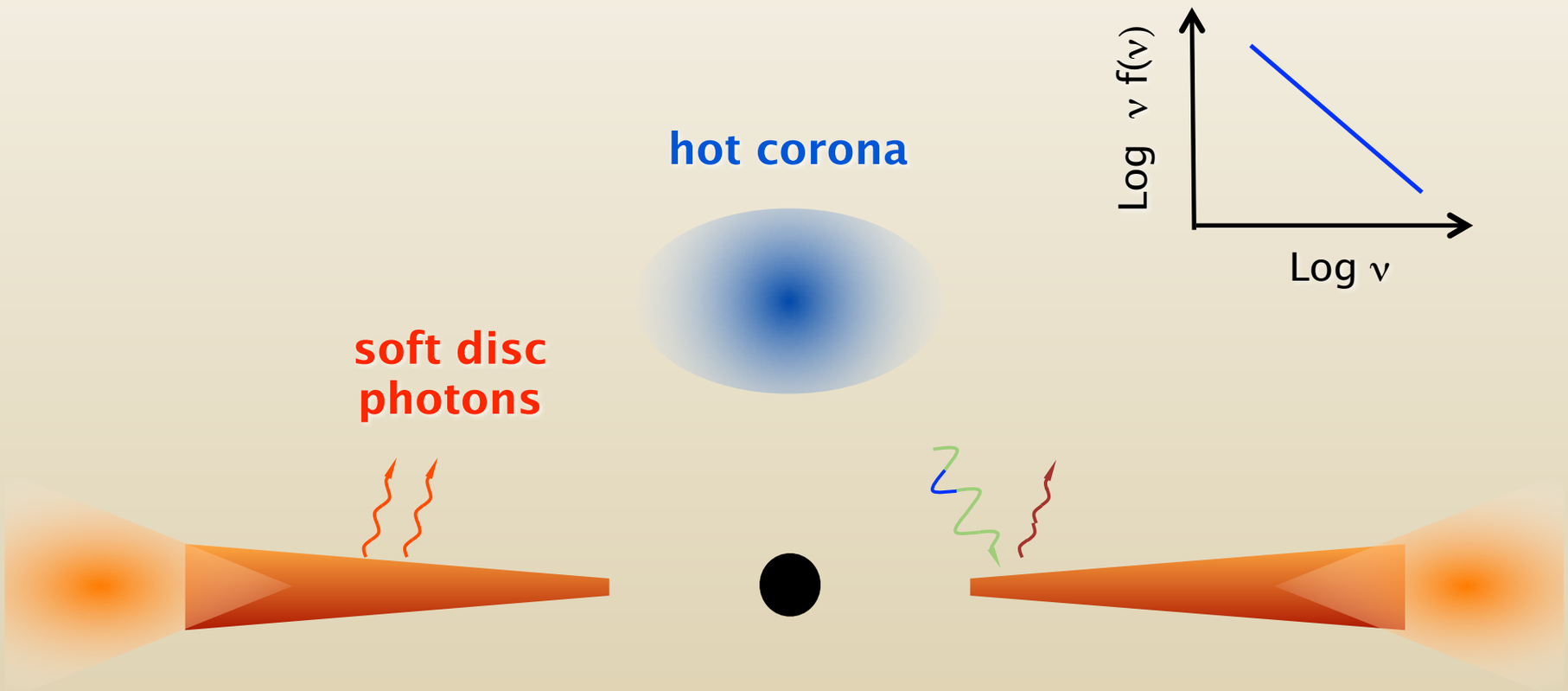
Seyfert Galaxies

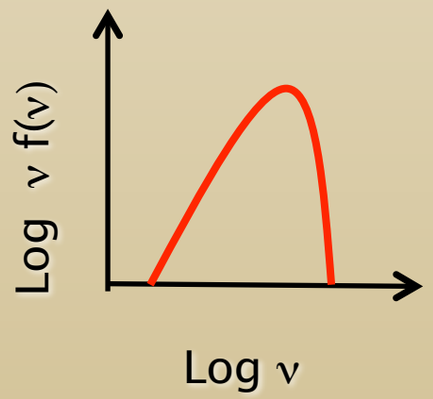
- most AGN display narrow optical lines
- Type 1: also display strong broad optical emission lines
- Type 2: broad component obscured by the dusty torus (**unification model**, Antonucci 1993)



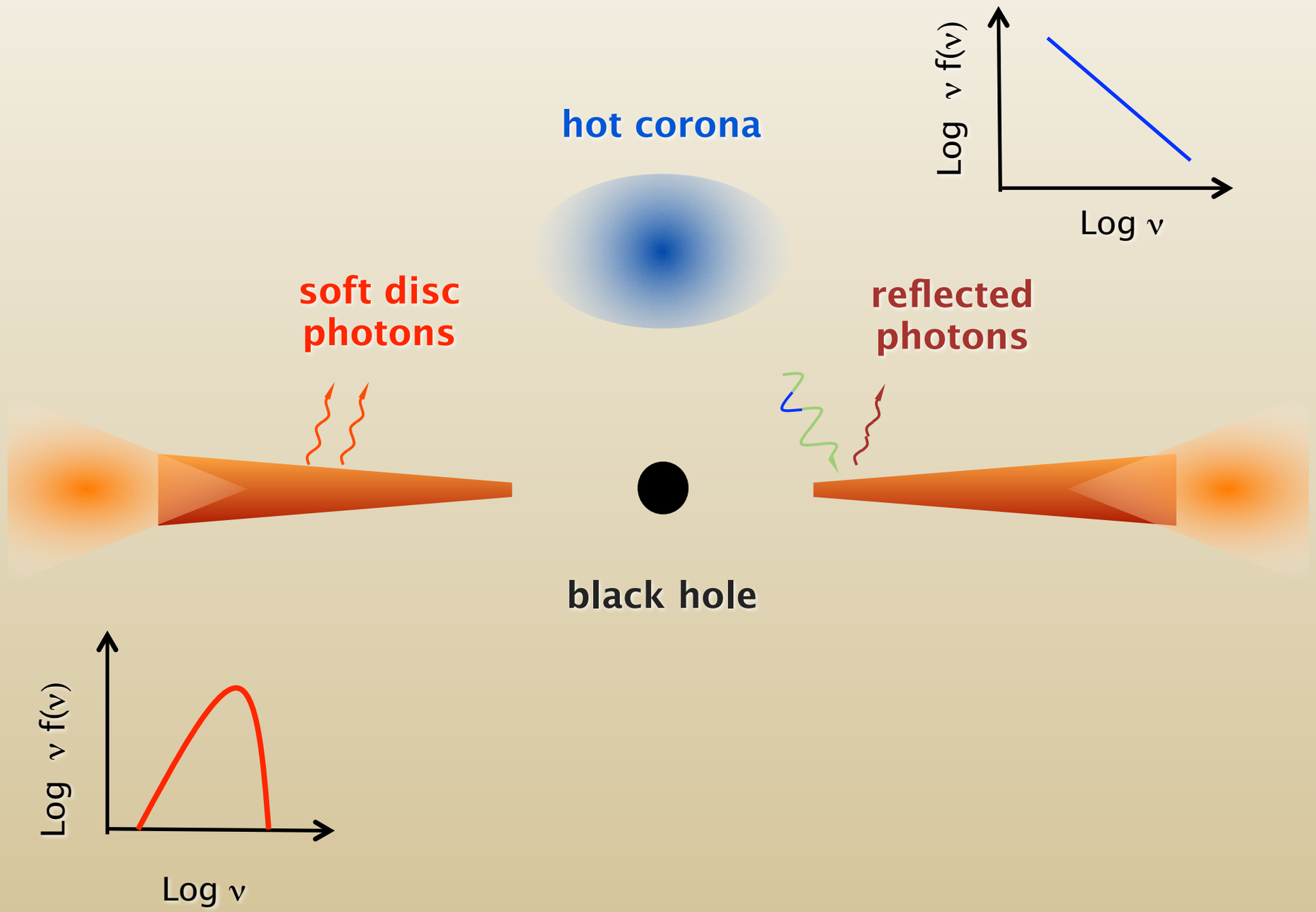
Geometry


hot corona
soft disc
photons
black hole

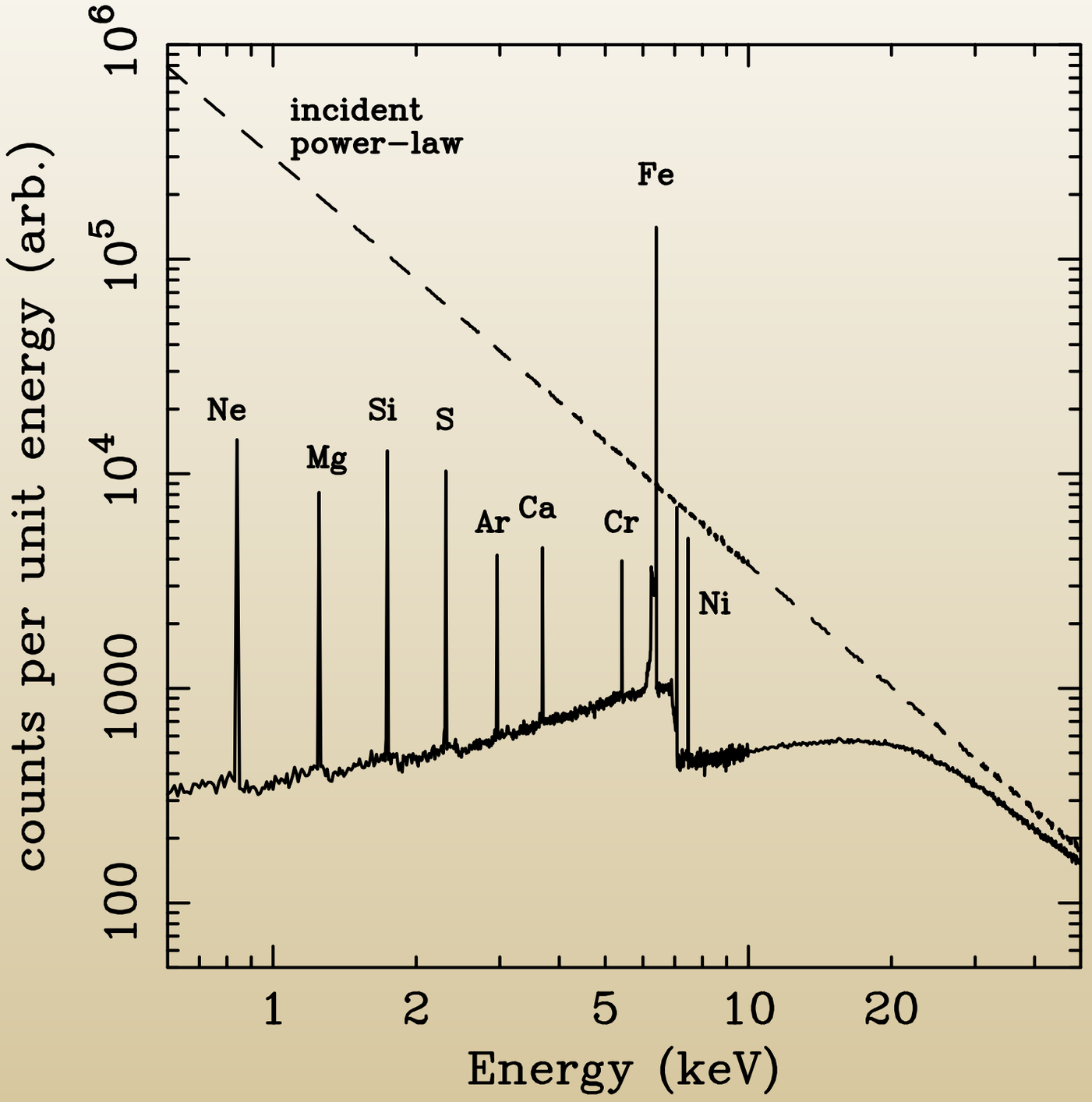
Log ν f(ν)
Log ν


Log ν f(ν)
Log ν

Geometry

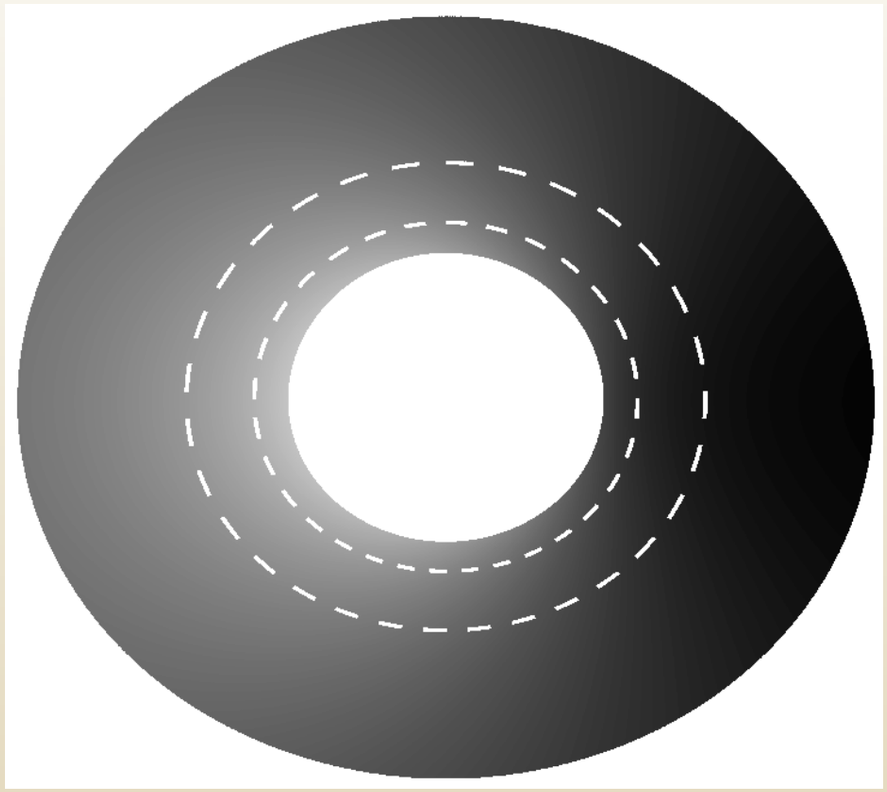

hot corona
soft disc
photons
reflected
photons
black hole
Log ν f(ν)
Log ν
Log ν f(ν)
Log ν

Reflected Spectrum

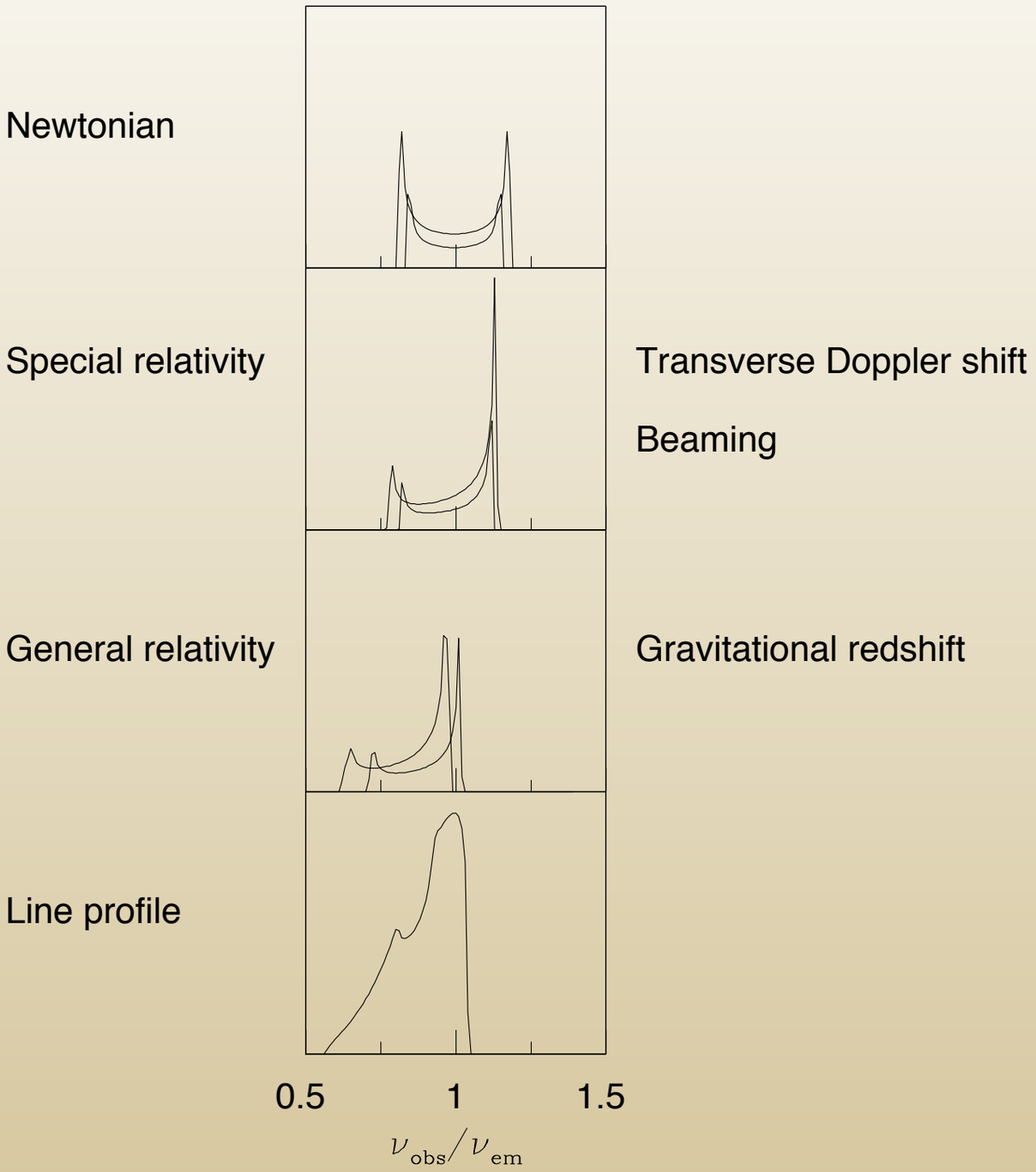


Reynolds (1993)

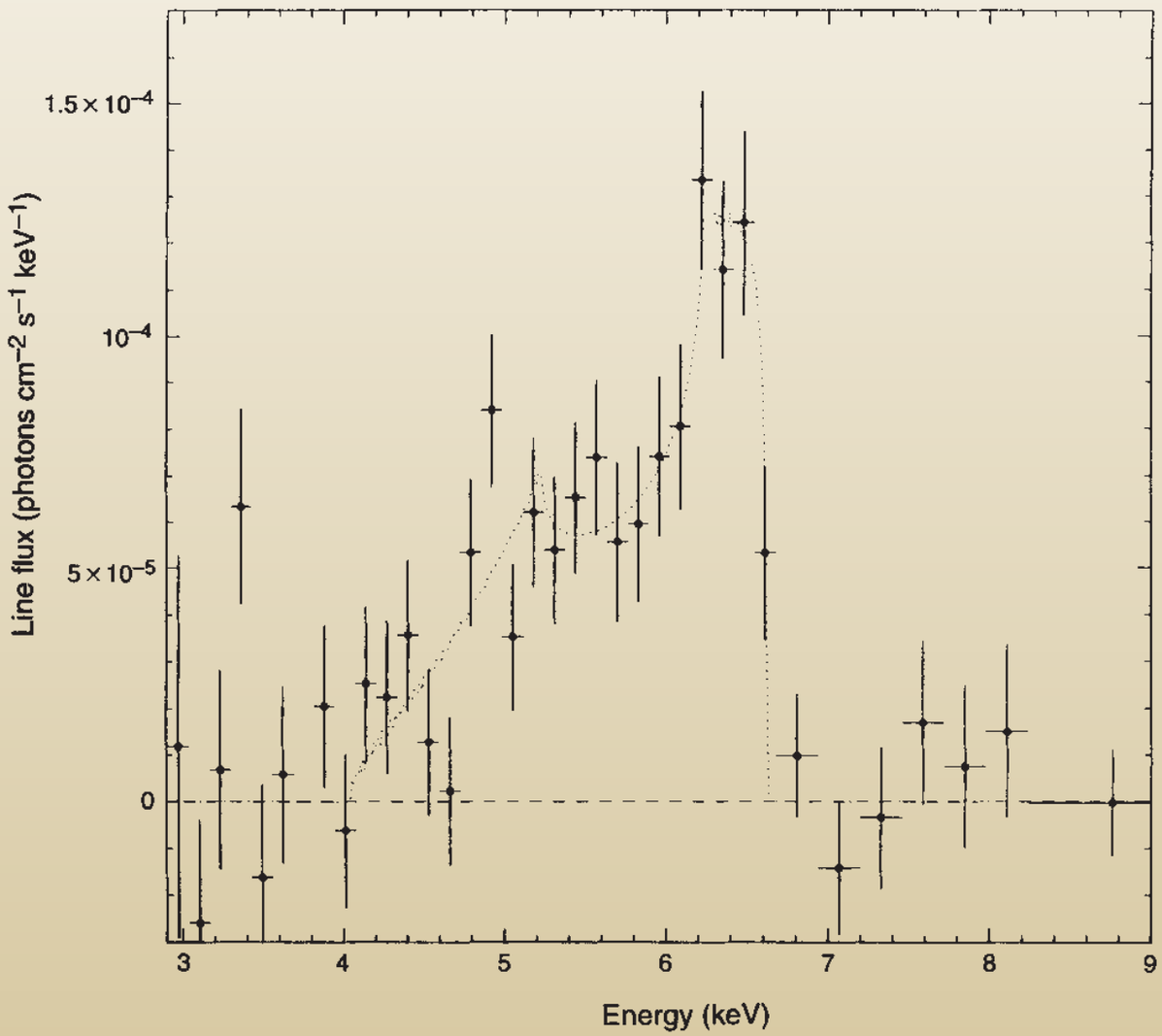
Relativistic Effects



Fabian et al. (2000)



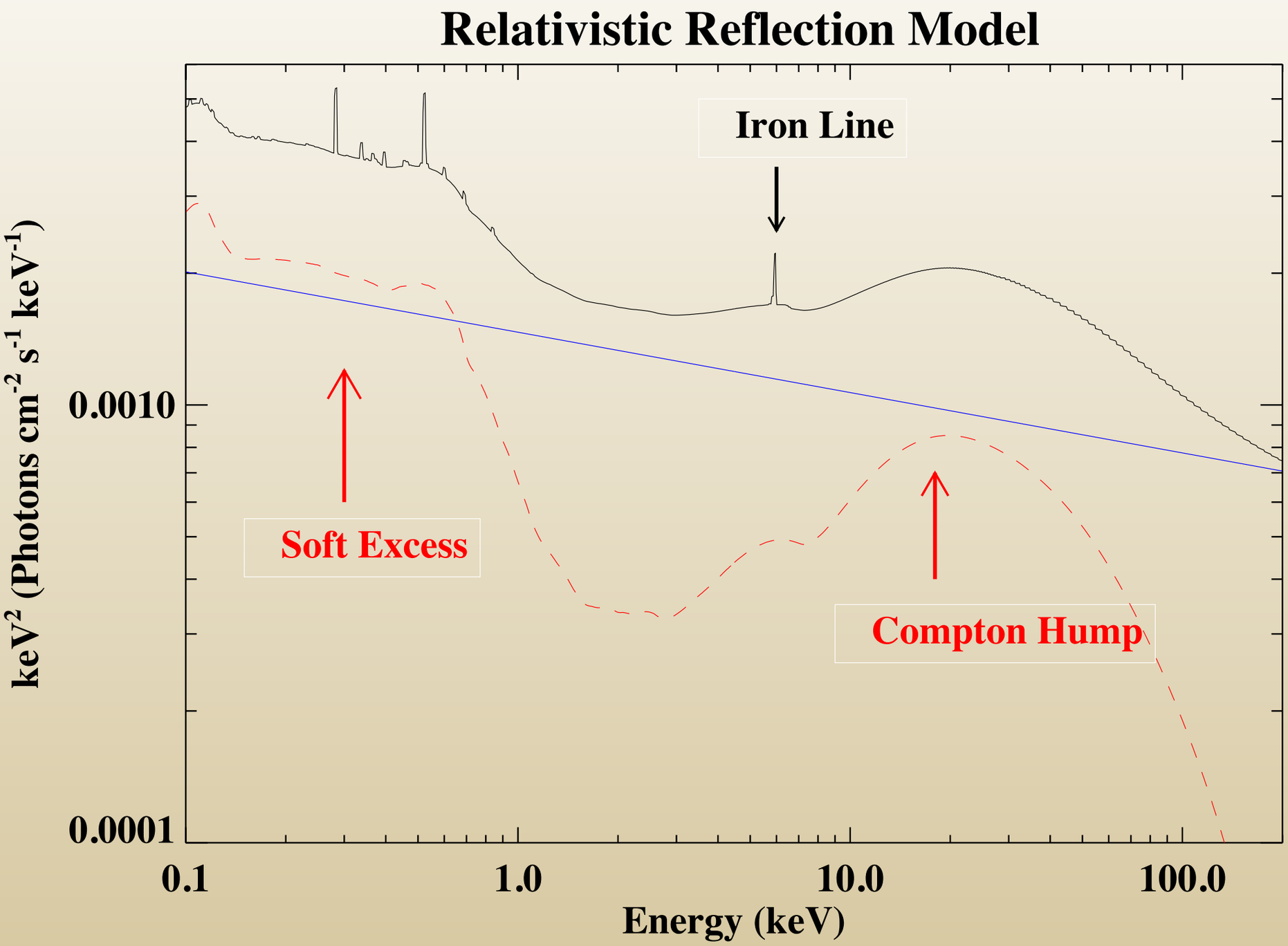
Broad Fe Kα Line



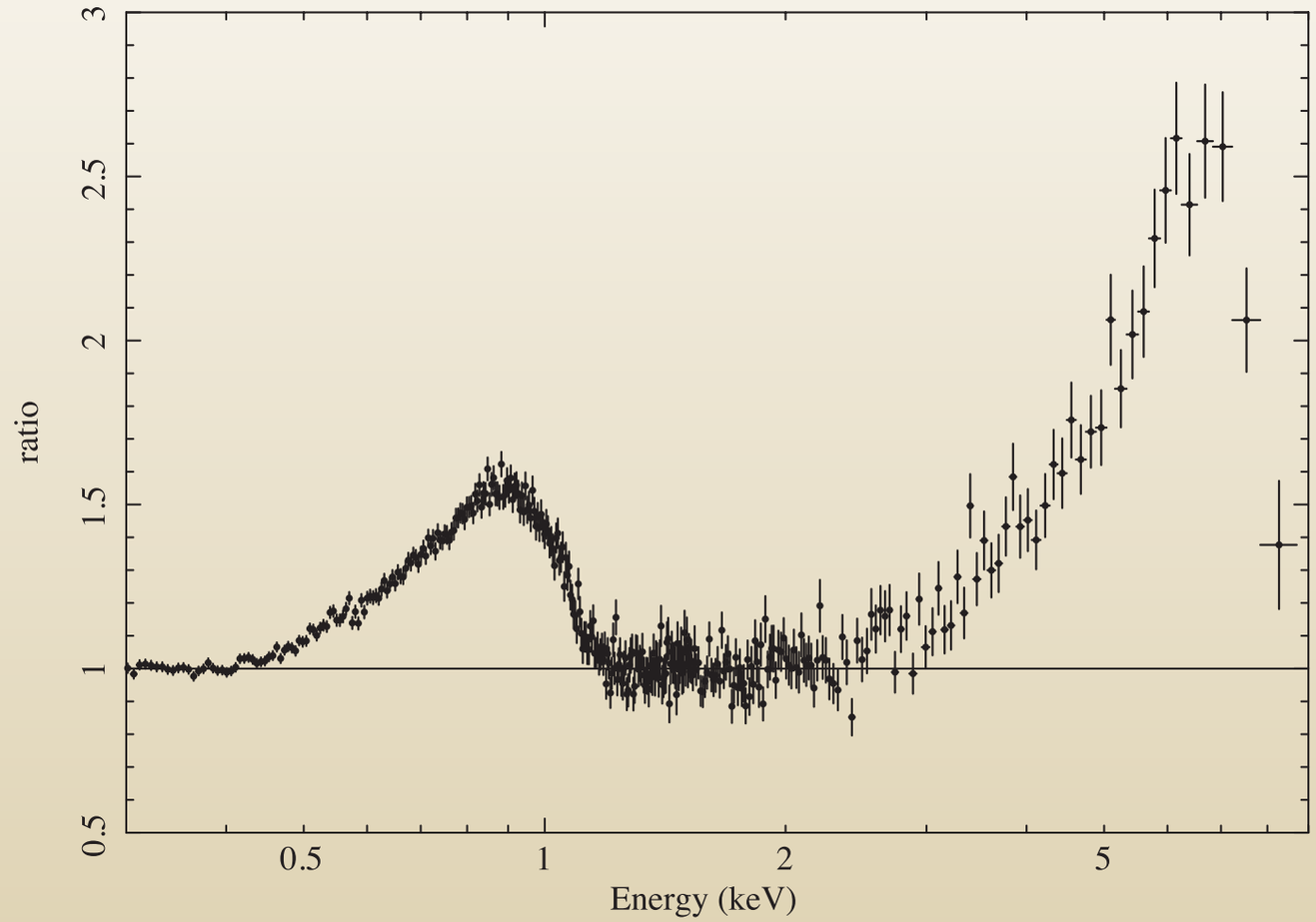
Tanaka et al. (1995)

- Broad iron line first discovered in *ASCA* observation of Type I AGN MCG-6-30-15
- Found in both AGN and stellar-mass black holes
- Line profile can be used to measure the black hole spin

AGN X-ray Spectrum



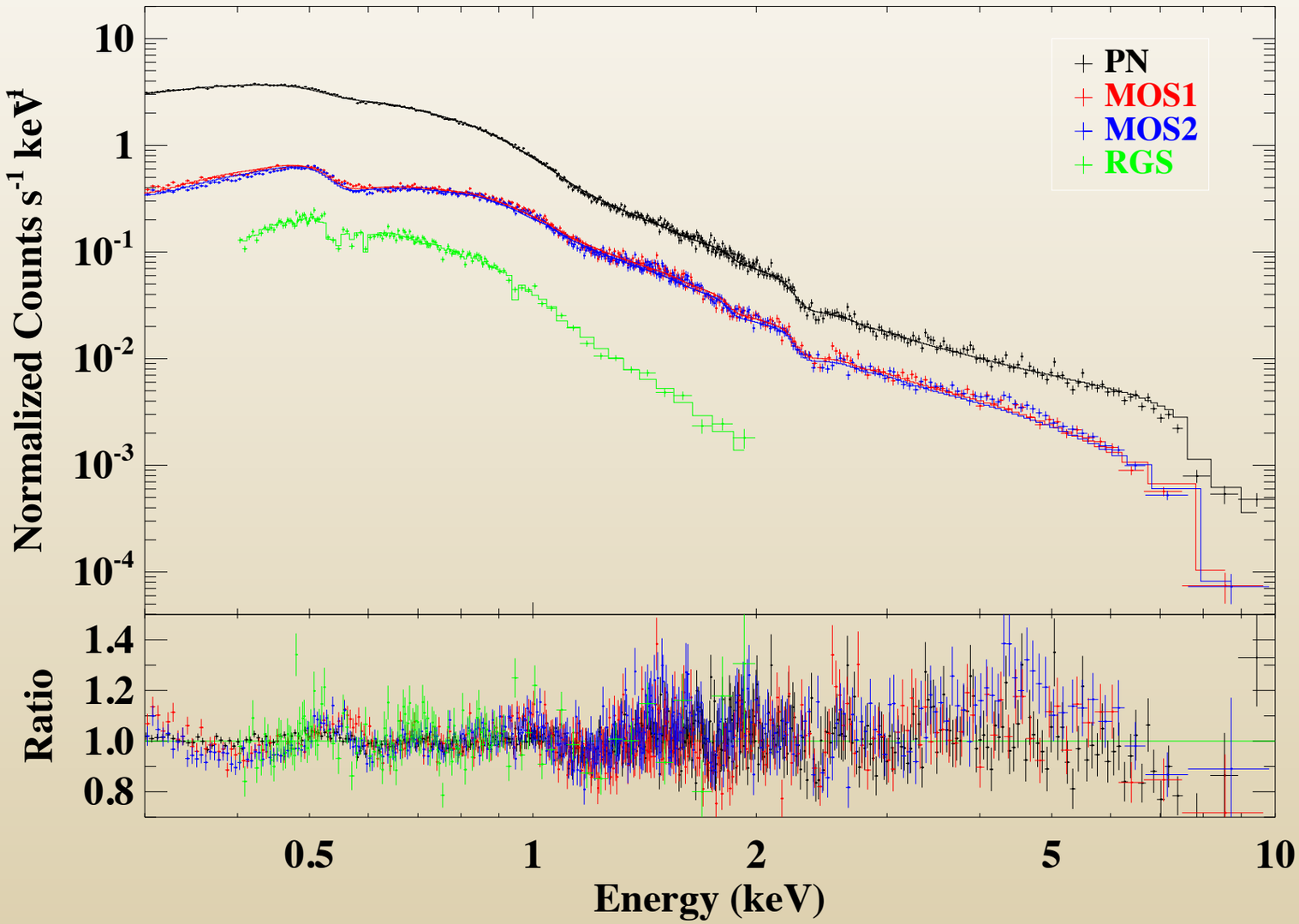
IRAS13224-3809



500 ks *XMM-Newton* observation in 2011, Fabian et al. (2013)

- strong Fe K & Fe L lines,
- sharp edge at ~8 keV
- large variability
- small central black holes, high accreting rates
- high iron abundance

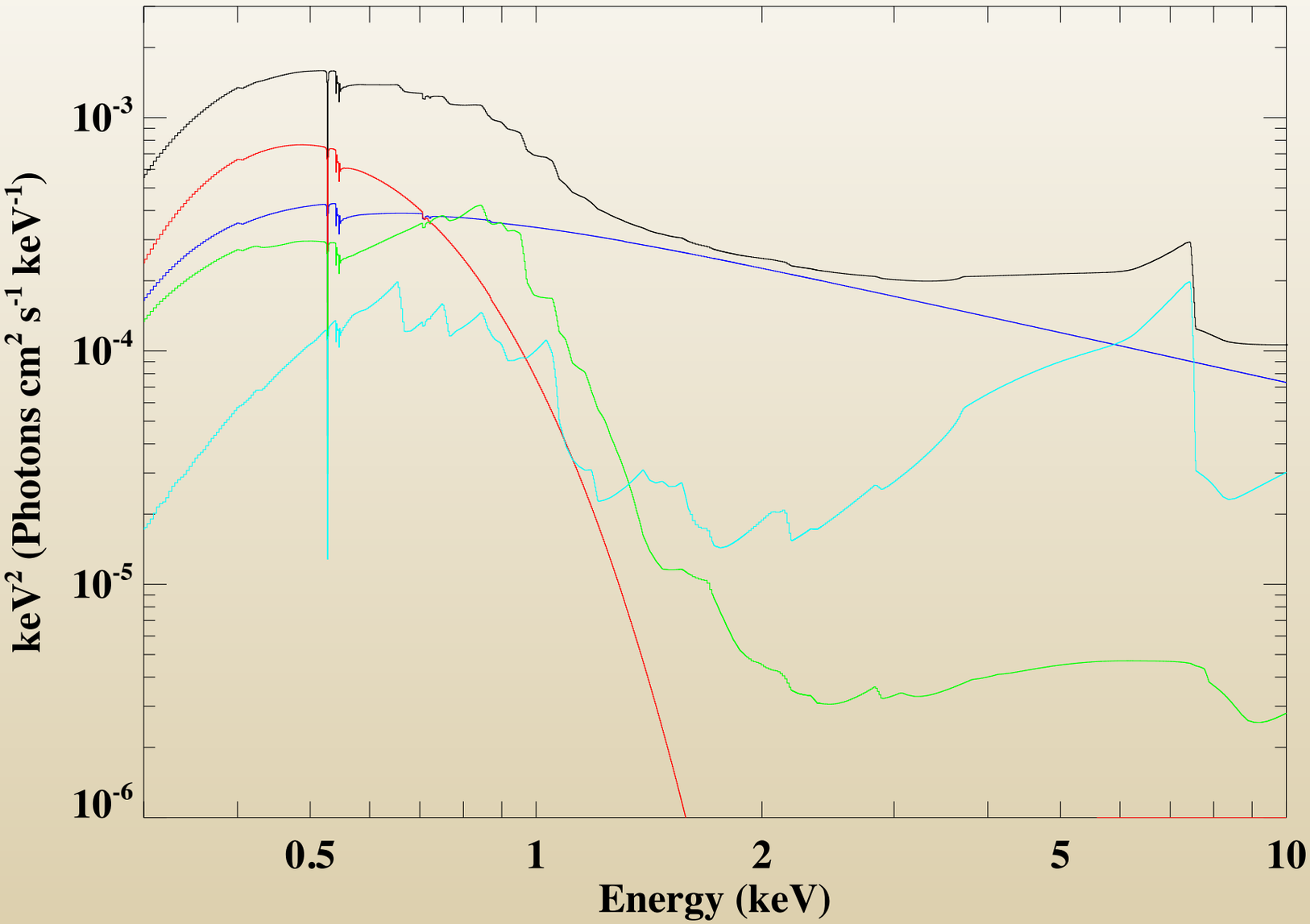
Time-averaged Spectra



Galactic absorption * (powerlaw + blackbody + blurred reflection)

Chiang et al. (2014)

Model



Galactic absorption * (powerlaw + blackbody + blurred reflection)

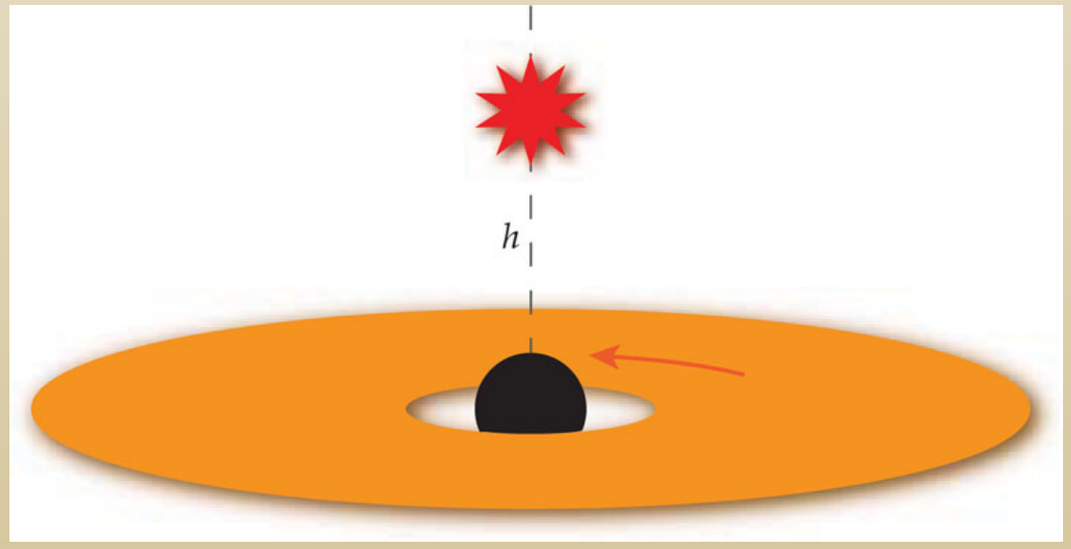
Chiang et al. (2014)

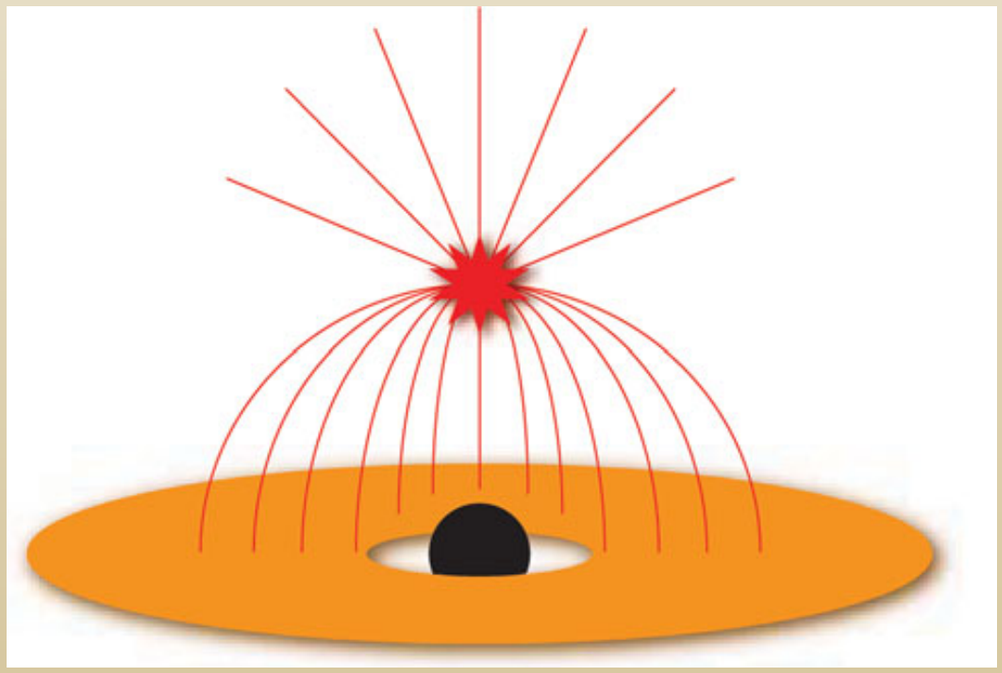
Emissivity Profile

- illumination pattern of accretion disc
- reveals the reflected power per unit area

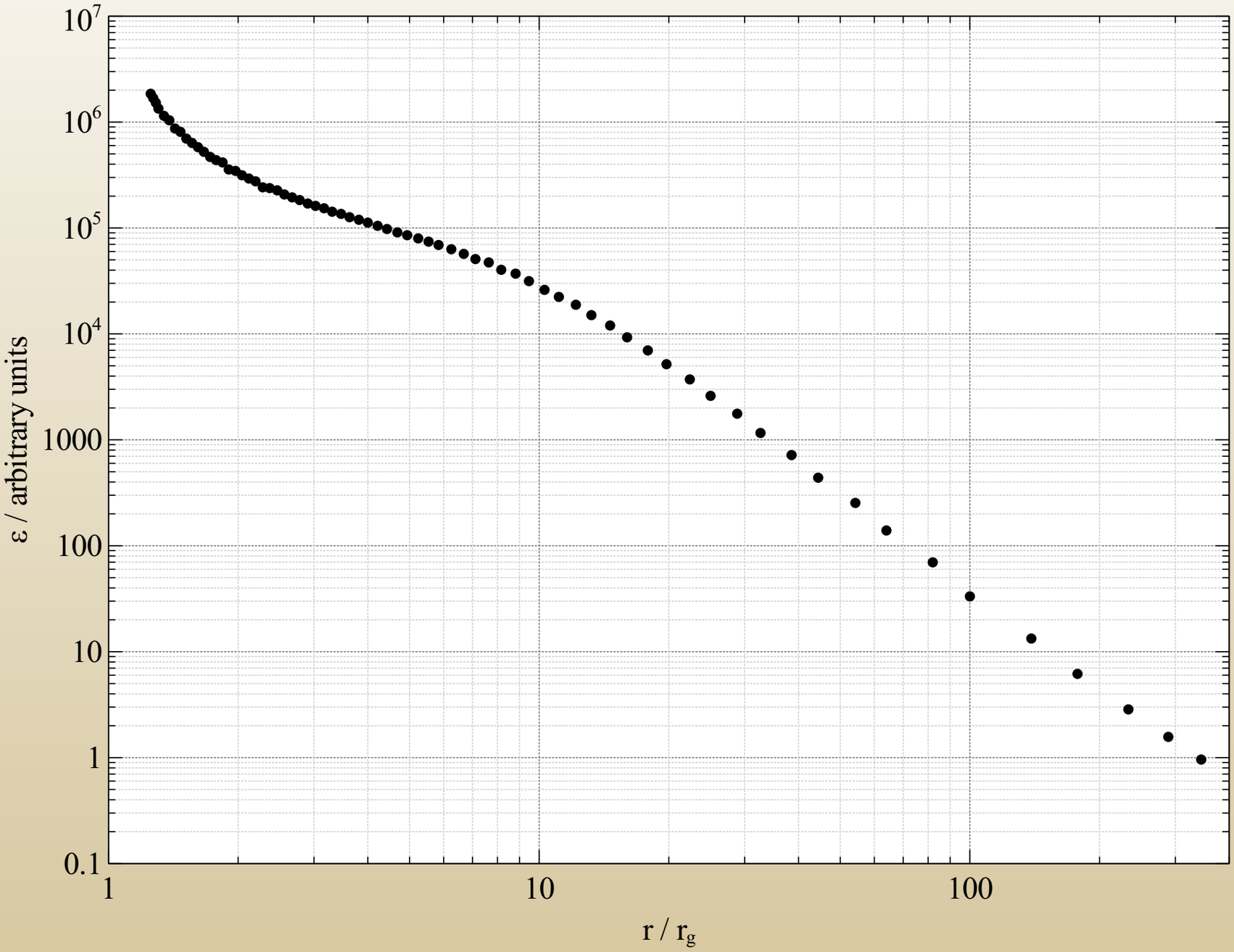
$$\varepsilon(r) = r^{-q}$$

- $q = 3$ if relativistic effects are not included



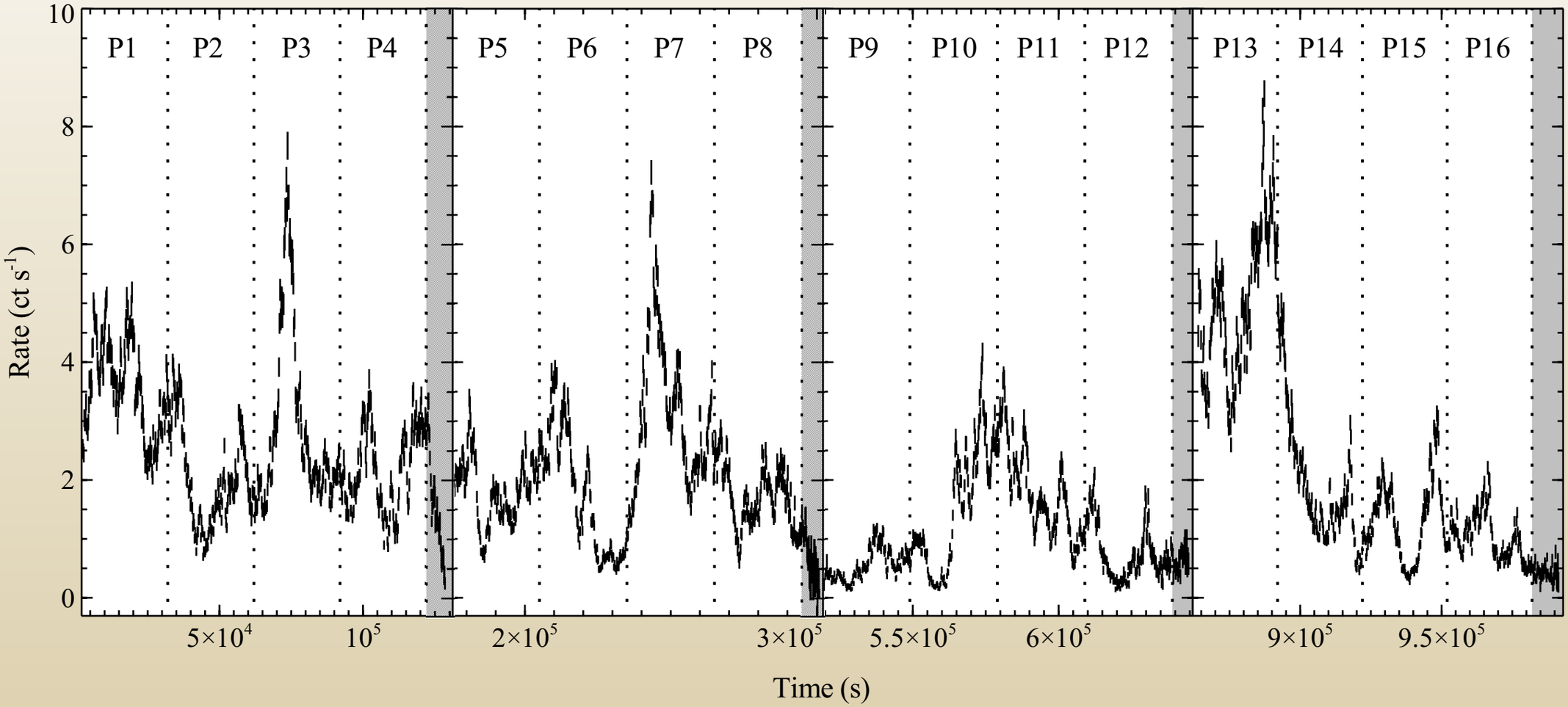


Emissivity Profile



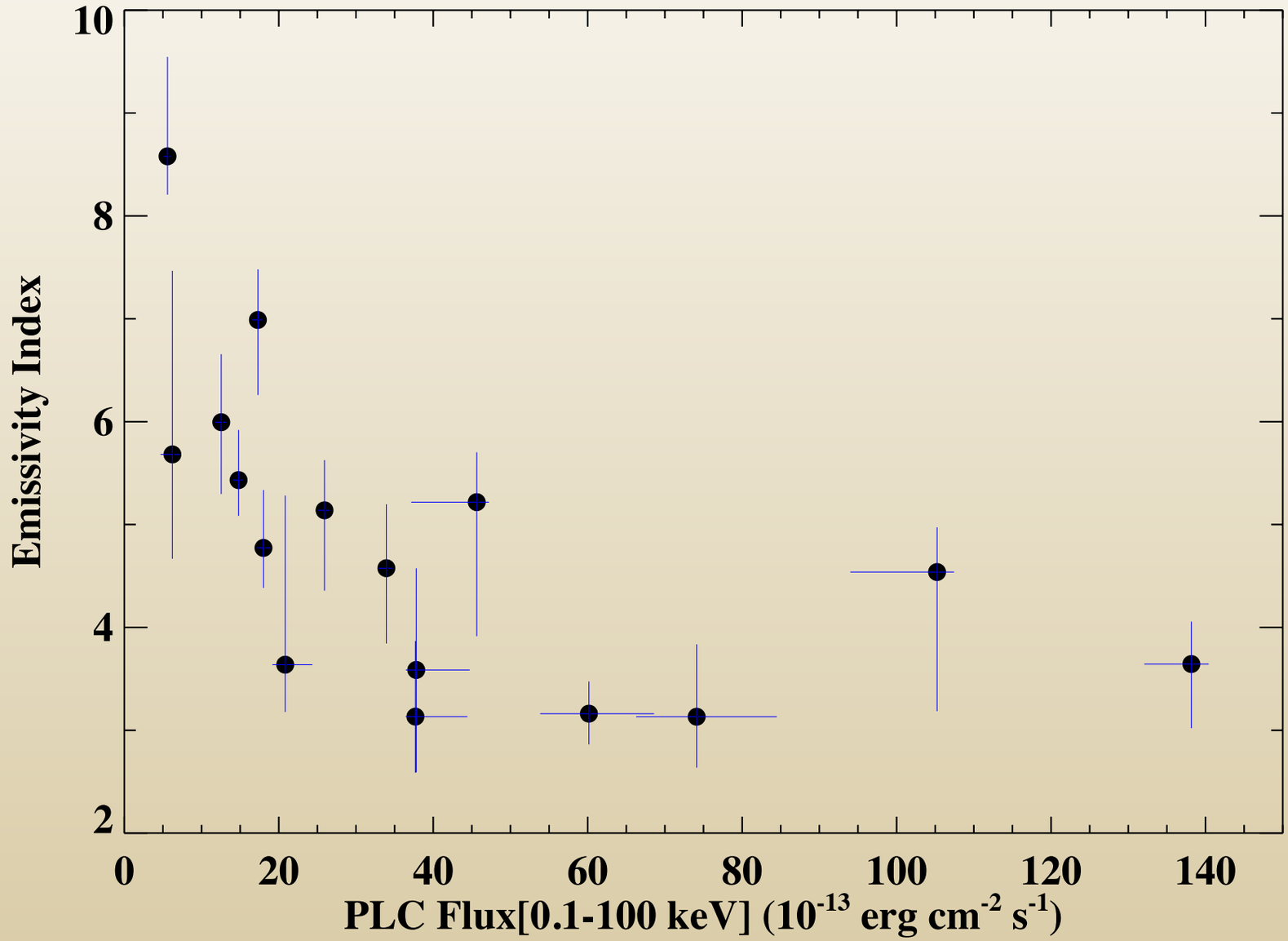
source at h = 10 R_G, Wilkins & Fabian (2012)

Time-resolved Spectra



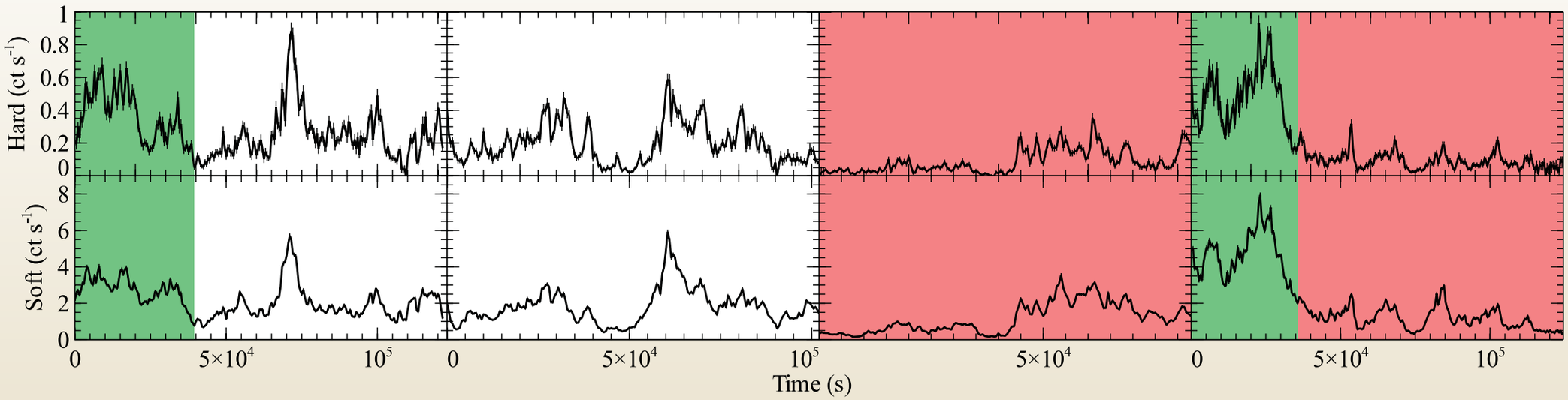
Chiang et al. (2014)

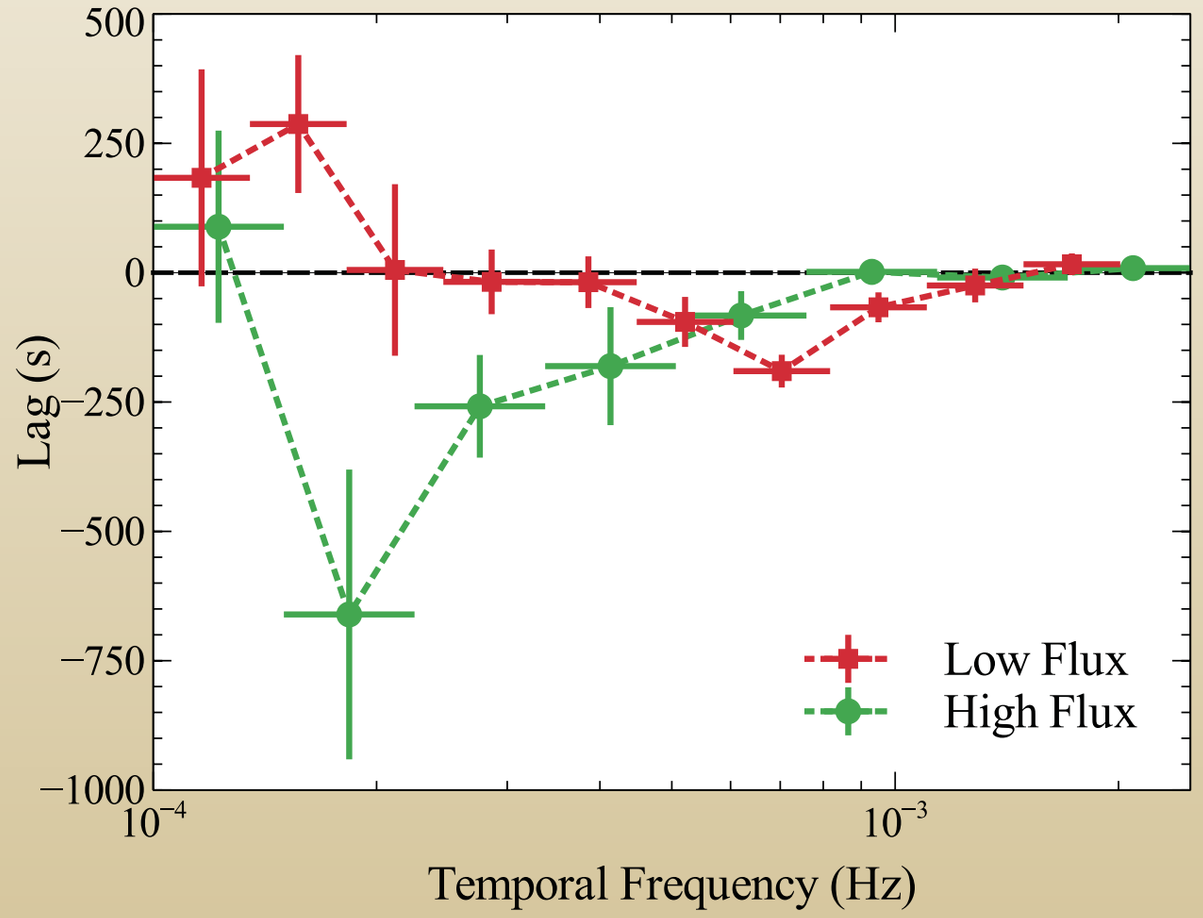
Emissivity Evolution



Chiang et al. (2014)

Lags from different bands





- hard (1.2-5.0 keV); soft (0.3-1.0 keV)
- soft lag of hard band occurs on longer time scales
- corona more vertically extended during high-flux states

Kara et al. (2013)

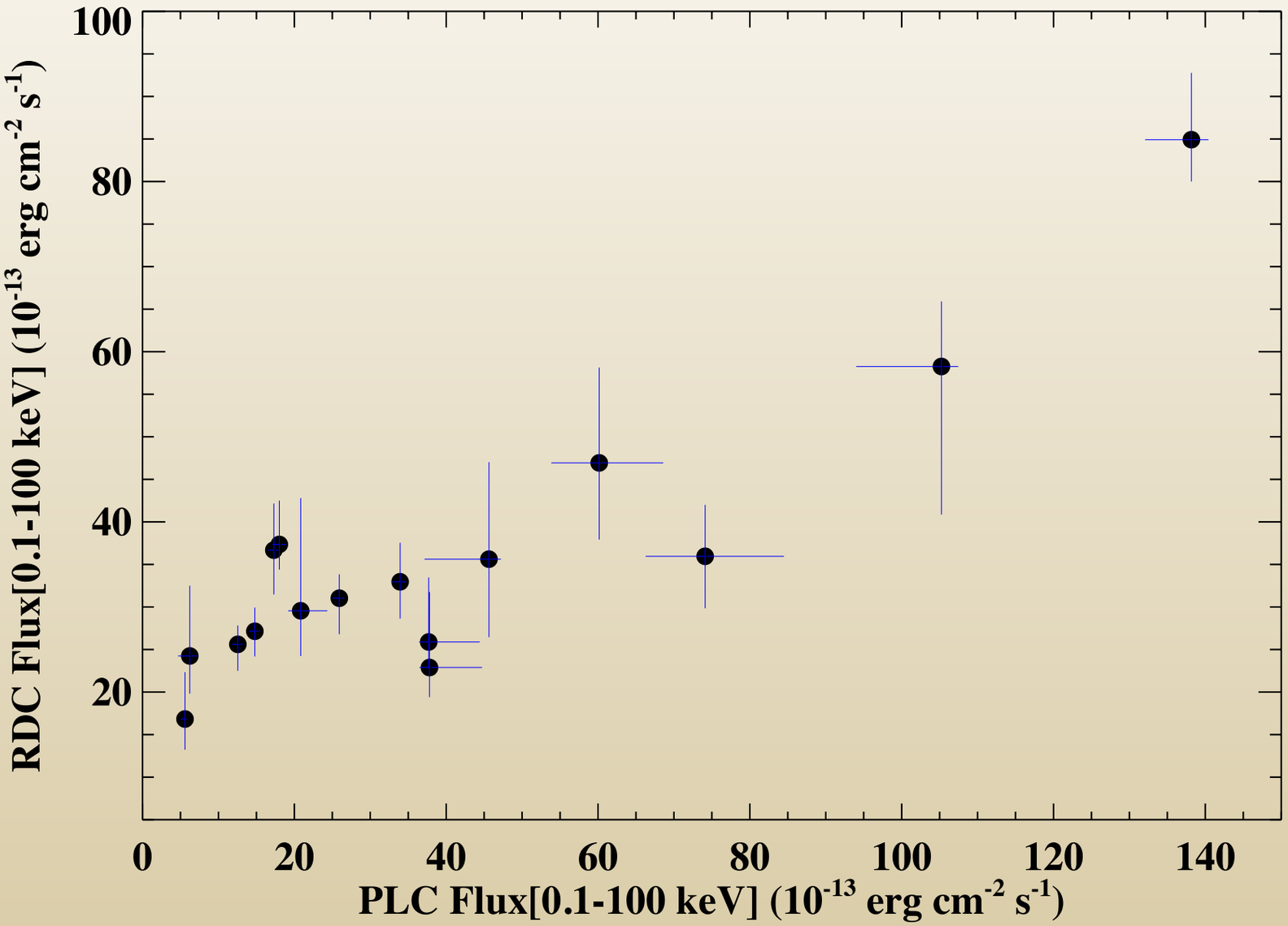
Summary

- Relativistic reflection model can explain the X-ray spectra of most AGN, including extreme sources.

- source geometry can be probed by combining results of timing and spectral analyses

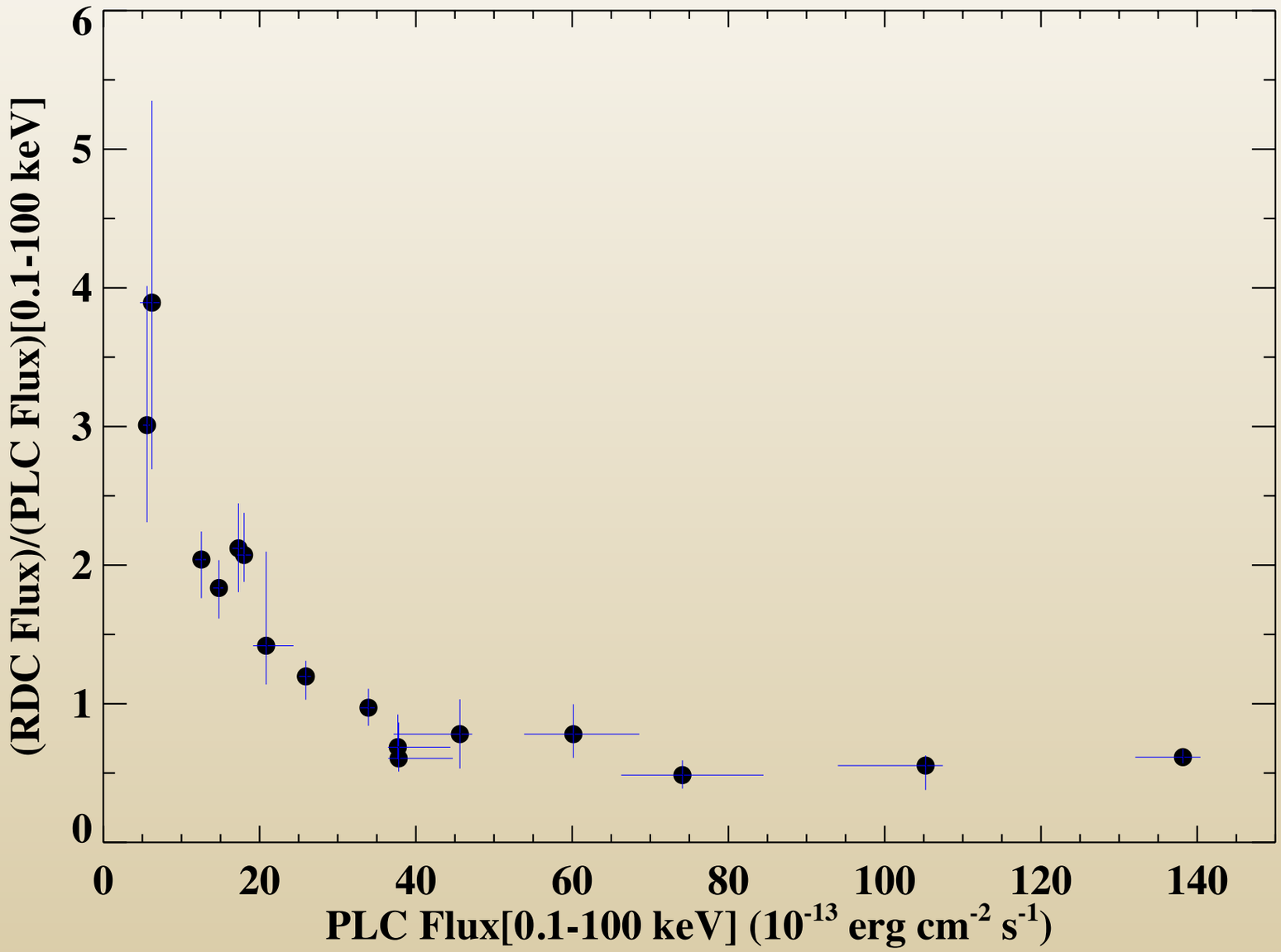
Thank you very much
for your attention!

Powerlaw vs. Reflection



Chiang et al. (2014)

Powerlaw vs. Reflection



Chiang et al. (2014)