Theoretical Study of the Geometry of Accretion Flow in AGN

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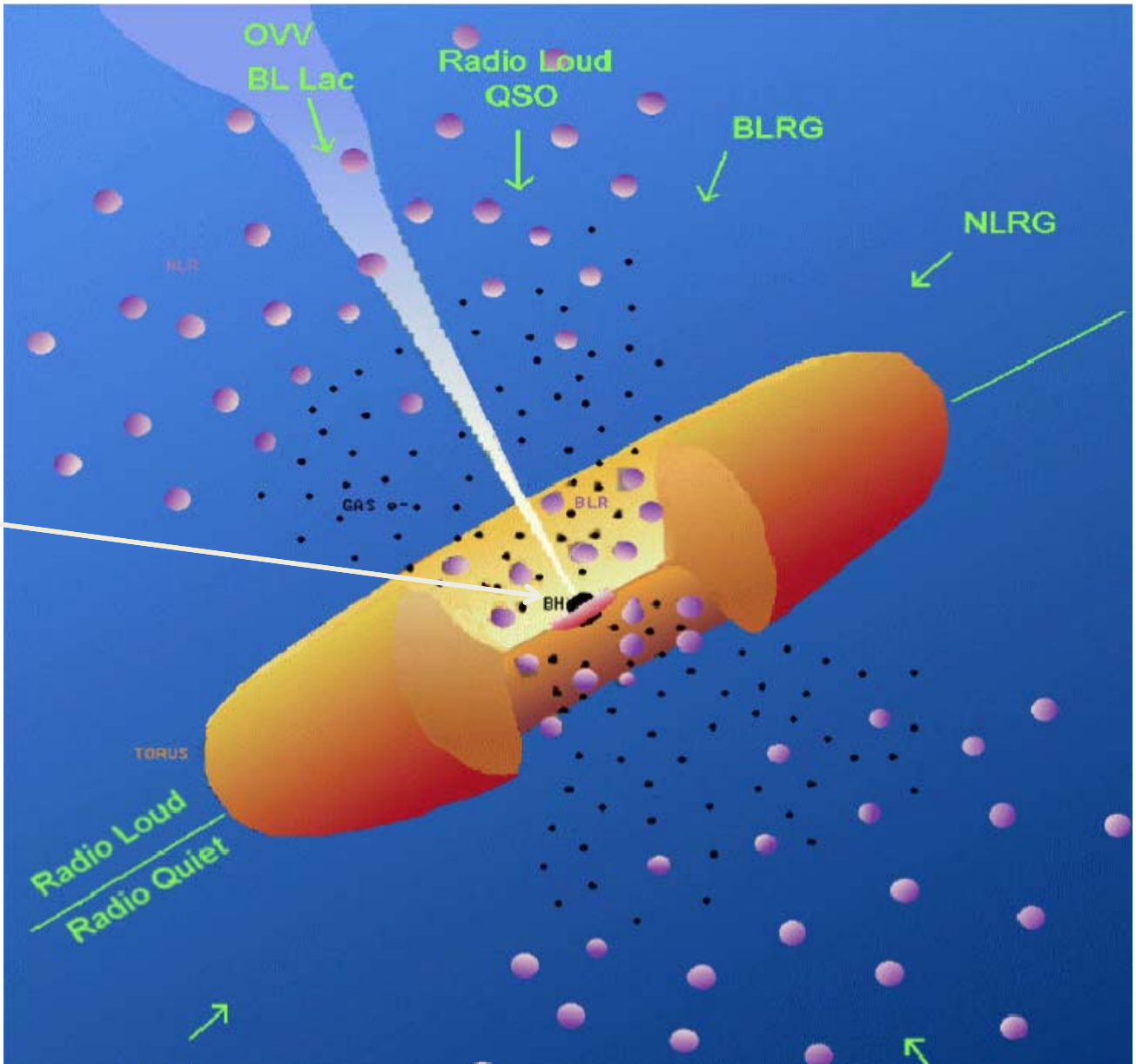
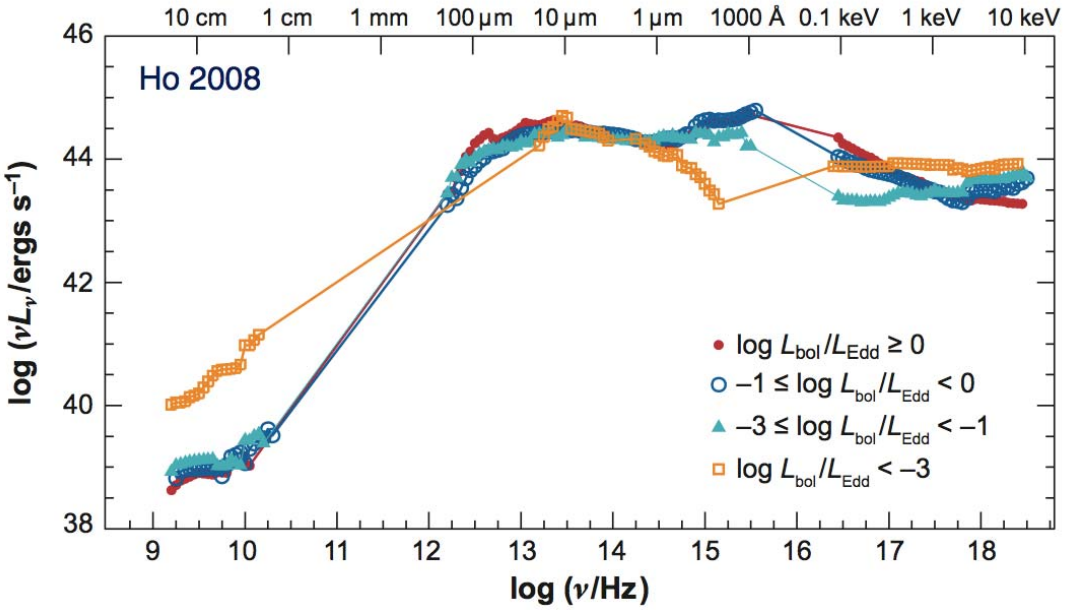
d model for AGN

Geometry?

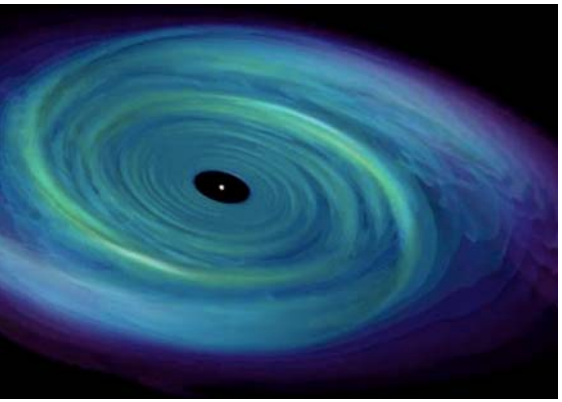


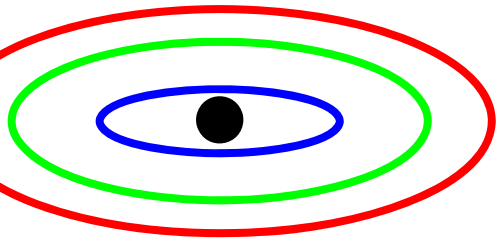
ols for investigating the central geometry and
ysical processes: spectrum and variability



Overall spectra from AGN

/UV: from standard thin accretion disk

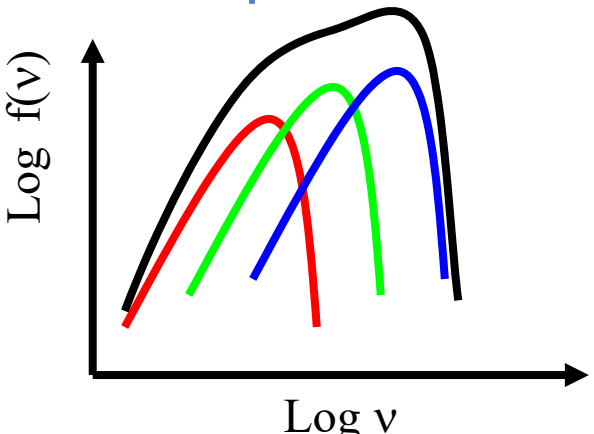




$$F_\nu^{ob} \propto \nu^{-0.5}$$

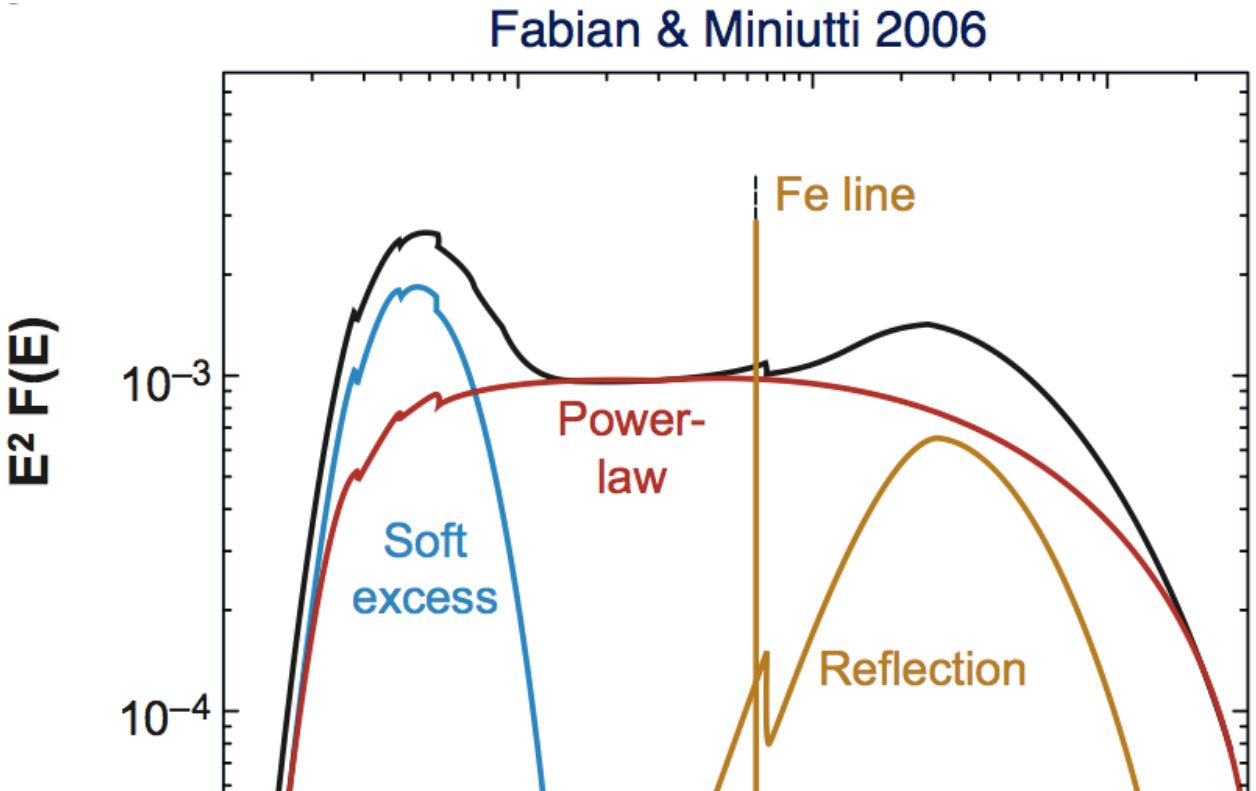
wind? absorption?

$$F_\nu \propto \nu^{1/3}$$



ray emission:

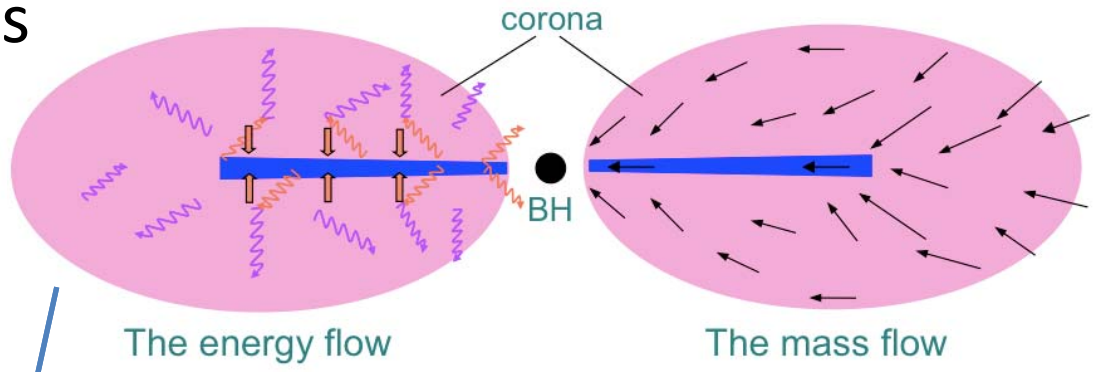
direct power-law continuum + reflection



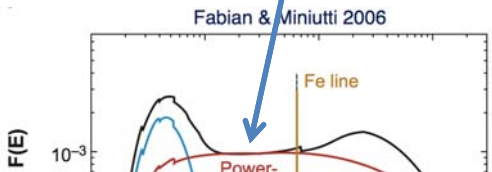
nary/direct X-ray emission:

nverse Compton scattering in a hot corona

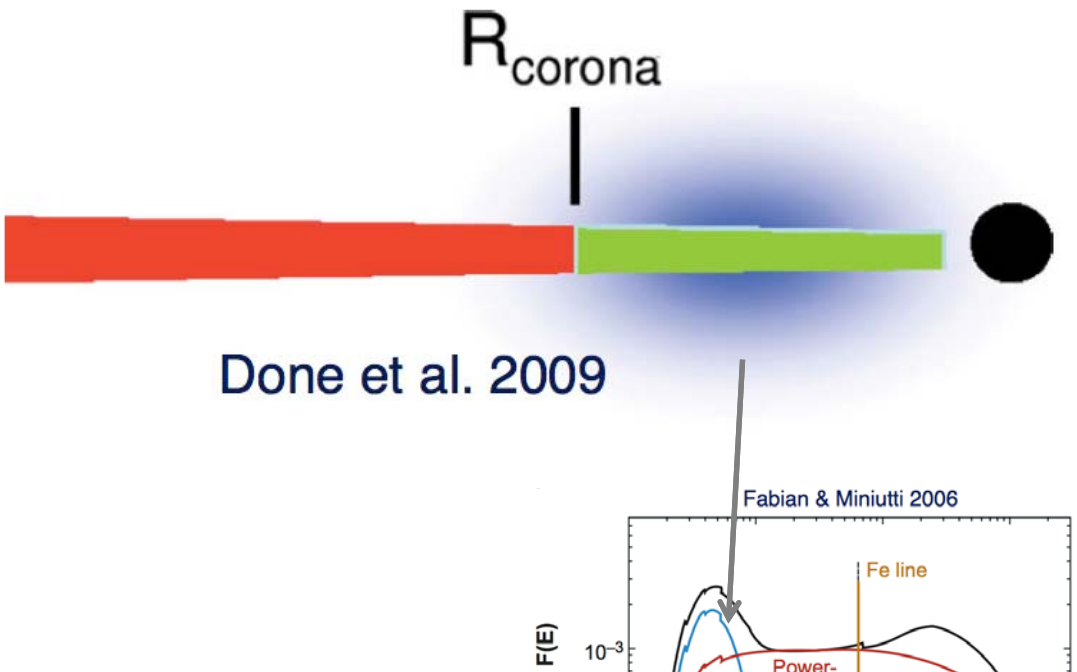
- Coronal accretion heated? ➔physical model
- Magnetic reconnection heated? Complicated, open questions



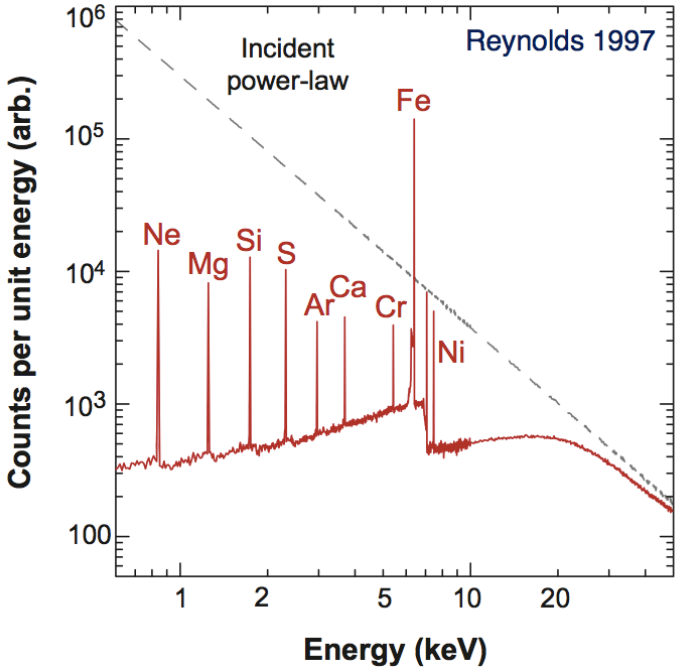
Liu et al. 2015

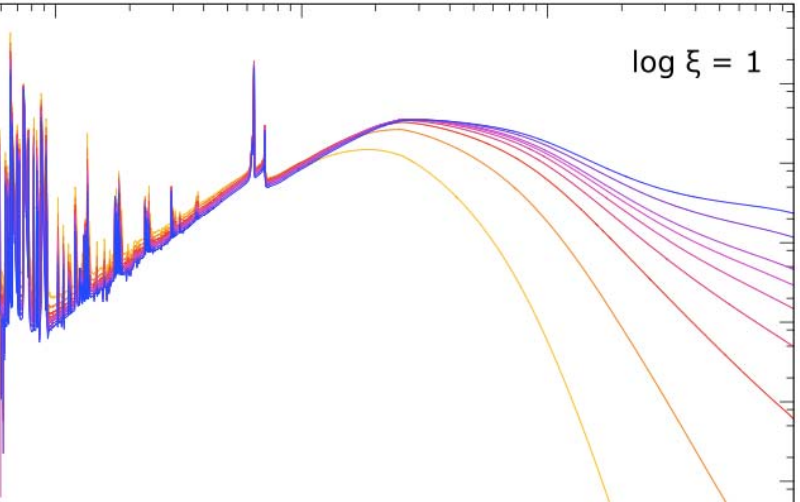


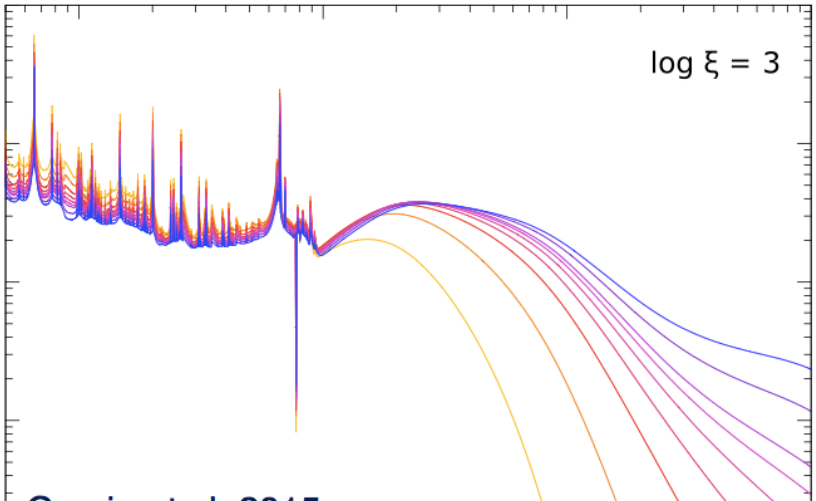
he soft X-ray excess in AGN is speculated to be caused
y atomic absorption with relativistic smearing or
dditional component



lection: depends strongly on
geometry of the central
retion flow, ionization of the
k





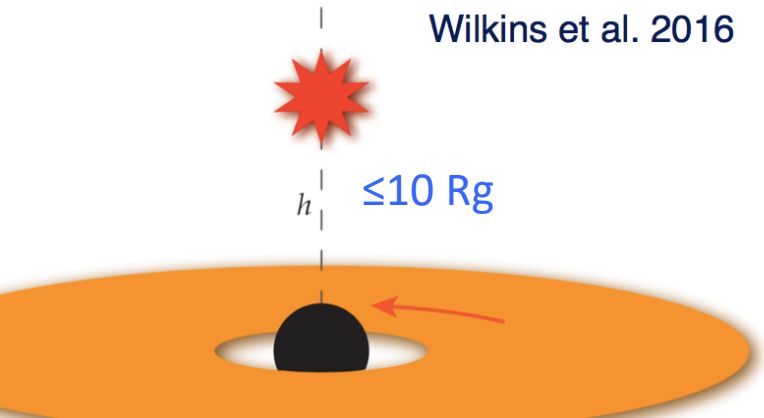


- The X-ray spectra, both continuum and reflections, provide strong evidences for the coupling of cold disk and hot corona
- What does variability tell us?

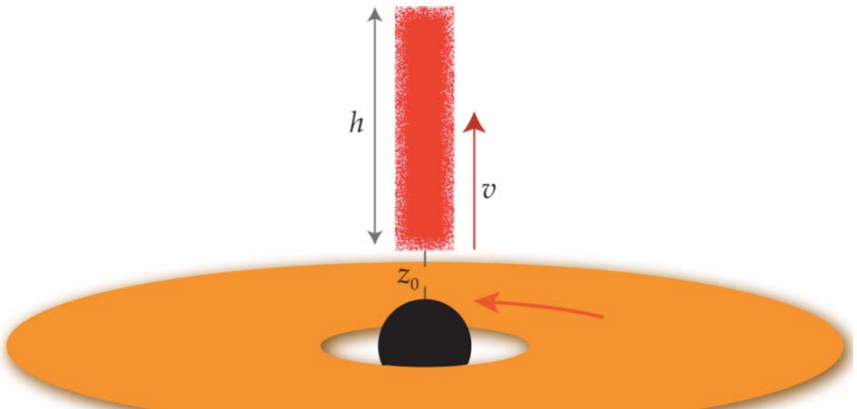
- Reverberation time lag demand that hard X-ray emission in black hole systems be centrally concentrated, with height H ≤10 Rg (e.g. Fabian 2009)
- Micro-lensing measurements show half-light radius ≤20 Rg (e.g. Chartas et al. 2009)

Lamppost

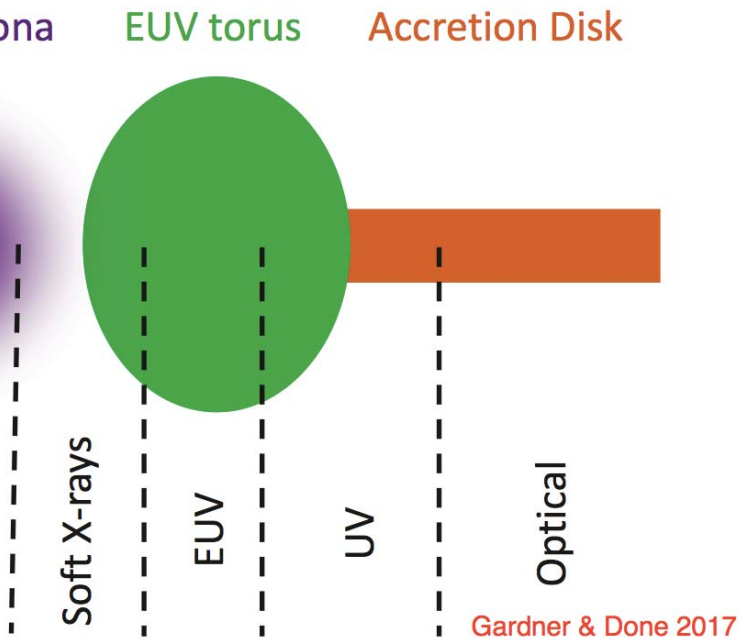
Wilkins et al. 2016

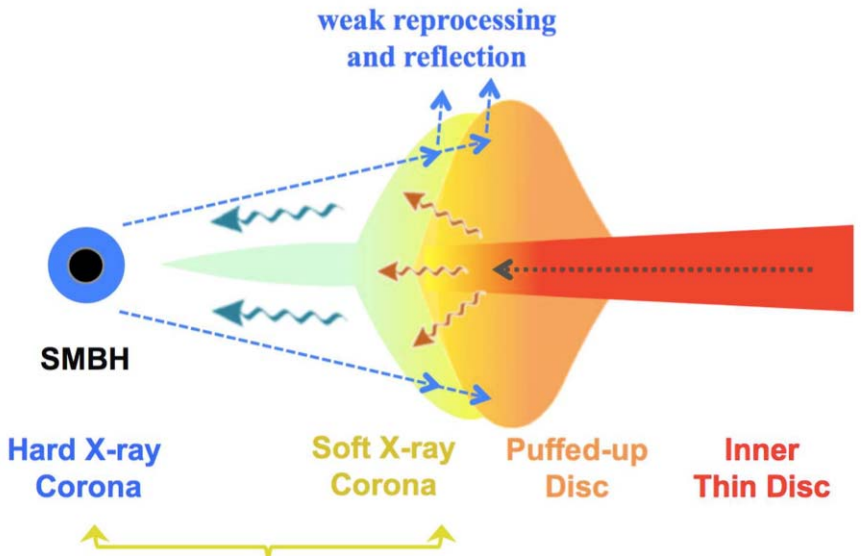


Vertically collimated corona/ejecta/outflows



native model for reverberation lags





- The X-ray spectrum, both continuum and reflections, provides strong evidences for the coupling of cold disk and hot corona
- The time lag of reflection components

  supports the coupling of the disk and corona

  but constrain the radiation region to be very small

close look at the observational models:

- Hot gas origin and maintenance

  The X-ray emitting gas cannot stay still near the BH ←continuous gas supply← solely provided by accreting gas

  either accretion coronal flow or outflows/jet

- Energy source for the energetic X-ray emissions:

  accretion, or extract from BH spin?

The natural, physical scenario for the X-ray emission

A disk/corona proposed for AGN

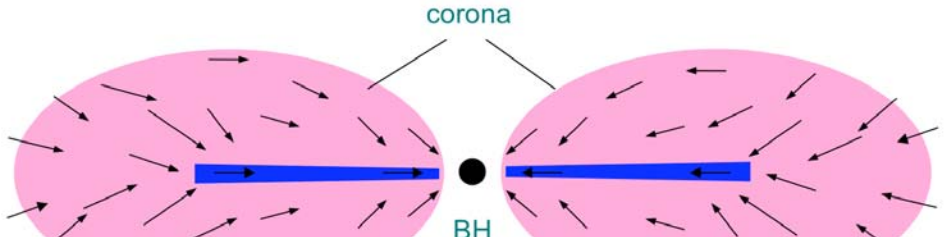
Liu et al. ApJ 806:223,2015

Mass supply for the accretion in AGN is stellar wind or interstellar medium

Diverse distributed gas ➔not necessary to form a thin disk, but easy to form a hot flow in outer region

Coronal gas condenses to the inner disk, supporting a thin accretion disk

Disk and corona are coupled through radiation and gas



ysical Processes in the accretion flow

corona is coupled with the disk ◦

n the corona

- Heating by viscosity
- Cooling by Syn, Bremsstrahlung, Compton scattering
- Vertical conduction by electrons
- Vertical mass flow (evaporation or condensation)
- Radial accretion

n the disk

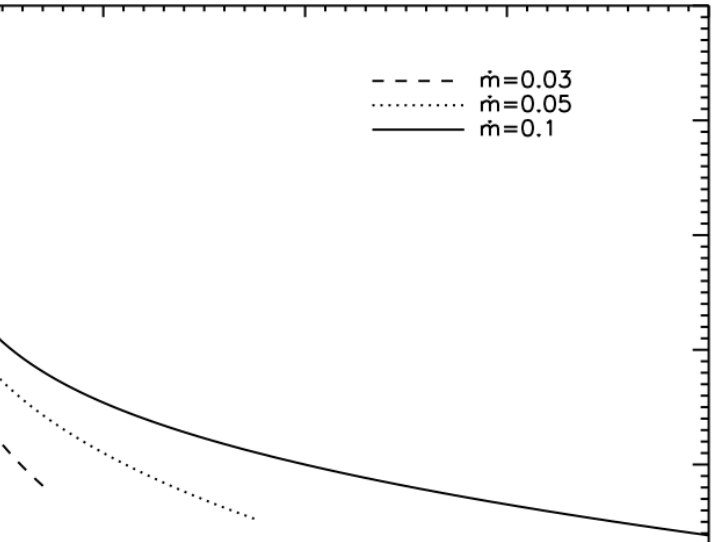
- reflection

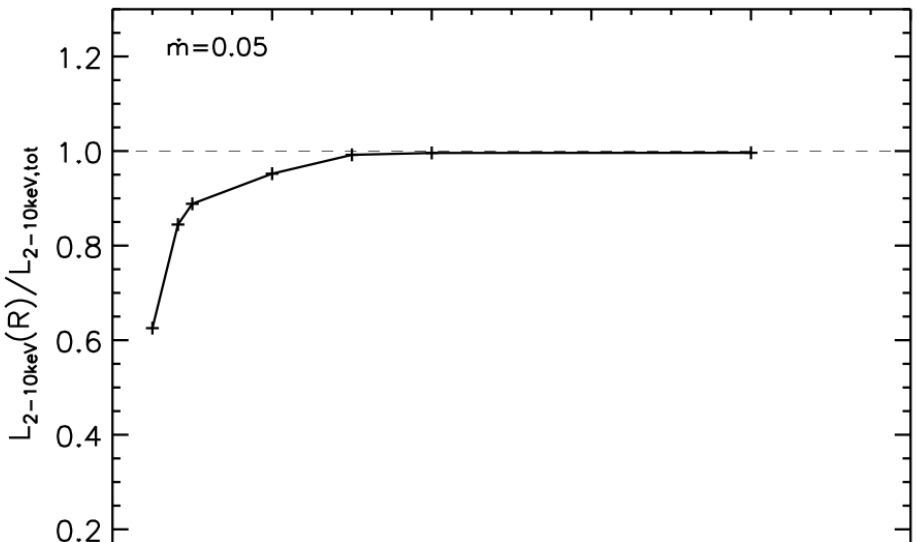
ay emission is centrally concentrated,

k X-ray emission is concentrated within R<10Rs

onsistent with reverberation time lag and

ro-lensing measurement

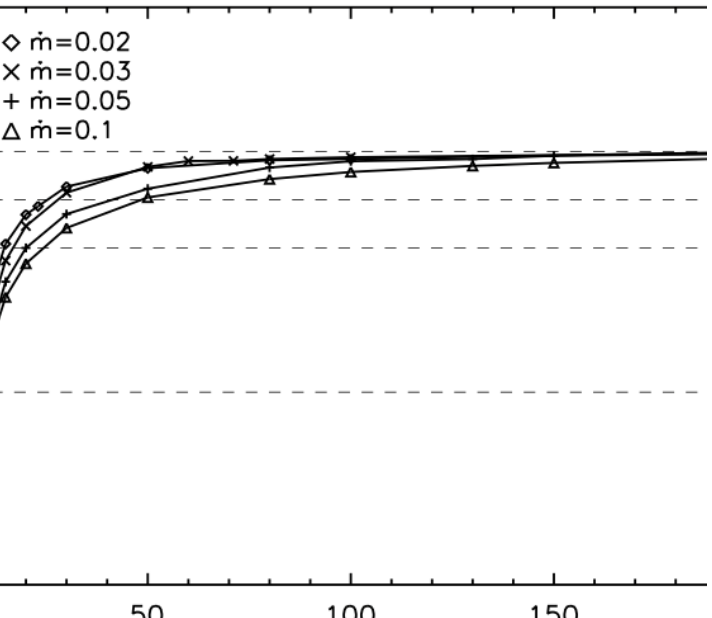


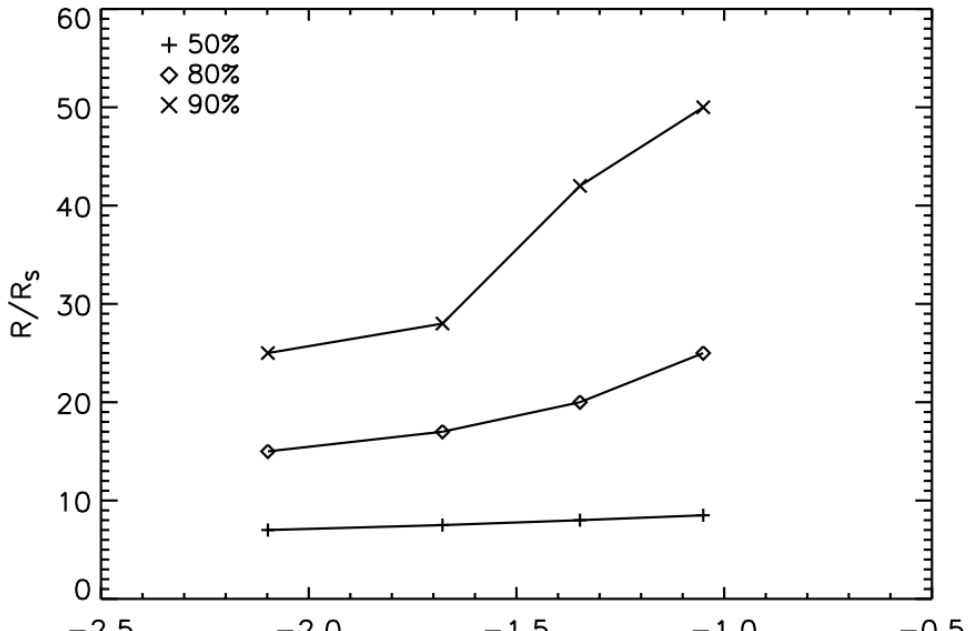


he higher Eddington ratio, the larger the bulk

mission region

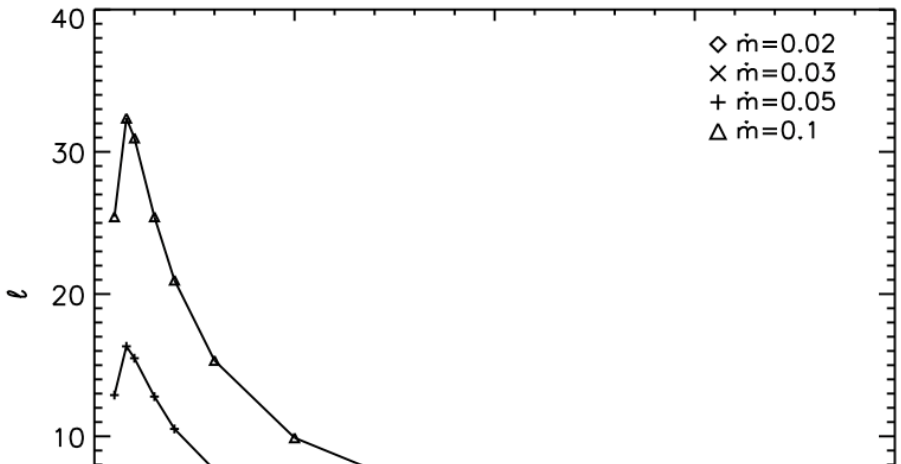
➔consistent with large sample results (Kara et al)





gh-energy photons in a small region could result in
ectron-positron pair production, changing the spectrum
e compactness parameter $l = \frac{L}{R}\frac{\sigma_{\rm T}}{m_{\rm e}c^3}$
marginally below the critical value for pair production,
dicating pair production not the dominant process
IC spectrum is not affected by pair production

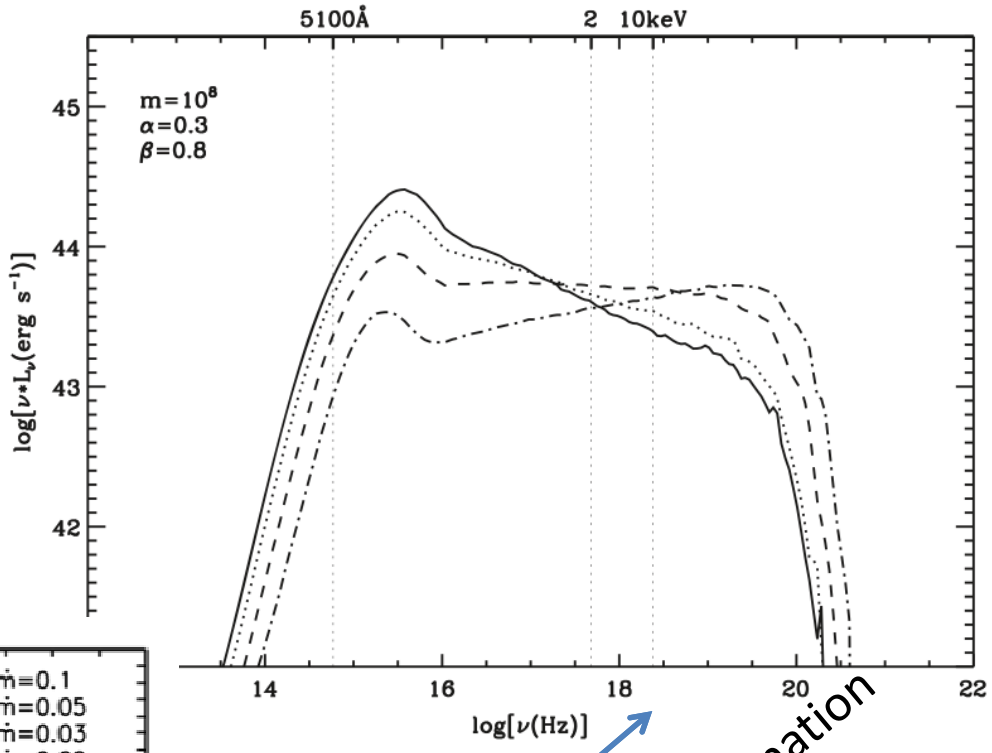
Self-consistent model

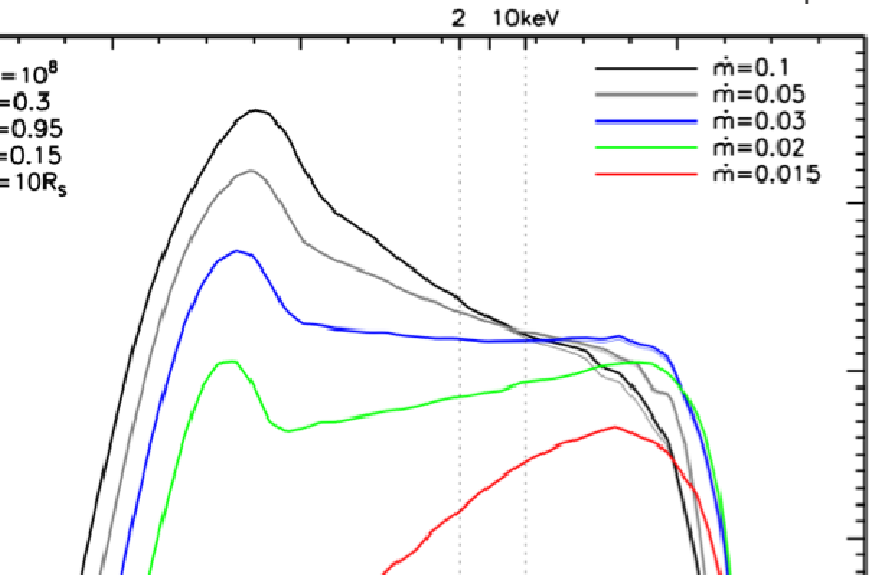


ctra from the accretion

k and corona (Liu et al.

5; Qiao &Liu 2017)





ferent magnetic filed and illumination

Conclusion

hin accretion disk+ hot accretion corona is sufficient to erpret the observational spectra and variability verberation lag) in bright AGN

The small height of the X-ray illumination deduced from reverberation lag is a consequence of concentrated emission from the extended corona

An extremely small corona is not necessary for most of the AGN

outflowing hot gas as X-ray emission,