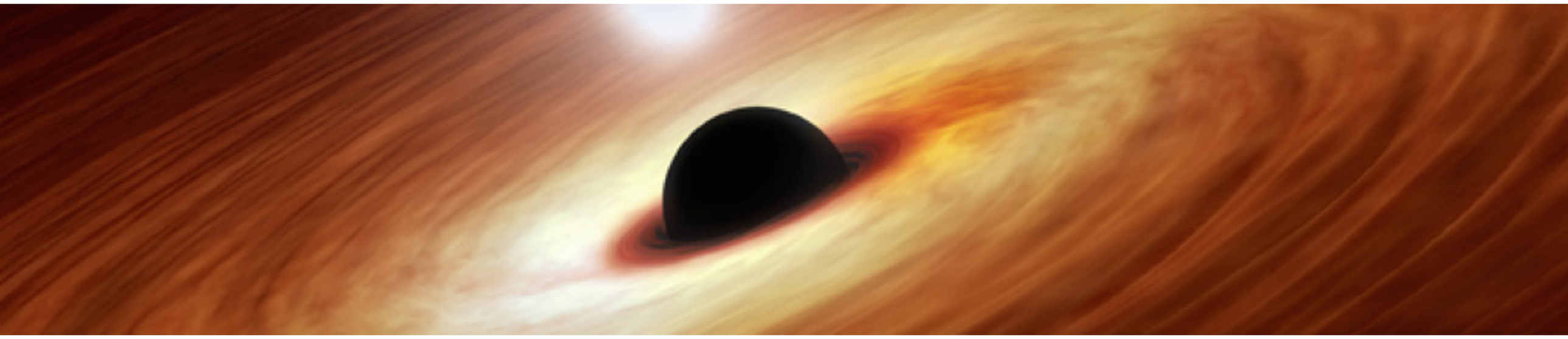
Corona accretion in active galactic nuclei and the observational test



Erlin Qiao

National **A**stronomical **O**bservatories,
Chinese Academy of Sciences（**NAOC**）

Collaborators:

B.F. Liu(NAOC)

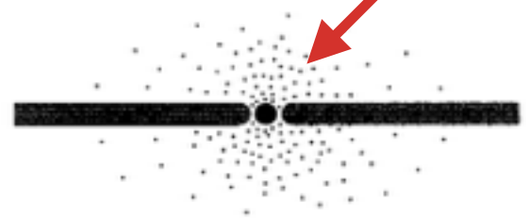
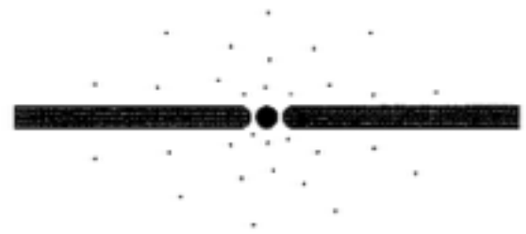
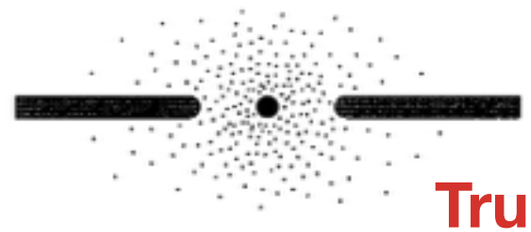
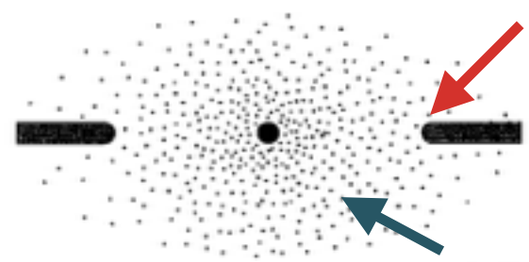
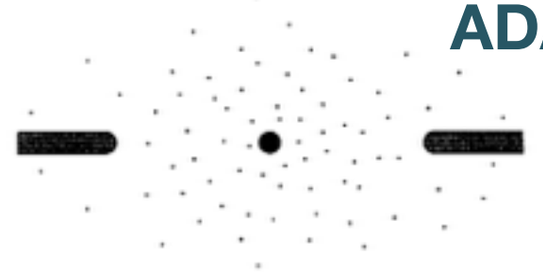
R. Taam (ASSIA)

W.M. Yuan (NAOC)

The X-ray universe 2017, Rome,
June 8, 2017

- **Motivation:**

  Where is the X-ray emission from for active galactic nuclei? It is a very important question to be answered!

AGNs		BHXBs
NLS1s Radio-loud QSOs		very high state
Classical Seyferts Radio-quiet QSOs		high/soft state
Low-Luminosity Seyferts		Intermediate state
LINERs		low/hard state
Nearby galaxies, Sgr A* et al.		quiescent state

Meyer, Liu, Meyer-Hofmeister et al. 2000a,b; Liu et al. 2002…
Liu et al. 2002,2003; Qiao & Liu 2015…

Esin et al. 1997
(Black hole X-ray binaries)

- **low-luminosity case**, the X-ray emission is dominated by the advection-dominated accretion flow (ADAF) and its variants (e.g., Yuan & Narayan 2014, ARA&A, 52, 529)

- **High-luminosity case**, the X-ray emission is produced by the so-called corona above a accretion disk, e.g.,

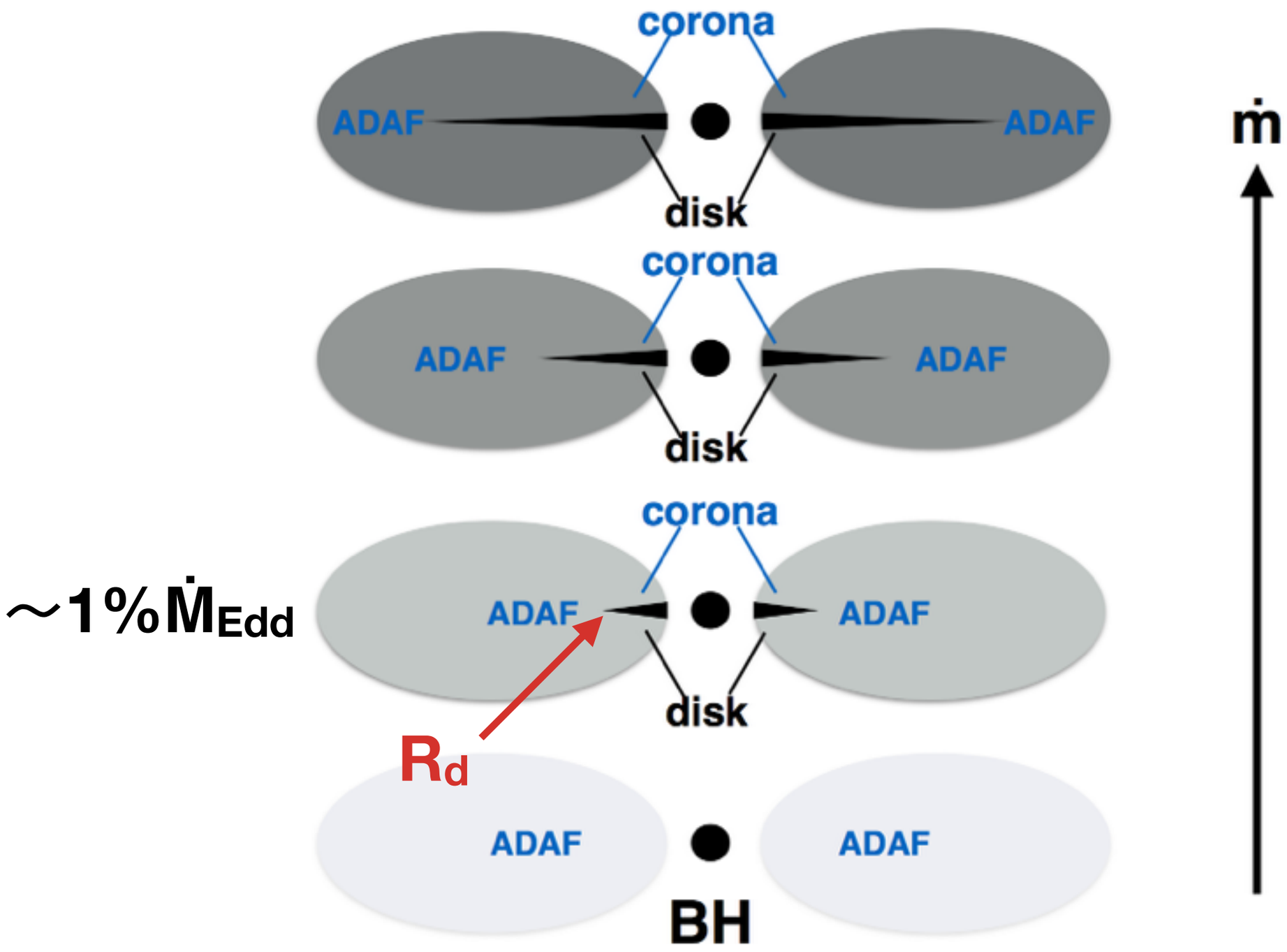
  - Assumed a fraction of the accretion energy dissipated in the hot corona (Haardt & Maraschi 1991, 1993; Svensson & Zdziarski 1994; Stern et al. 1995)

- Due to Parker instability, Magnetic reconnection is invoked (e.g., Galeev et al. 1979; Liu et al. 2002, 2003; Goodman & Uzdensky 2008)

- Some Numerical simulations have been done for the formation of the corona, However, it still too weak to match the observations very well (e.g., Uzdensky et al. 2013; Jiang et al. 2014; Vasudevan & Fabian 2007, 2009).

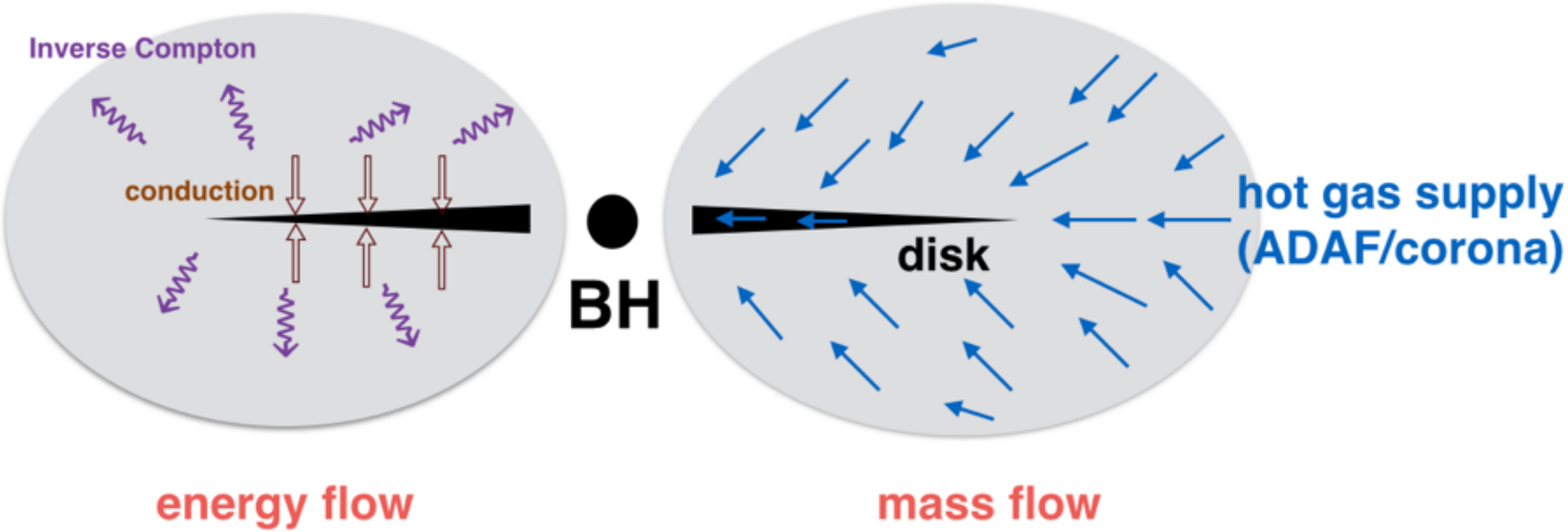
- We suggested that the **initial condition** of the fuel gas is important for the X-ray emission for the luminous AGNs **(Liu, Taam, Qiao & Yuan 2015, ApJ, 806, 223).**

- **So our picture is as follows,**



$\sim 1\% \dot{M}_{Edd}$

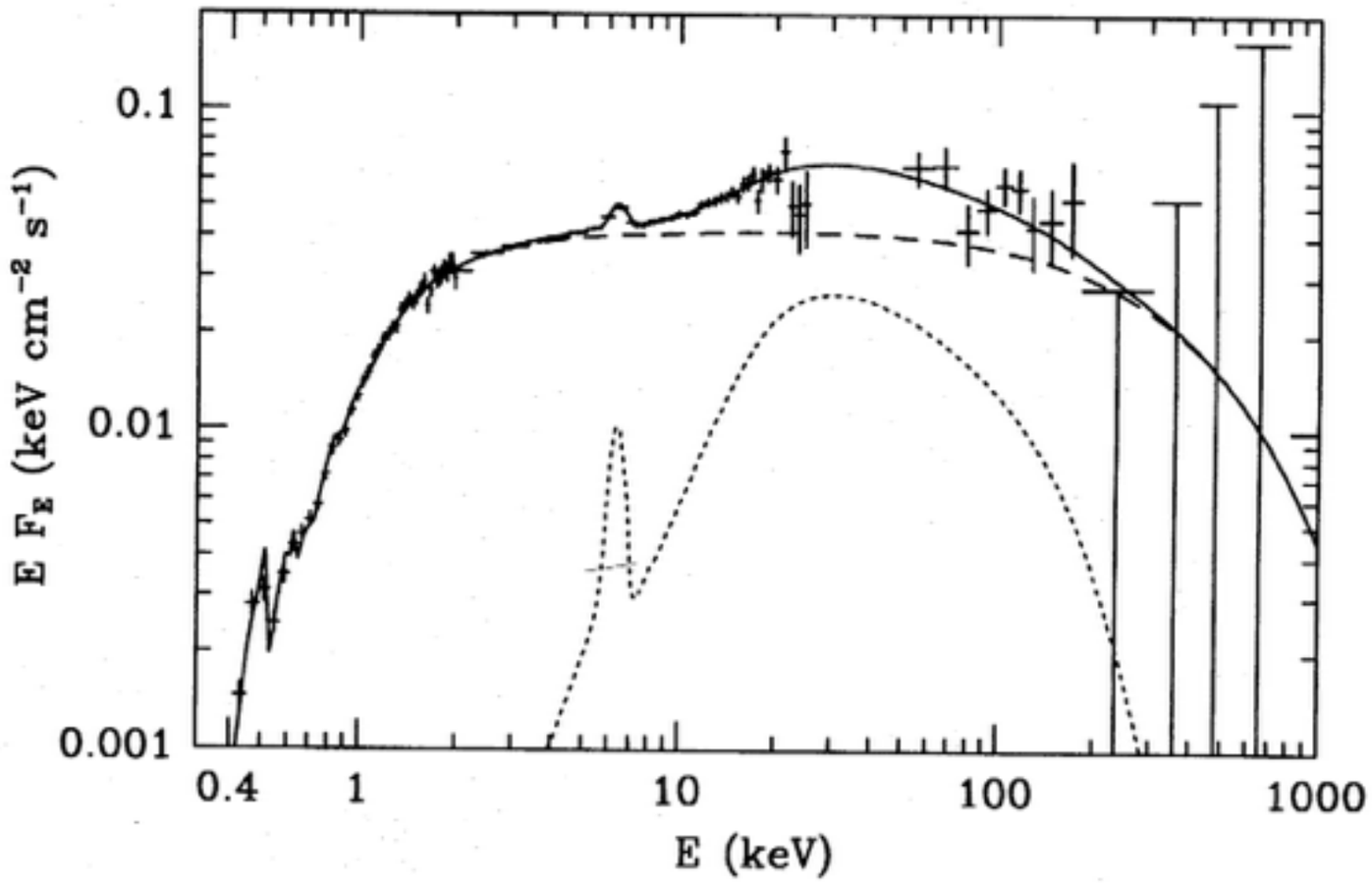
Condensation of ADAF/corona in AGNs



Qiao & Liu 2013, ApJ, 764, 2 (BHXBs)
Liu, Taam, Qiao & Yuan 2015, ApJ, 806, 223 (AGNs)

Observational test in AGNs:

X-ray spectrum of Seyfert I, IC 4329A



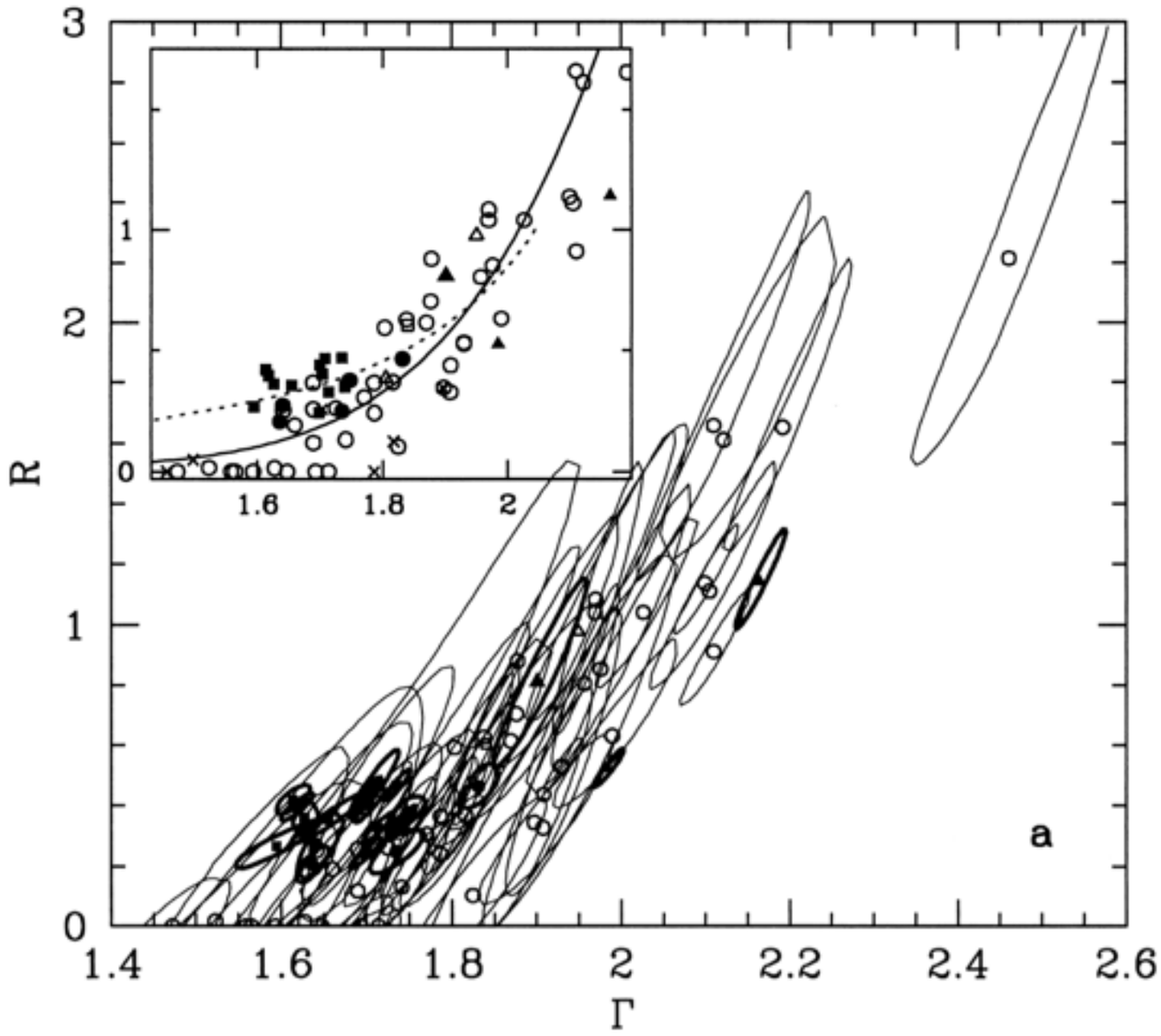
ROSAT, Ginga, OSSE

- **Hard X-ray photon index Γ**
- **R = Ω/2π**

θ=30° $R = 0.68^{+0.16}_{-0.14}$, $\alpha = 0.96^{+0.03}_{-0.03}$, and $E_c = 410^{+270}_{-120}$ keV.

Magdziarz & Zdziarski 1995

Γ-R correlation in AGNs

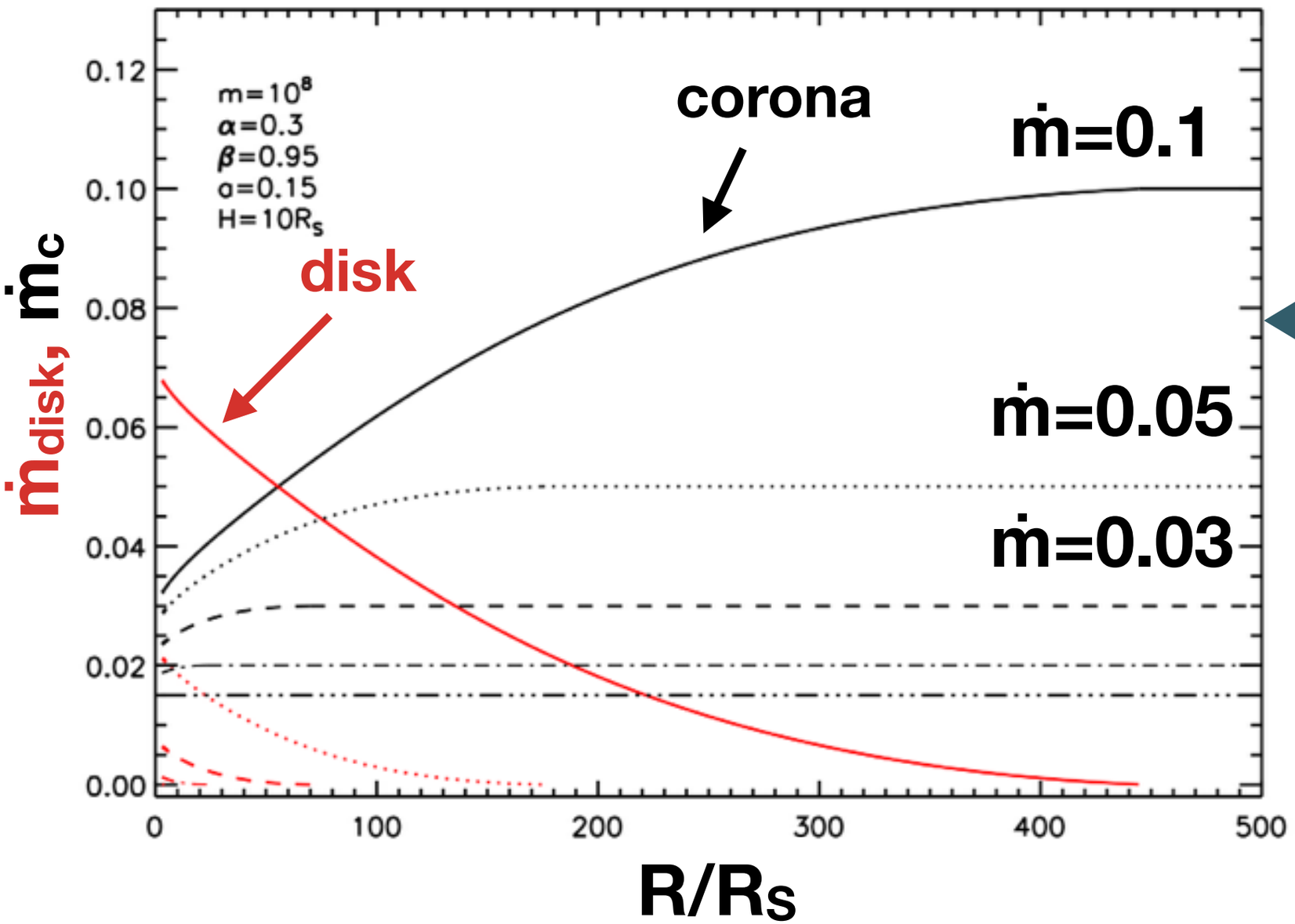


47 data sets for
23 RQ AGNs

Zdziarski et al. 1999

- **Theoretical Results:**

The distribution of accretion rate in disk and corona



Input parameter:

$m=10^8$

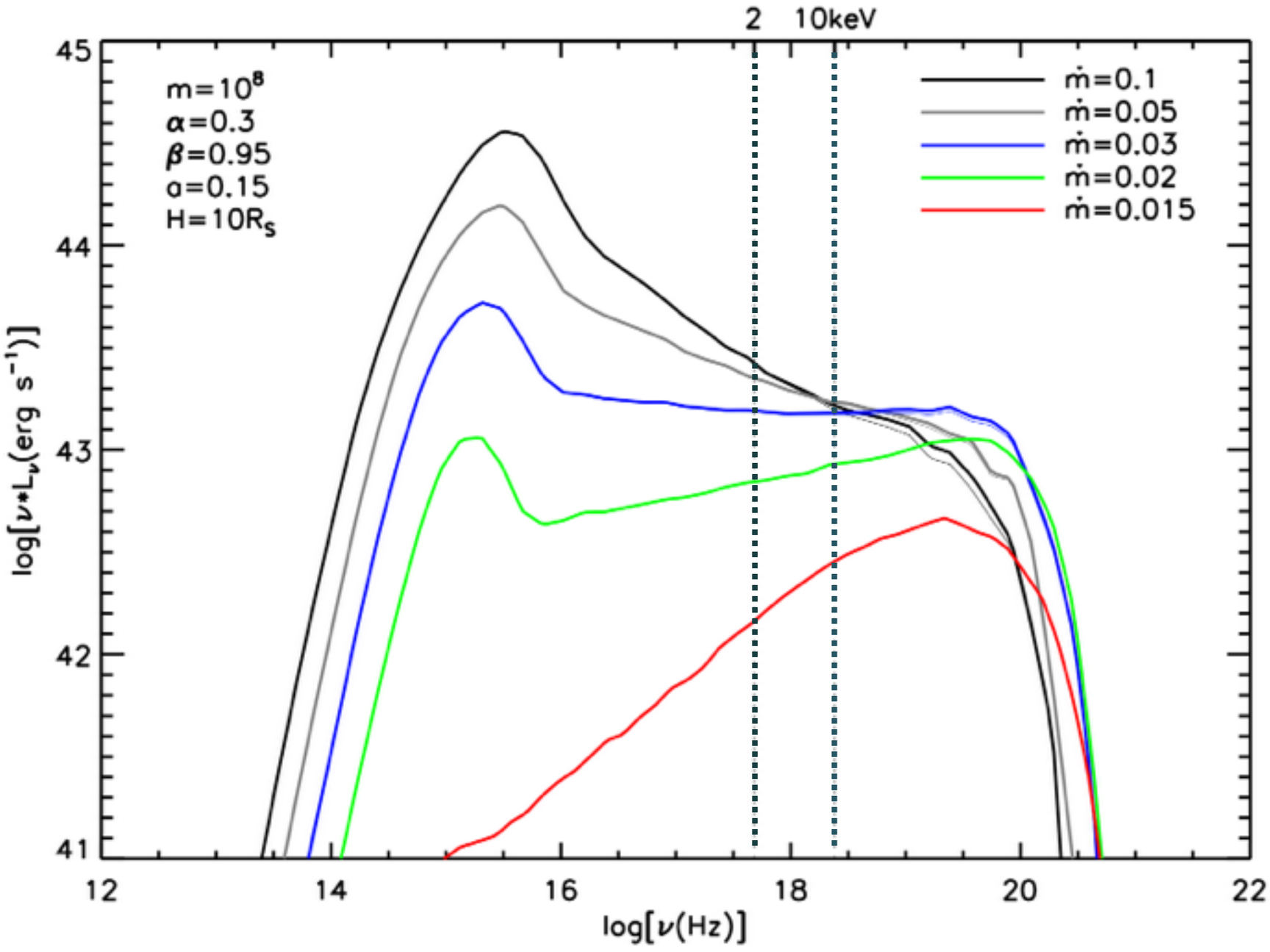
$\alpha=0.3$

$\beta=0.95$

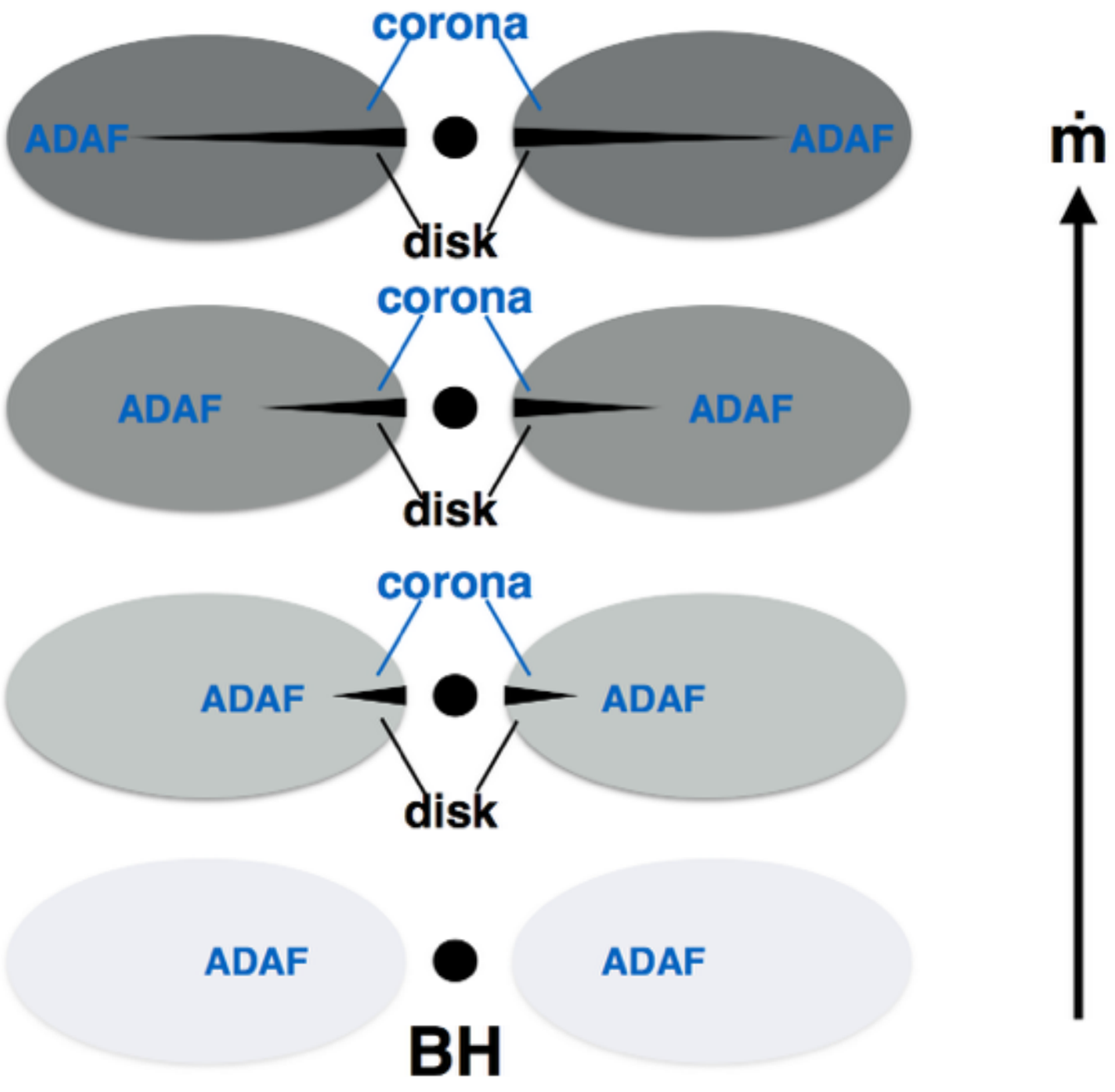
$a=0.15$

$H_s=10R_s$

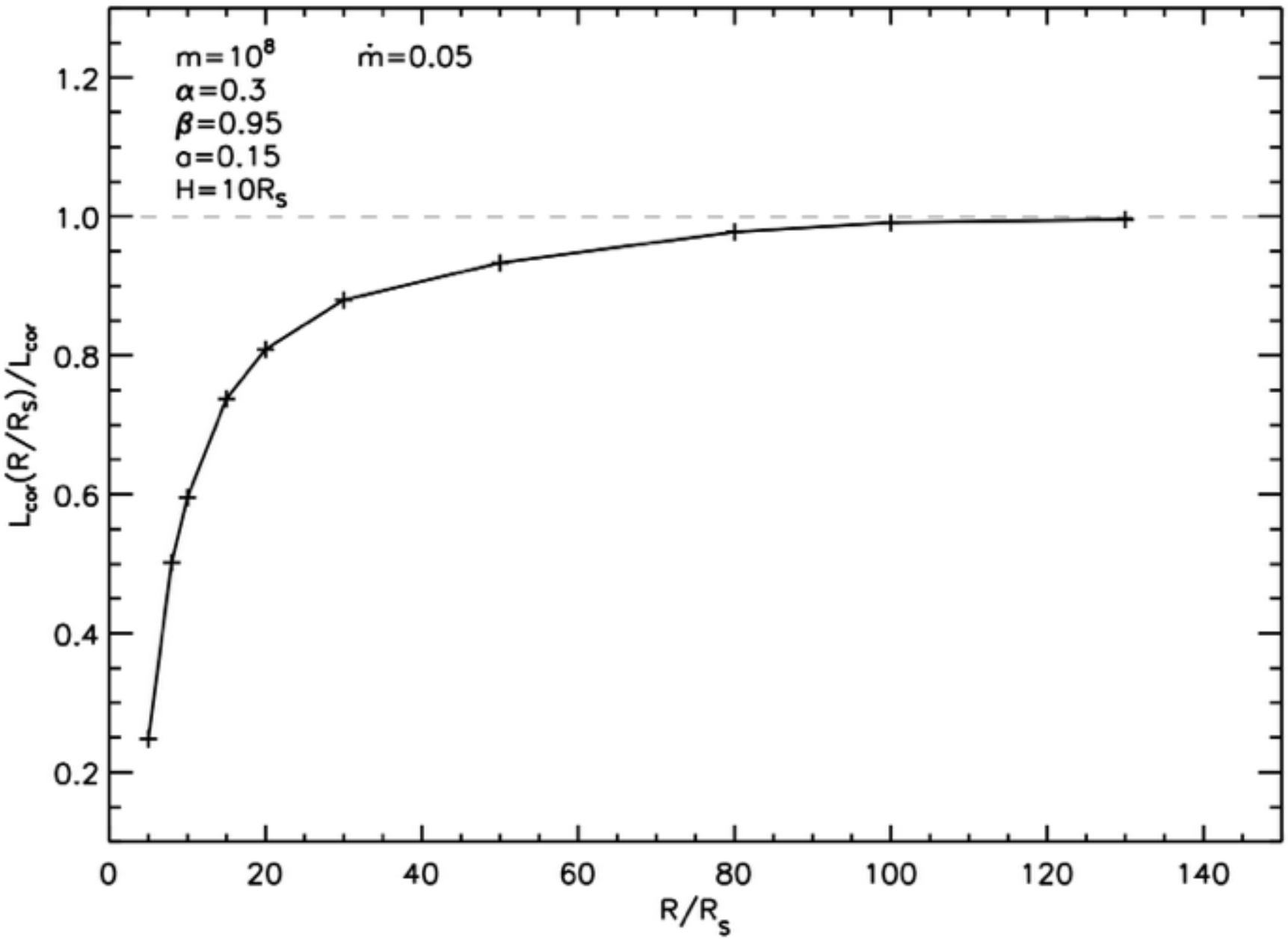
From the spectra, we can get Γ



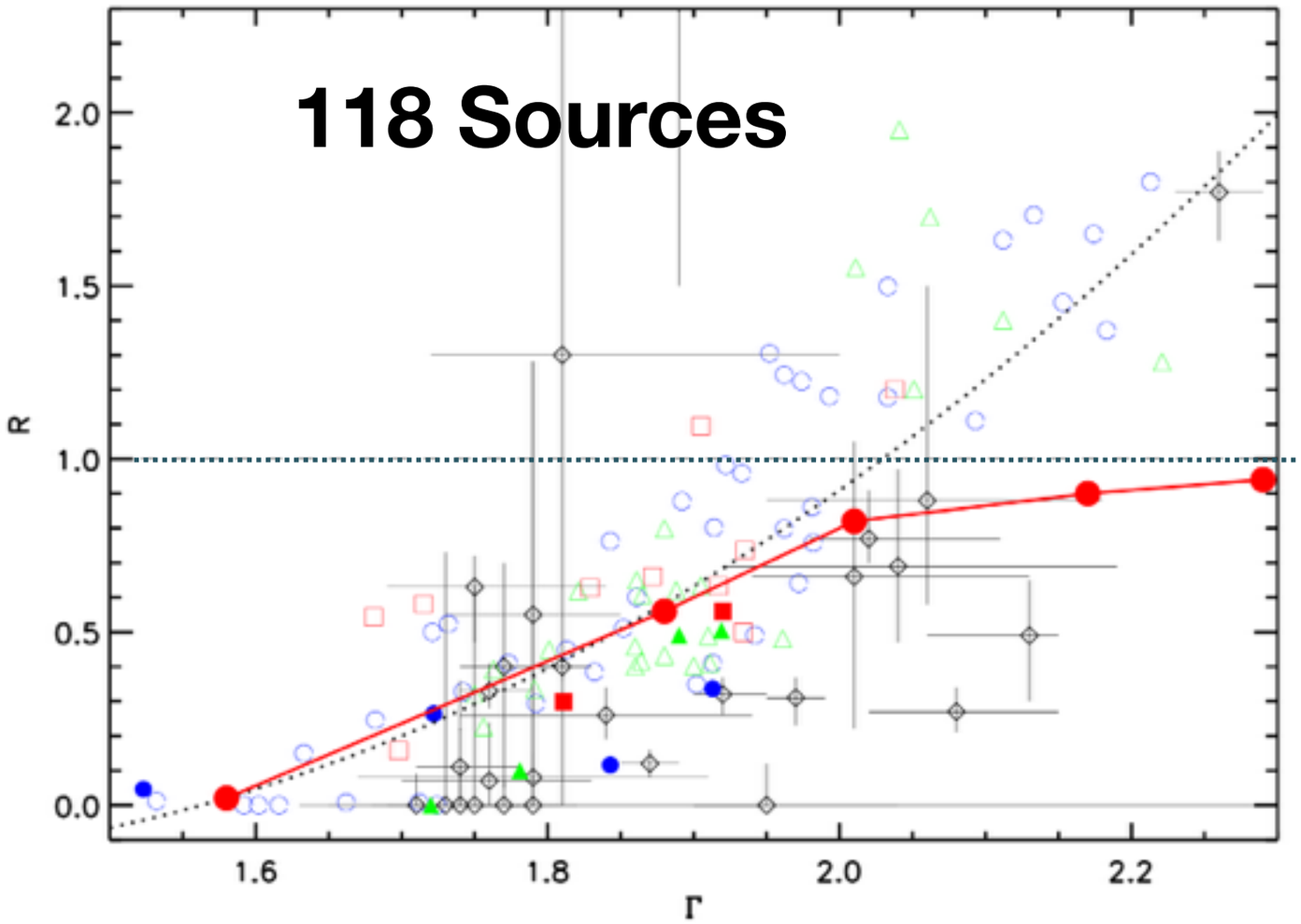
From the geometry, we can get R (R=Ω/2π)



The corona is very compact!



- **Comparing with observations:**



Qiao & Liu 2017, MNRAS, 467, 898

- Including Ginga, RXTE, BeppoSAX obaervations RQ 和 RL 90 AGNs!
Zdziarski et al. 2003

- Including 28 bright Seyfert galaxies (INTETRAL, XMM, Suzaku, RXTE)
Lubinski et al. 2016

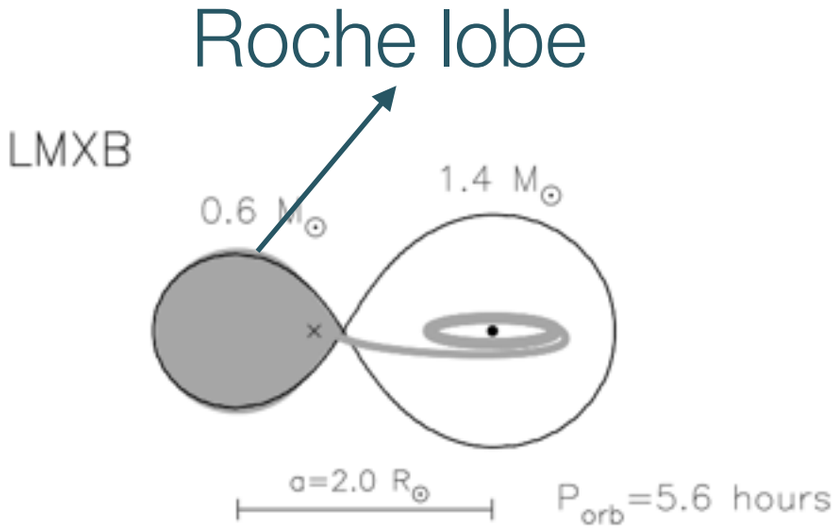
- **Red dots are theoretical results**

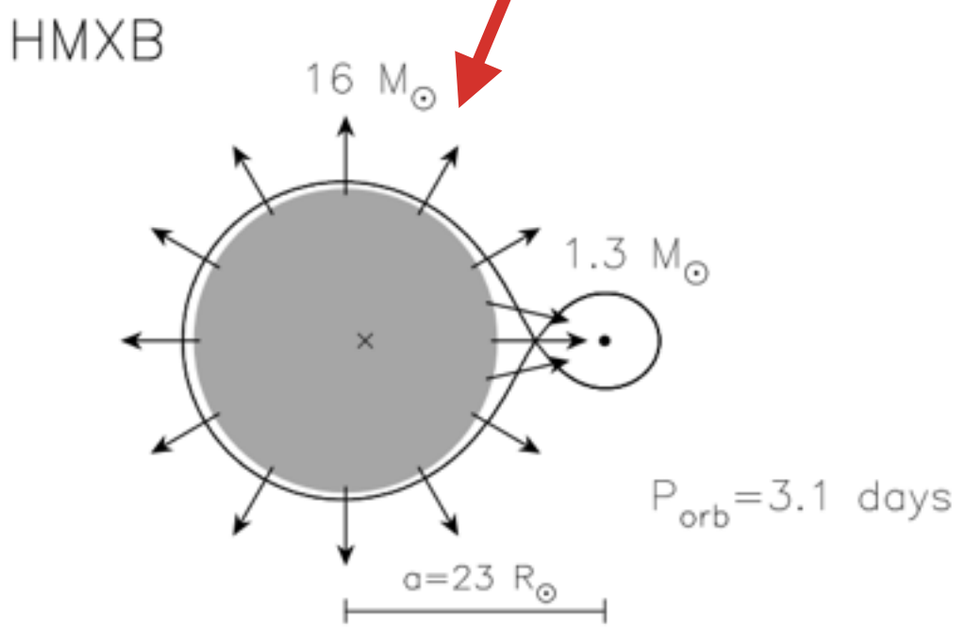
Can explain R<1 ,
Can not explain R>1

Discussions

- The disk-spheroid model (Zdziarski et al. 1999); Plasma ejection model (Beloborodov 1999) for the Γ-R correlation
- The GR effect (e.g., light bending) has not been included in the model
- More generally, initially, the matter should be clumpy, including both cold and hot components (In progress…)
- Future numerical simulations are needed to confirm such a accretion geometry
- We need collect further observational evidence (like, Te, compactness,variability etc) to support our model (Fabian et al. 2015; Liu, Taam & Qiao ApJ 2017, submitted)
- Applying our model to high mass X-ray binaries (wind accretion)?

Cyg X-1, LMC X-1,LMC X-3





low mass X-ray binaries
via Roche lobe

high mass X-ray binaries
via stellar wind

Thanks!