Spectral analysis of LMXB Aql X-1 in soft and hard states with *Suzaku*

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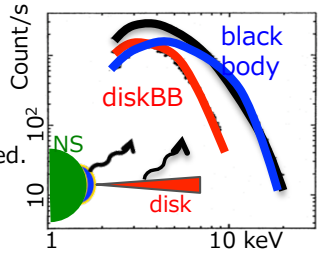
(1) Introduction ~ Soft and Hard states of LMXBs ~

Soft state

- Well studied since the 1980's. (Mitsuda+1984, White+1988,..)
- High mass accretion rate.
- Bright in enregy below ~20 keV.
- A firm picture has been established.
  - ➢ diskBB from a standard disk.
  - ➢ blackbody from the neutron-star surface.
    - A clear difference from BHBs. (event horizon → no surface)



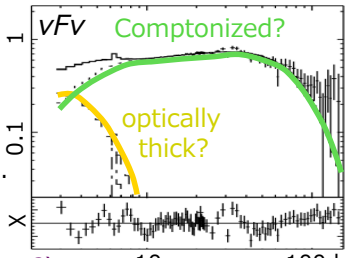
Sco X-1 spectrum (*Tenma*) (Mitsuda+1984)

Hard state

- Researches have recently started (e.g., Barret2001, Lin+2009etc)
- Low mass accretion rate.
- Spectra with Γ~2 power law shapes.

Unsolved Problems

- ➢ What is correct mission model? (the source of Compton seed photons ?)
- ➢ What is the accretion geometry like? (disk, corona, neutron-star surface, ..?)

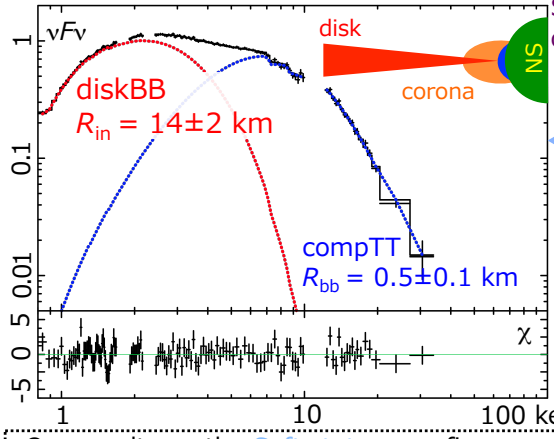


Aql X-1 spectrum (*RXTE*) (Lin+ 2007)

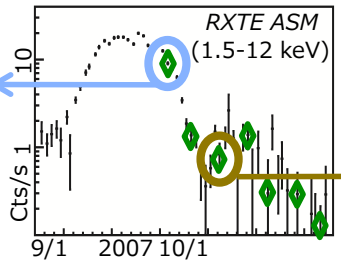
(2) *Suzaku* results on Aql X-1 in the Soft and Hard states

(reanalysis of the archival data originally published as Raichur et al. [6])

Soft state

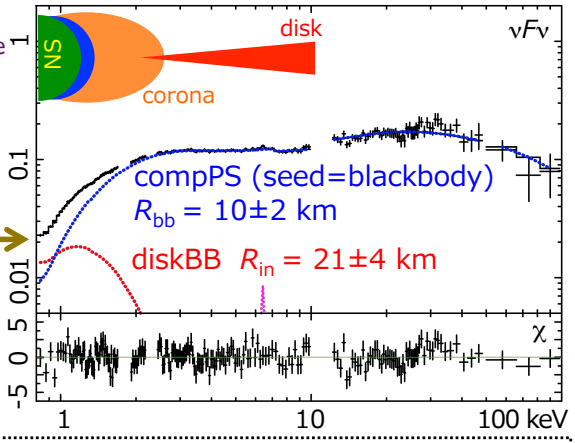


Seven *Suzaku* observations (◊) of Aql X-1 on the *ASM* light curve



The remaining 5 data sets being analyzed…

Hard state



Our results on the Soft state reconfirm previous studies.
In the Hard state, the emission model and accretion geometry (above right) were successfully identified.
Model: diskBB + compPS(seed = black body) + Gaussian(E=6.4 keV)

- ➢ Seed photons of compPS are from the NS surface.
- ➢ The standard disk is truncated at r~20 km.
- ➢ Most of the NS surface becomes hot (kT = 0.51±0.02 keV).
- ➢ Coronal parameters: T_e=35±5 keV, τ~2.7

(3) Discussion

A fully physical emission model in the hard state was determined for the first time, wherein the seed photons of compPS are identified with the blackbody from the neutron-star surface.

Geometrical features of the accretion flow in the Soft/Hard states

	Accretion Disk	NS surface	Flux ratio (corona+NS / disk)
Soft state	The disk inner edge is close to the NS surface.	Accretion/emission occurs mainly onto/from an equatorial zone.	F_{comp}/F_{disk} ~ 0.44 (from the data) The disk is rather luminous.
Hard state	Truncated at ~20 km. At <20 km, it becomes an optically-thin and geometrically-thick hot flow, to be identified with the Compton corona.	Matter accretes almost spherically, and the whole NS surface shines.	F_{comp}/F_{disk} ~ 6 (from the data) The ratio is reversed from that in the soft state; the corona + NS much brighter.

(4) Conclusion

We analyzed archival *Suzaku* spectra of Aql X-1 in the Soft/Hard states. The Soft state results reconfirmed previous studies. In the Hard state, we have for the first time identified major emission components and obtained a fully physical picture of the accretion geometry.

References

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[4]Mitsuda, K., Inoue, H., Koyama, K., et al. 1984, ApJ, 281,354
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[6] Raichur, H., Misra, R., & Dewangan, G. 2011, arXiv:1105.5523