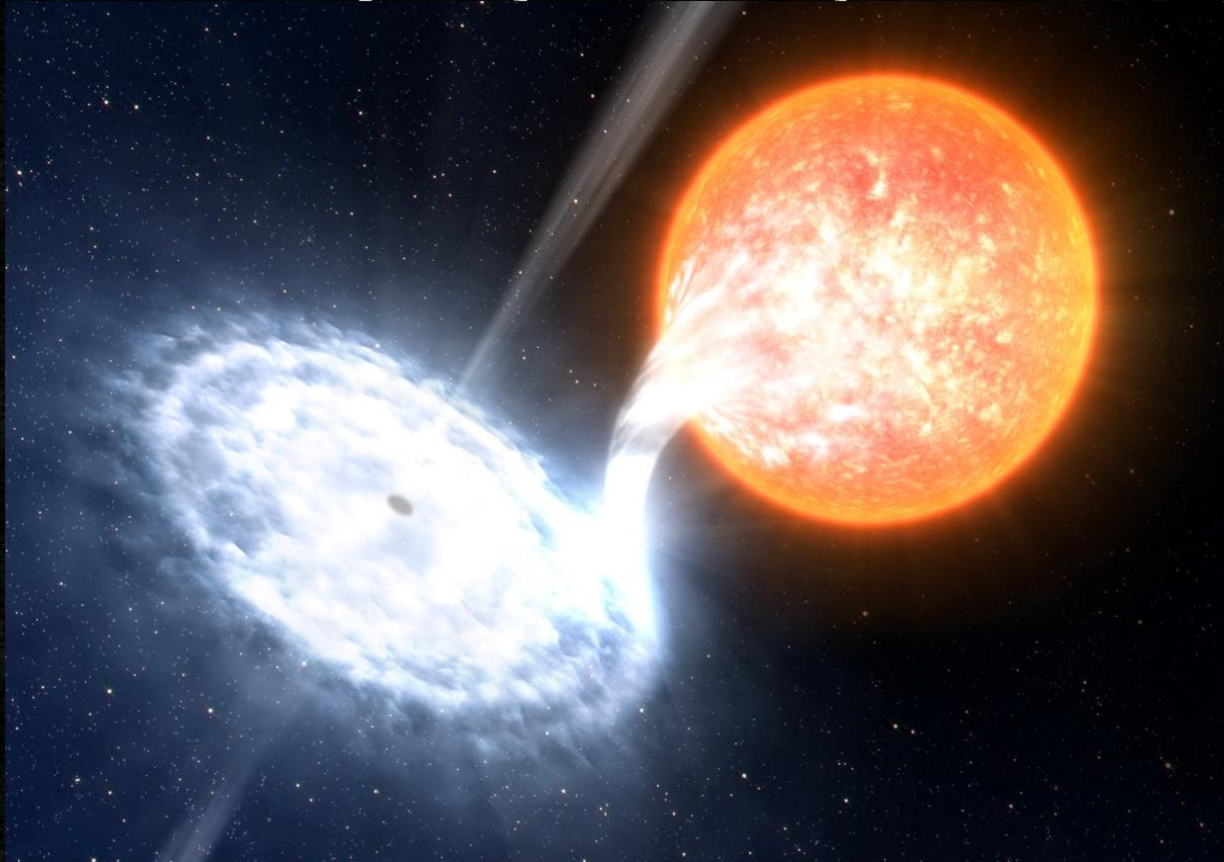


Suzaku Observation of the Black Hole Binary 4U 1630-47 in the Very High State

Kyoto University
Takafumi Hori

Yoshihiro Ueda, Megumi Shidatsu,
Taiki Kawamuro (Kyoto University),
Aya Kubota (Shibaura Institute of Technology),
Chris Done (Durham University),
Satoshi Nakahira (JAXA)

Black Hole (BH) Binary



- Close binary systems
- Variety of X-ray spectra according with their X-ray luminosity

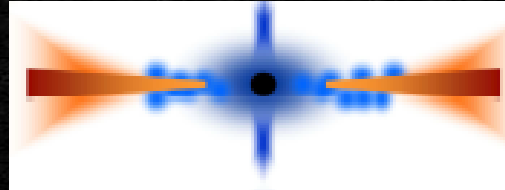
Black Hole (BH) Binary

Luminosity



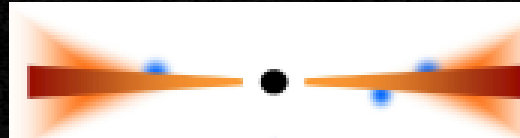
very high state

$$R_{\text{in}} > R_{\text{ISCO}} ?$$



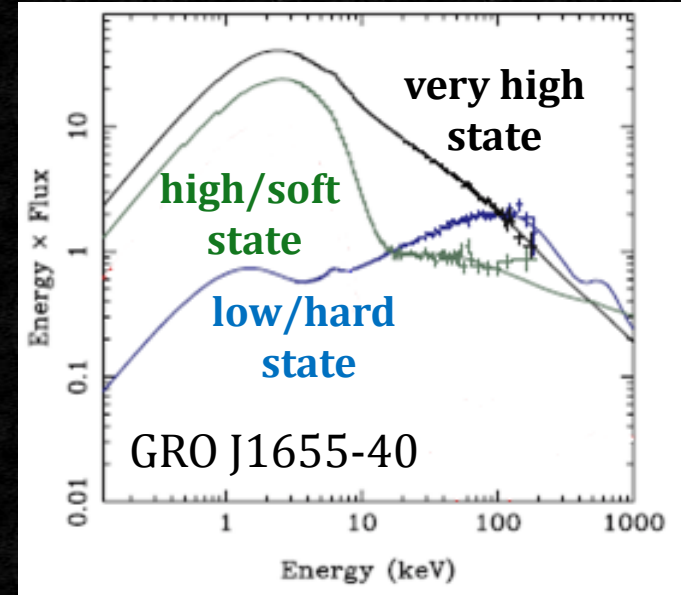
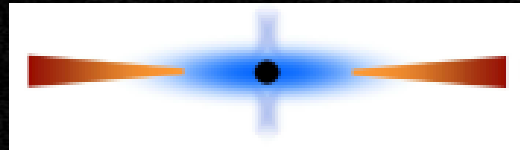
high/soft state

$$R_{\text{in}} = R_{\text{ISCO}}$$



low/hard state

$$R_{\text{in}} > R_{\text{ISCO}}$$



ISCO : (Innermost Stable Circular Orbit)

(Done et al. 2007)

Disk Emission

Inverse Compton from Corona

Fe absorption line due to disk wind (high/soft state)

Fe emission lines from baryonic jet (very high state)

Very high state (VHS)

VHS is the most luminous state

→ Investigate the property of the disk in the critical accretion

Many properties of the very high state is not well known

- $r_{\text{in}} = r_{\text{ISCO}}?$ $r_{\text{in}} > r_{\text{ISCO}}?$
Standard disk? corona?

- Baryonic jets stability
- Disk wind in the VHS?
outer disk properties

4U 1630-47

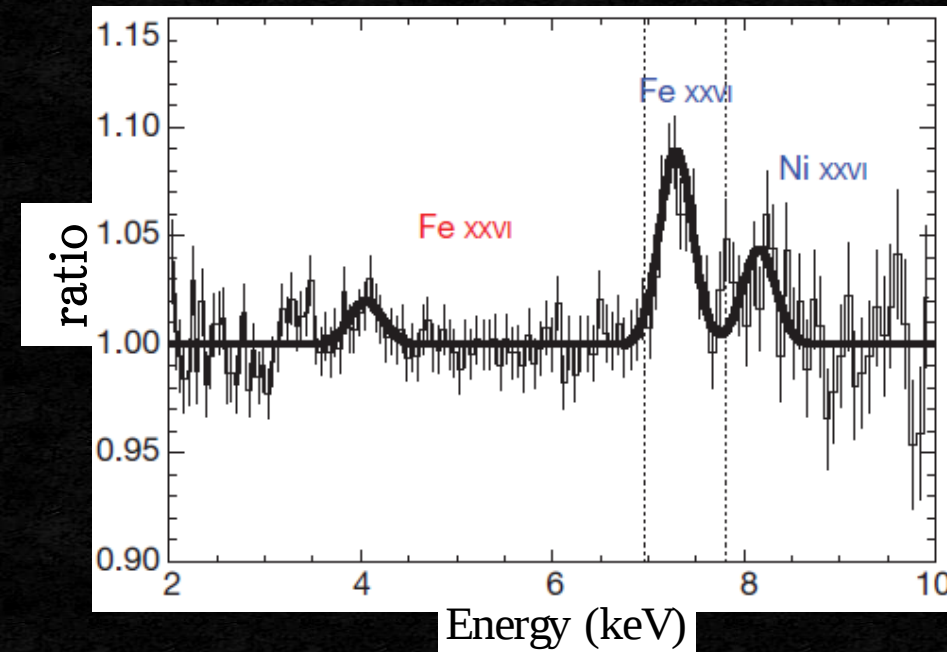
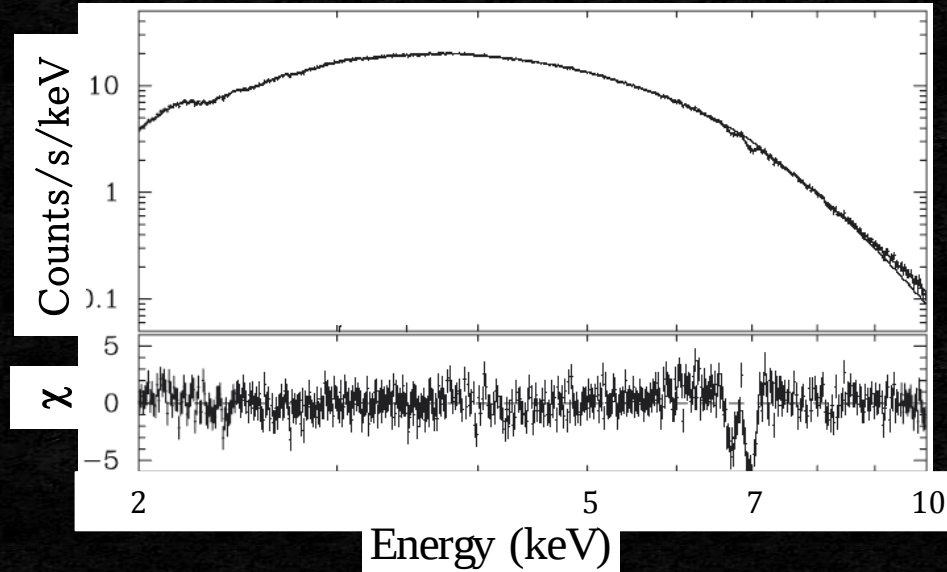
Black Hole Candidate

We assume

distance : 10 kpc 、

Inclination angle : 70°

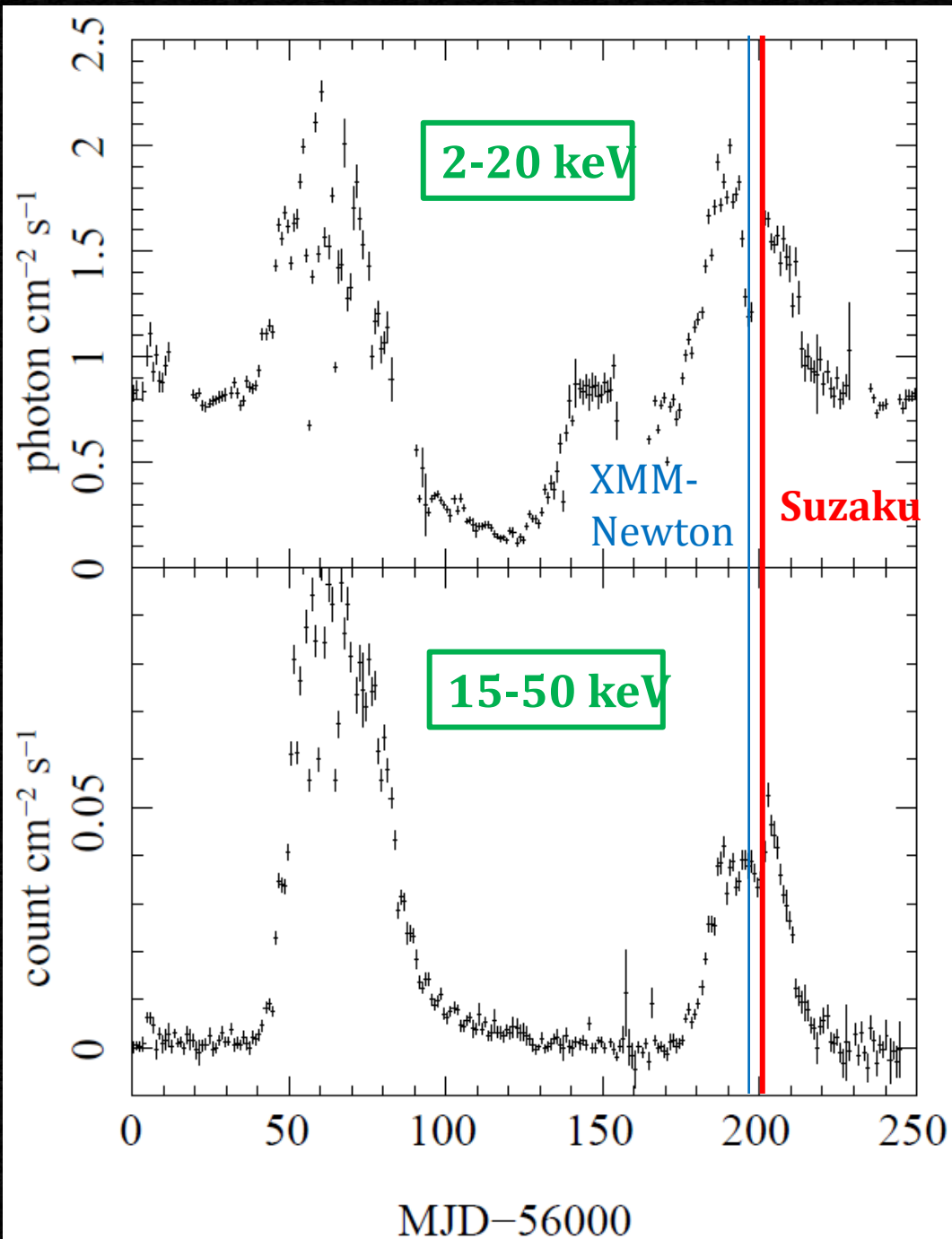
- Disk wind in the high/soft state (Kubota et al. 2007)
- $r_{\text{in}}^{\text{HSS}} = 34.2^{+0.02}_{-0.03} (\text{km})$
- Baryonic jets with $\sim 0.3 c$ in the very high state (Diaz Trigo et al. 2013)

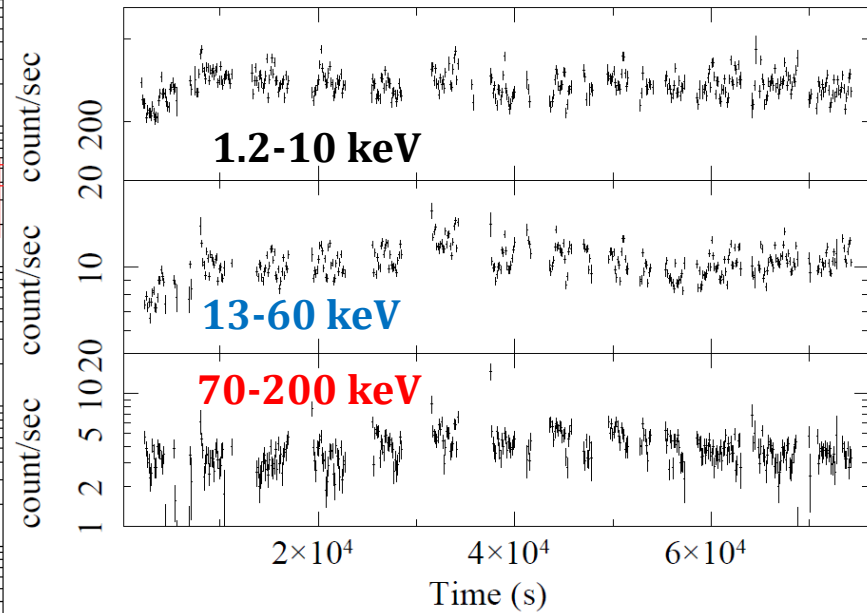
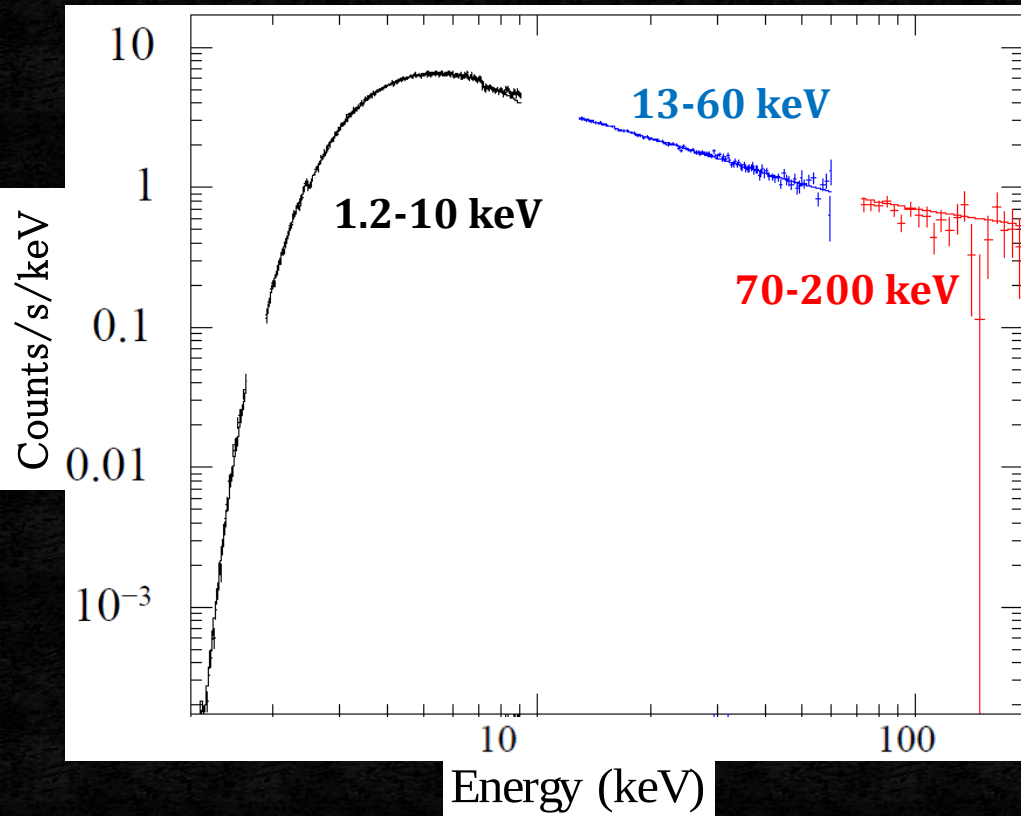


Observation

- X-ray satellite
“Suzaku”
- Date
2012/10/2

Only 4 days after of
the baryonic jet
observation by
XMM-Newton





No significant variation

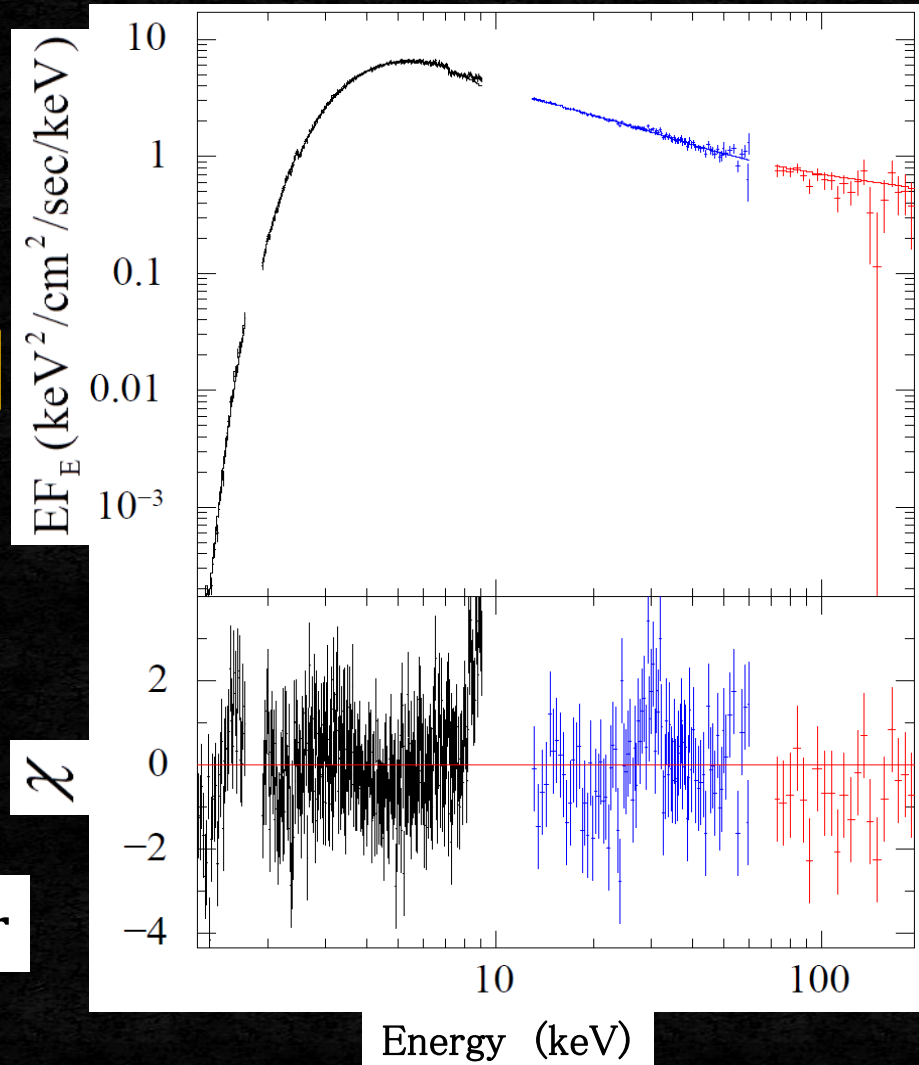
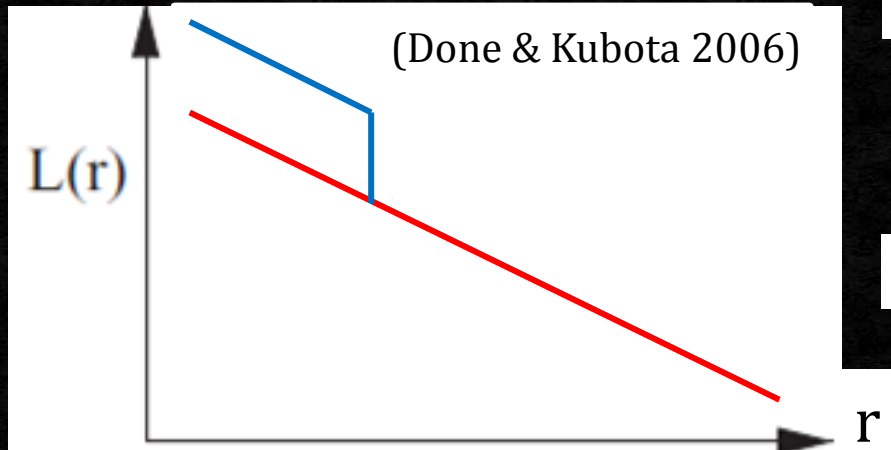
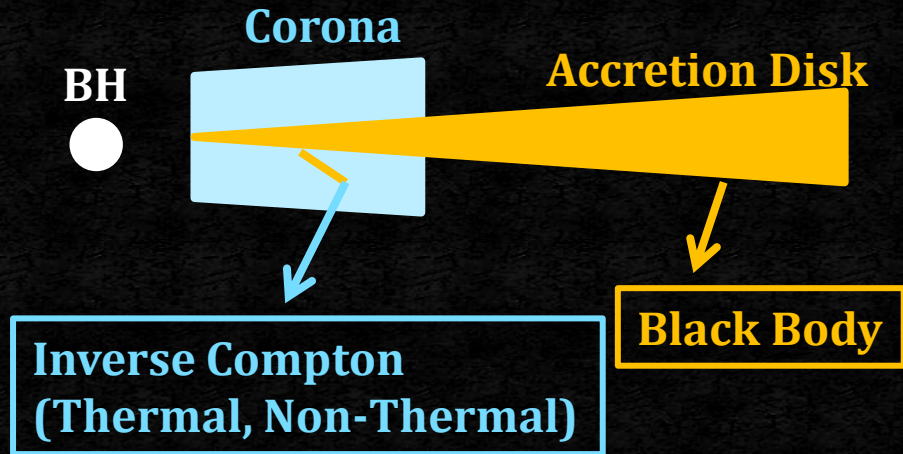
Very wide band & Very good quality spectra

- Neither Fe emission lines nor absorption lines
→ Did not detect **Baryonic Jet or Disk Wind**

Source of Continuum

Model

Coexist thermal and non-thermal corona (Gierliński & Done 2003)



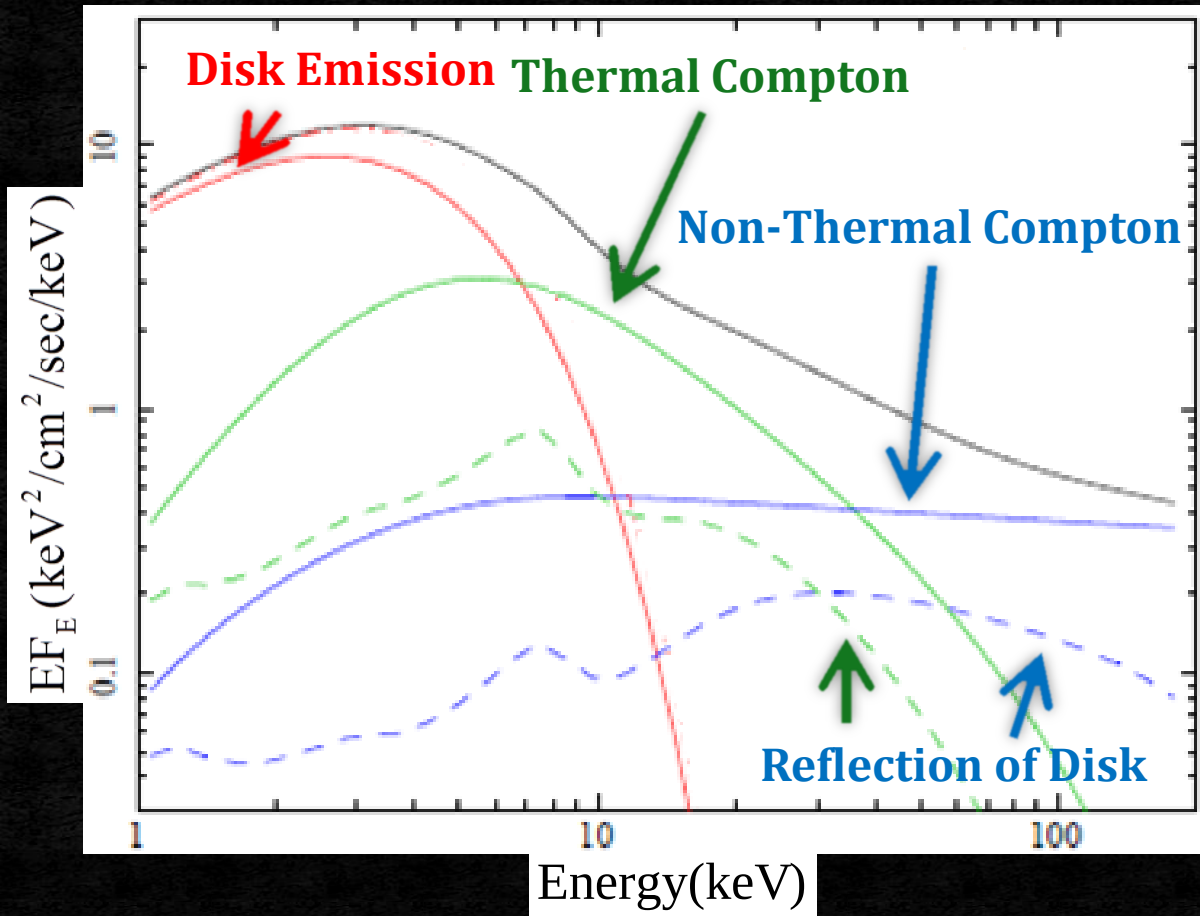
Gravitational Energy

Disk Emission

Inverse Compton From Corona

$\chi^2 / \text{dof} = 1248 / 1027$

Result



Innermost Disk Radius
(Kubota & Makishima 2004)

$$r_{\text{in}} = 39.9^{+2.9}_{-1.3} (\text{km})$$

Observation of high/soft
state during 2006 outburst

$$r_{\text{in}}^{\text{HSS}} = 34.2^{+0.02}_{-0.03} (\text{km})$$

**The accretion disk
does not extend to
the ISCO**

Disk emission and Strong Comptonization
→ Very High State

Discussion

- The accretion disk does not extend to the ISCO in the very high state (GX 339-4 : Tamura et al. 2012)
 - The state of accretion flow to the BH is not standard disk
- The baryonic jets are not detected
 - They are not stable
- The disk wind which observed in the high/soft state is also not detected
 - Quenching disk wind?
 - The structure of the outer disk is also changed

Summery

We investigate the accretion disk of BH binary in the VHS

- The accretion flow takes low density state
- The baryonic jet is not steady ejected
- The disk wind is not detected
 - The structure of the outer disk is changed