

Unveiling the spectral transition of Aql X-1 from the hard to soft state

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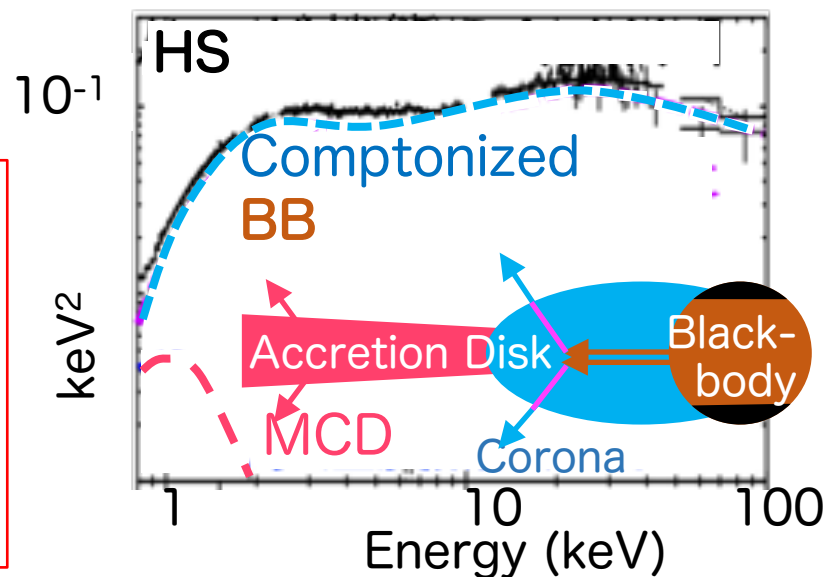
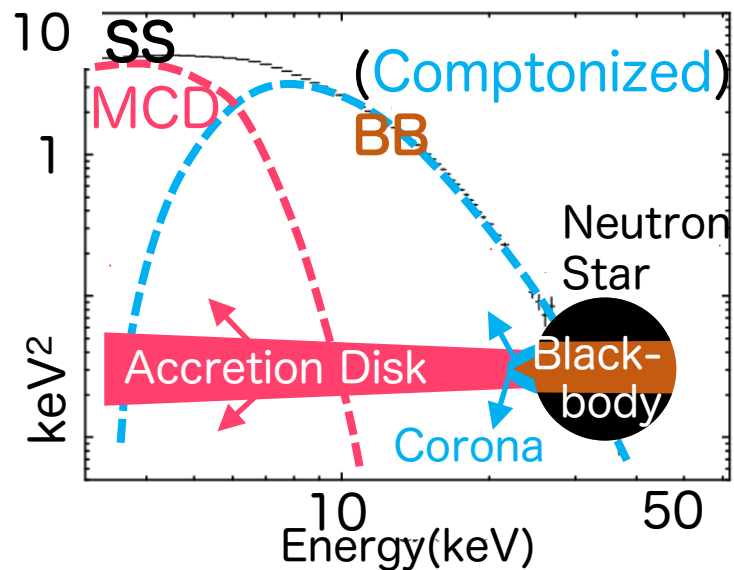
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Spectral states of NS-LMXBs

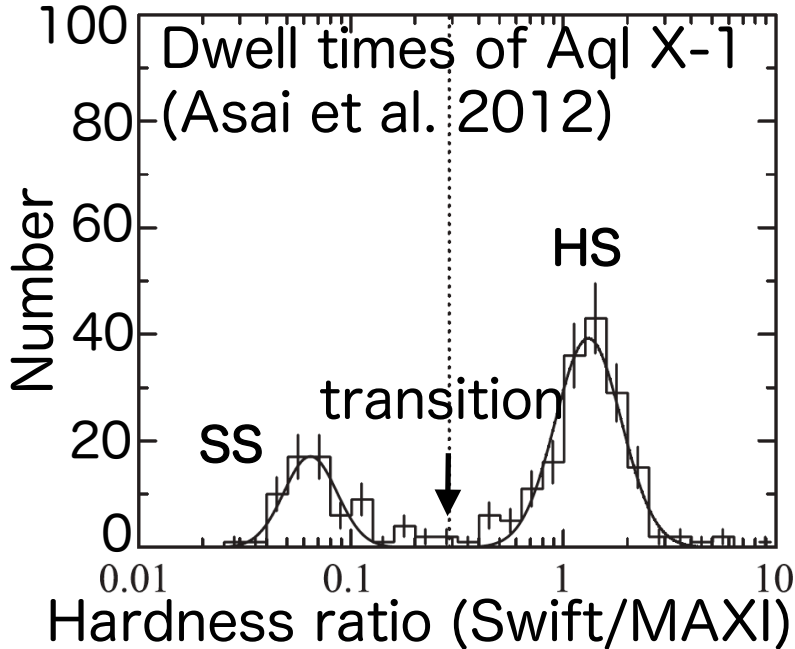
- The soft state (SS) is well explained by an **accretion disk (MCD)** and a weakly **Comptonized blackbody (BB)** (Mitsuda+84).
- The same model with much stronger **Comptonization** may explain the hard state (HS) spectrum as well (Sakurai+14).
- However, the HS interpretation is still ambiguous (Lin+07).

To strengthen our unified model, the best way is to trace the spectral evolution during a state transition. If correct, our modeling will **continuously** evolve with **reasonable parameter values**.

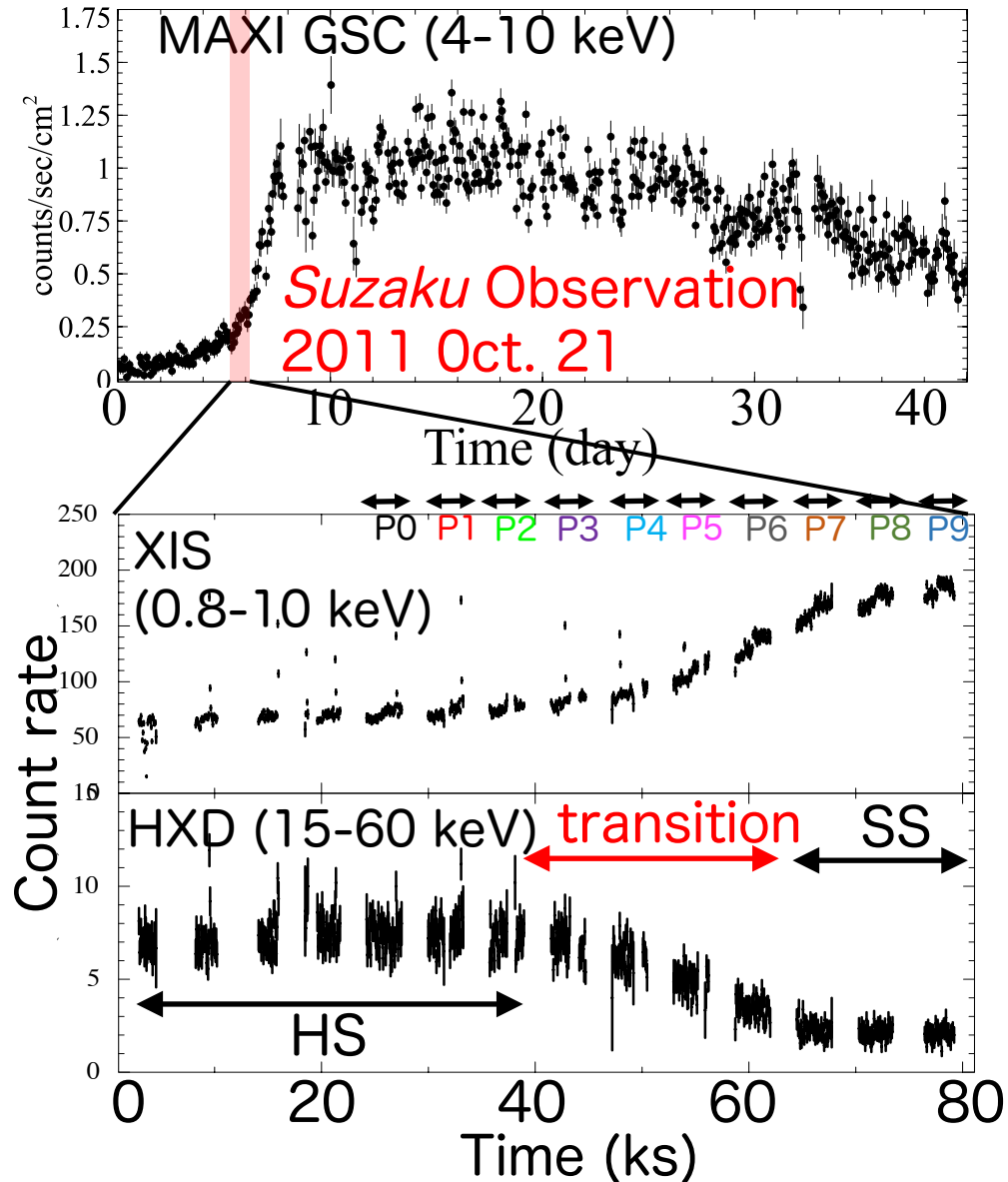


A HS-to-SS transition of Aql X-1

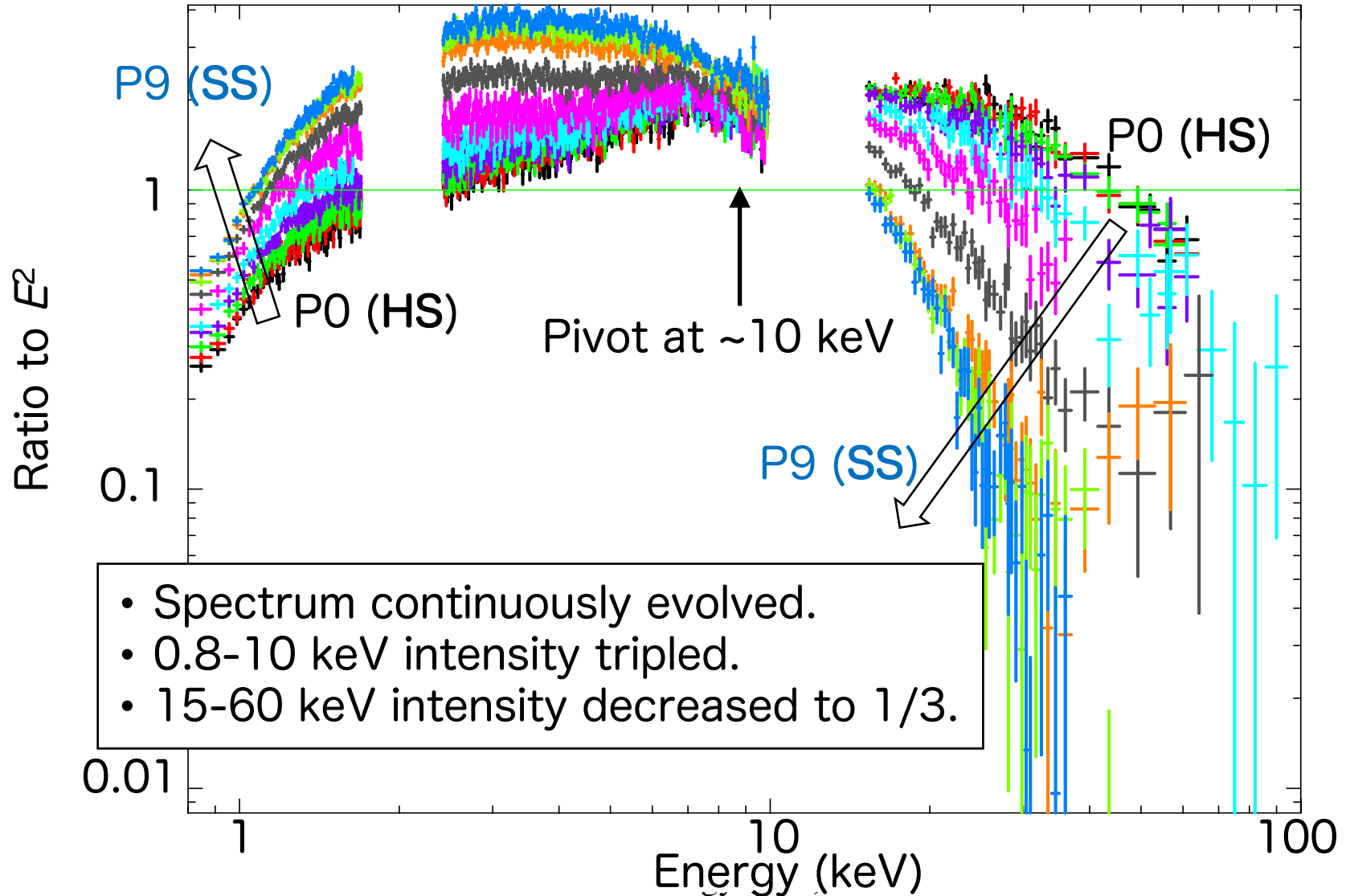
Aquila X-1: recurrent transient.



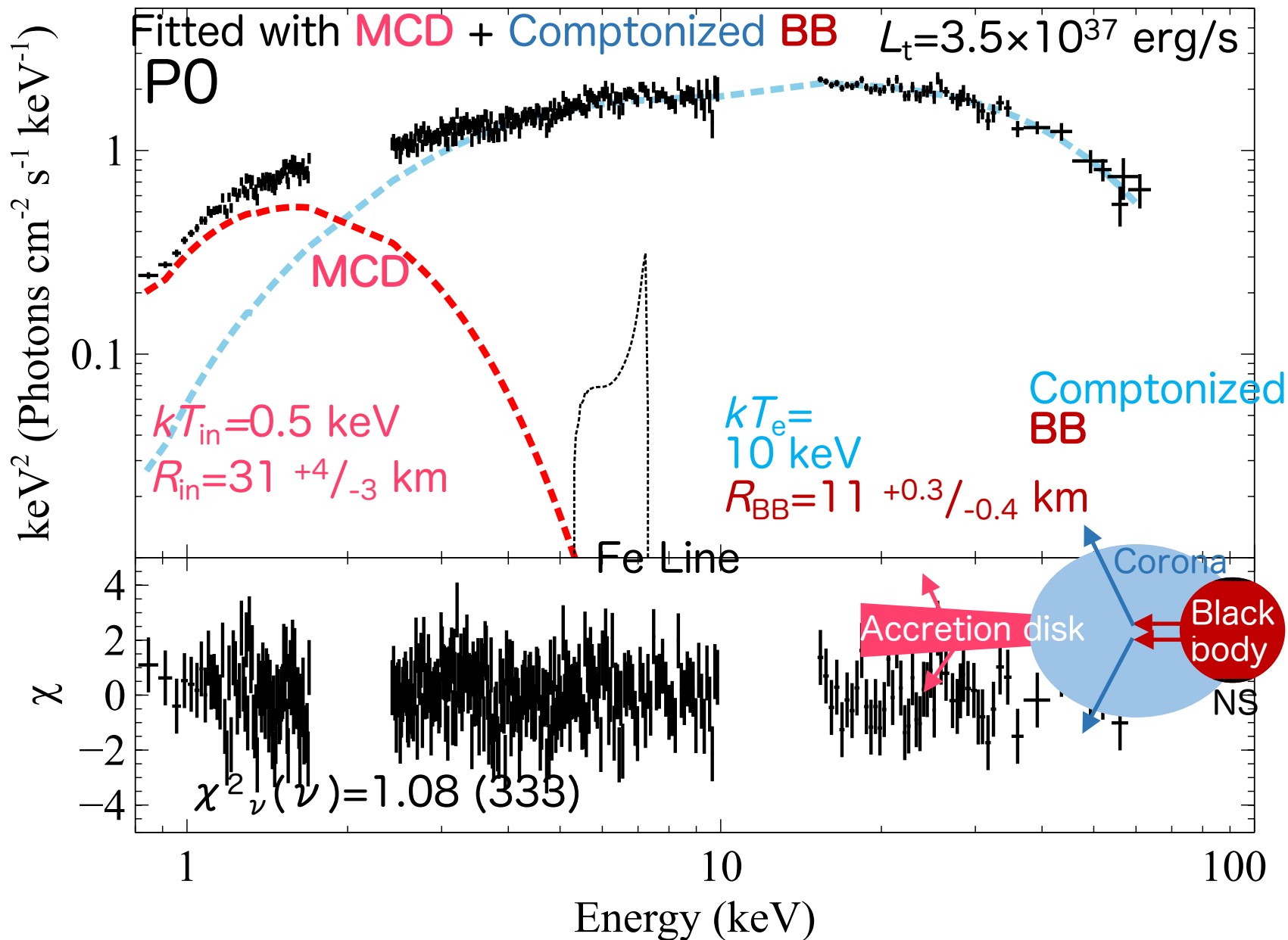
- On 2011 Oct. 21, a ToO observation was conducted with *Suzaku* (PI: Yamaoka) triggered by *RXTE*.
- A **HS-to-SS transition** took place during the observation, on ~20 ks.



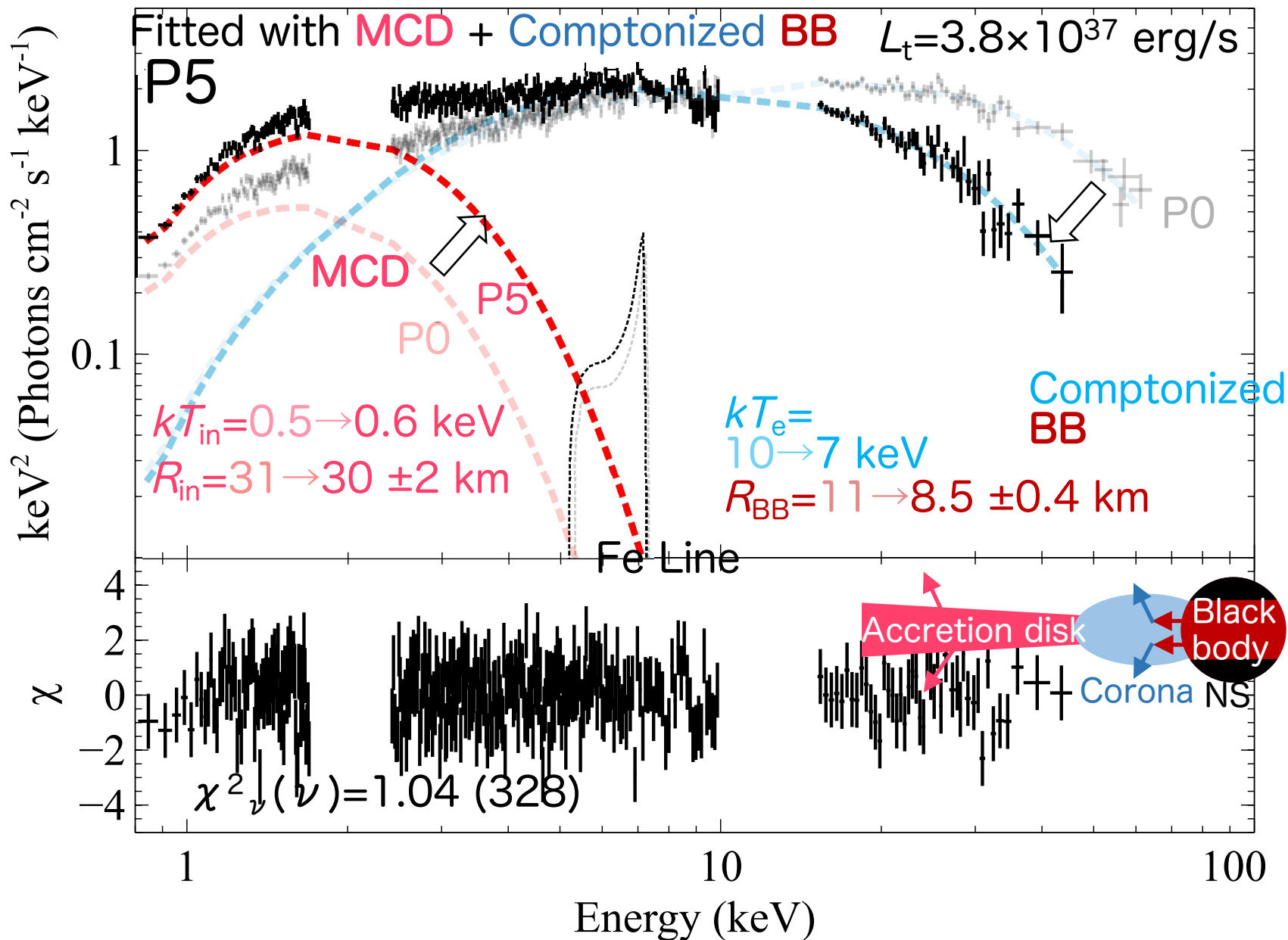
Spectral evolution during the transition



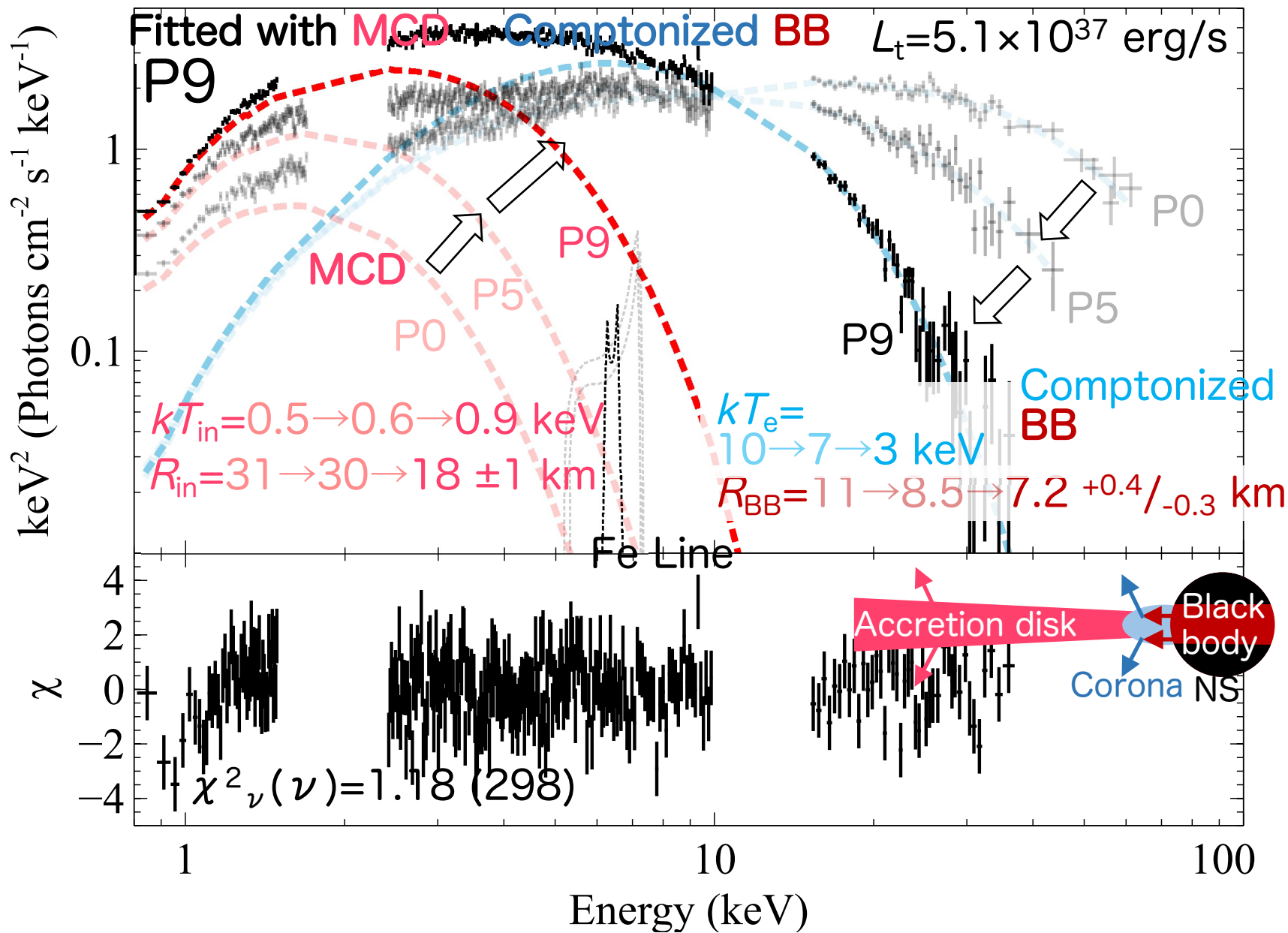
Spectral fitting



Spectral fitting

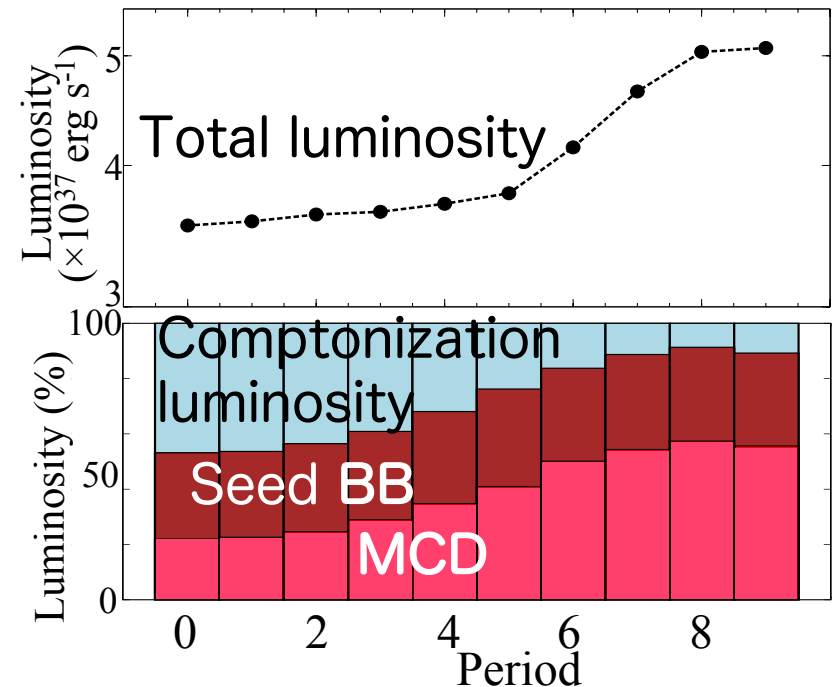
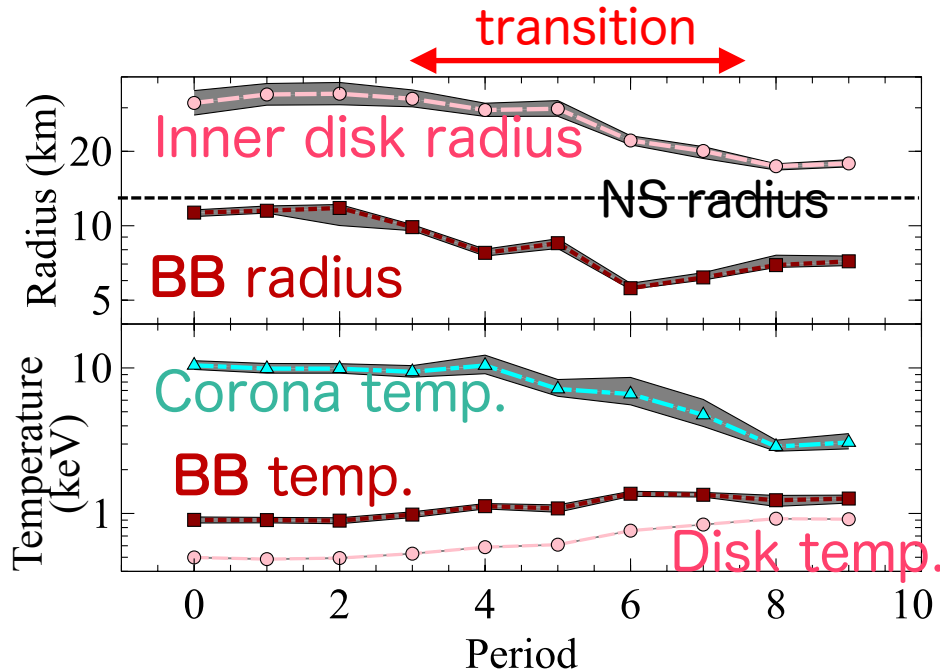


Spectral fitting



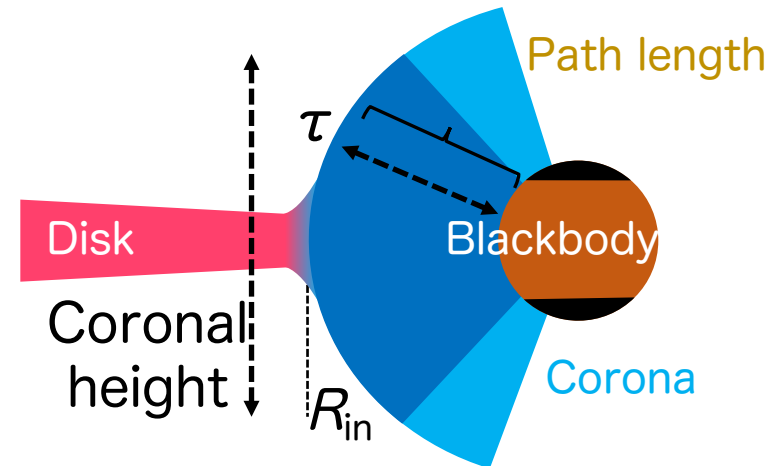
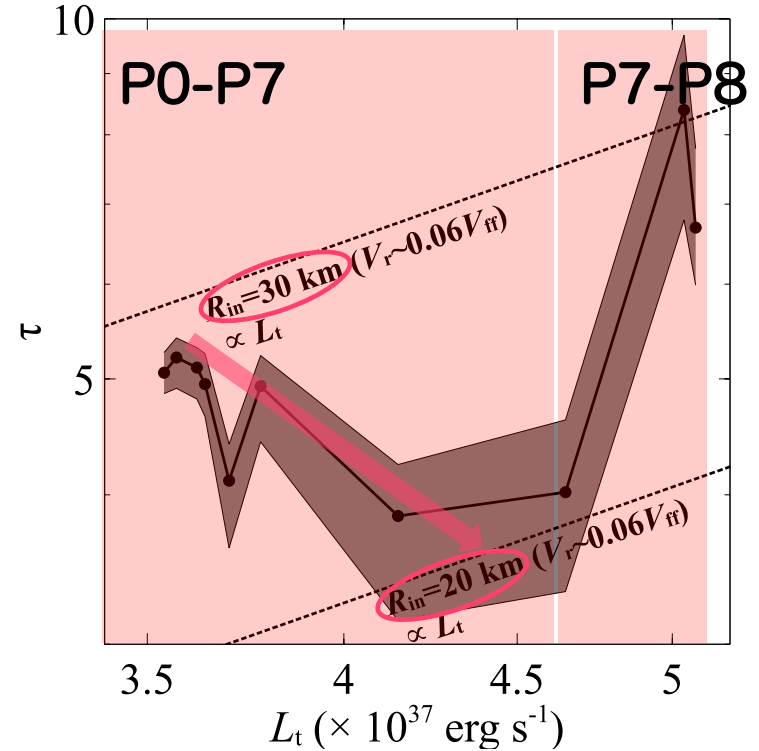
Discussion -parameters-

- The **MCD+Comptonized BB** model was successful throughout.
- The derived parameters are **physically reasonable** and **continuously changed**.
- Therefore, our unified modeling has been reinforced.
- The total luminosity increased monotonically by 50%.
- The transition can be characterized by the decreasing **Comptonization luminosity**, and the increasing **MCD luminosity**.



Discussion -coronal geometry-

- The coronal optical depth τ has also been obtained.
- $\tau \sim (\text{density}) \times (\text{path length})$.
If the coronal geometry does not change, $\tau \propto \text{density} \propto \dot{M}$
- Constant τ at P0-P7 is due to decreasing $R_{\text{in}} \sim \text{path length}$.
- The rapid increase at P7 and P8 suggests an increase of the coronal density.
- -A decrease of the coronal scale height?
- -A decrease of the radial velocity of the corona?
- Coronal radial velocity $V_r \sim 1-6\%$ of the free-fall velocity V_{ff}



Conclusion

- Across the transition, all spectra have been explained by the **MCD** plus **Comptonized blackbody** model, with continuously changing parameters and with **reasonable parameter values**.
- Since the HS is thus **connected smoothly** to the SS, our interpretation of the HS, in terms of the above common model, has been reinforced.
- From the **HS** to the **SS**, the corona shrinks radially. Flattening corona or slower V_r was suggested.
- The coronal radial velocity was slow ($V_r \sim 1-6\% V_{ff}$).
- The results are submitted to PASJ.