

論文 / 著書情報
Article / Book Information

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種別(和文)	論文要旨
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論文要旨

THESIS SUMMARY

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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

The key question in the studies of black hole is to understand its nature. In terms of the observational approach, researchers are aiming to understand the physical mechanisms and to obtain the system parameters of black holes. Investigating the spectral state evolutions of X-ray black hole binaries would help us to understand the radiation mechanism that black hole binaries experience during their outbursts. Another important scientific task is to obtain the system parameters, particularly the black hole mass since the black holes in these systems are remnants of massive stars and their mass distribution plays a key role in testing the theory of stellar evolution. Galactic black hole transients (GBHTs) show distinct X-ray spectral states at different X-ray luminosities in their outbursts. The state transitions are considered to be associated with the change in the structure of the accretion flows, caused by the change in the mass accretion rate. Generally, the soft state is dominated by the thermal emission from the accretion disk exhibited in the soft band while the hard state is dominated by the non-thermal emission exhibited in the hard band. Currently commonly used state classifications are summarized based on the spectral characteristics (such as spectral photon index) and timing properties using RXTE data in the energy range above 2 keV. As the RXTE mission has ended its operation in 2012 while new missions provide the soft band observations, it is important to examine whether those state definitions are still suitable for the data including soft X-ray bands (< 1 keV). Moreover, a narrow distribution of X-ray luminosity at transitions in terms of the Eddington ratio had been found in previous studies of GBHTs based on RXTE data (Maccarone [2003]; Vahdat et al. [2019]) and it has been often used as an empirical relation to constrain black hole masses. Conventionally, a black hole mass can be estimated based on the radial velocity of the companion star in optical band or can be inferred from the inner disk radius of the accretion disk surrounding the black hole. Both methods require knowledge of inclination which is not always available. The Eddington ratio of transition luminosity can provide constraints of black hole mass independently and a more precious estimate of mass can be obtained by combining those methods. This empirical Eddington ratio is also employed in recent studies with instruments covering softer energy bands, such as Swift/XRT and NICER/XTI, covering energies below 1 keV to 10 keV. However, the X-ray states characterized by the spectral parameters may have different definitions depending on the energy ranges adopted in the spectral analysis, which means the transition connecting two different spectral states may occur at different dates using different energy bands. This also leads to the question whether the distribution of transition luminosity obtained with RXTE remains the same when we use the instruments covering softer energy bands.

In this work, I investigated the state transitions of 8 outbursts from 7 GBHTs using the Swift/XRT or NICER/XTI data (0.3–10 keV) by fitting the spectra to a model consisting of multi-color disk and a power-law component. Comparing the results from the Swift and RXTE for the same outbursts from GX 339–4, H1743–322 and XTE J1817–322, I found that the overall trends of spectral parameters are similar for both RXTE and Swift, although the specific values of parameters may be different. In combination with the analysis of the outbursts from MAXI J1305–704, MAXI J1820+070, MAXI J1727–203 and MAXI J0637–430, I found that the distinct changes in parameters such as photon index drop provide universal signs indicating the transitions of different states, while the thresholds values based on RXTE observations in previous studies are not always applicable for state classifications. I further examined the distributions of luminosities of the disk and power-law components for the 8 outbursts before and after the epoch of state transitions by the two definitions: the start of disk recession and the drop of photon index. Using a Monte Carlo simulation to accommodate the uncertainties in the flux estimates, distance, and black hole mass, we found that the bolometric power-law luminosity shows the tightest clustering right after the beginning of disk recession with a mean logarithmic Eddington luminosity fraction (ELF) of 1.82 ± 0.27 and can be used to give empirical constraints on the black hole mass. On the other hand, the bolometric power-law luminosity right after the index transition shows slightly broader distribution of ELF 1.00 ± 0.71 , which is comparable to previous studies using the RXTE data.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

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