# 論文 / 著書情報
# Article / Book Information

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| 題目(和文) | |
| Title(English) | Transition Luminosities of Galactic Black Holes Based on Swift/XRT and NICER/XTI Observations |
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| 出典(和文) | 学位:博士(理学),<br>学位授与機関:東京工業大学,<br>報告番号:甲第11687号,<br>授与年月日:2022年3月26日,<br>学位の種別:課程博士,<br>審査員:河合 誠之,堂谷 忠靖,松原 英雄,須山 輝明,宗宮 健太郎 |
| Citation(English) | Degree:Doctor (Science),<br>Conferring organization: Tokyo Institute of Technology,<br>Report number:甲第11687号,<br>Conferred date:2022/3/26,<br>Degree Type:Course doctor,<br>Examiner:,,,, |
| 学位種別(和文) | 博士論文 |
| Category(English) | Doctoral Thesis |
| 種別(和文) | 要約 |
| Type(English) | Outline |

# Abstract

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 (disk emission) exhibited in the soft band while the hard state is dominated by the non-thermal emission exhibited in the hard band. Currently well-known state classifications are summarized based on the spectral characteristics (such as spectral photon index) and timing properties using RXTE data (> 2 keV). As the RXTE mission has ended its observation in 2012 and more new instruments provide the soft band observations, it is important to examine whether those state definitions are still suitable for the data including soft X-ray emissions (< 1 keV). Moreover, a narrow distribution of transition luminosity in terms of the Eddington ratio has been found in previous studies of GBHTs based on RXTE data (Maccarone [2003]; Vahdat Motlagh 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 precise 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 for 8 outbursts from 7 GBHTs based on Swift/XRT or NICER/XTI data (0.3−10 keV). Compared the results from the Swift and RXTE for the same outbursts from GX 339−4, H1743−322 and XTE J1817−322, and I found that the overall trends of spectral parameters are similar for both RXTE and Swift/XRT observations, although the specific values of parameters can 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 should be universal signs indicating the transitions of different states, while the thresholds concluded from RXTE observations in previous studies are not not always applicable for state classifications. I further investigated the variations of luminosities of the disk and power-law components for the 8 outbursts and examined their distributions near the transition towards the hard state. I found that the disk recession starts after the bolometric disk luminosity drops below 1% Eddington luminosity. After performing a Monte Carlo simulation to accommodate the uncertainties in the flux estimates, distance, and black hole mass, I 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 $1.82 \pm 0.27$ and can be used to give empirical constrains on the black hole mass. On the other hand,the bolometric power-law luminosity shows a slightly broader distribution of $1.00 \pm 0.71$ ELF right after the index transition when the photon index starts to decrease towards the hard state, and it is comparable to previous studies using RXTE data (e.g., Vahdat Motlagh et al. [2019]).