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「普遍性と創発性から紡ぐ次世代物理学－フロンティア開拓のための自立的人材養成－」
双方向国際交流プログラム(BIEP, 派遣）報告書

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共同研究

研究課題名	和文	超臨界降着システムのスペクトルの変動について
	英文	**On spectral variability of supercritical accreting system**
派遣期間		６月２９日　ー　８月３０日

Theoretical study on supercritical accretion processes is far from being complete due to the complex interaction of matter and radiation. On the other hand, observations strongly suggest that supercritical accretion processes do occur in Galactic microquasar and some narrow-line Seyfert 1 galaxies (NLS1s) whose dynamical black hole mass estimation is available. Some ultraluminous extra-galactic X-ray sources, so-called ultraluminous X-ray sources (ULXs, hereafter), are also suggested as plausible candidate of supercritical accreting system. ULXs, however, still controversial due to the lack of information on the black hole mass.

We have conducted a detailed spectral study on a supercritical accreting system in our Galaxy, namely GRS 1915+105. This particular X-ray source is known to have some well-constrained properties, such as black hole mass and inclination angle of the system. This well-constrained properties allow us to carry out a detailed study on its nature by means of X-ray spectral fitting. The goal of our study is twofolds: firstly, to study the supercritical accretion processes in GRS 1915+105 by ways of detailed spectral study, and secondly to study the supercritical accretion processes in general based on our study on GRS 1915+105.

On the other hand, observational study on the spectral variability of ULXs has started to flourish. Previously, people only used a snapshot observation to study ULXs which leads to an unsettled dispute on their nature, that is their black hole mass. Our present data quality do not allow us to discriminate between available theoretical models. On the other hand, the study on the spectral variability will give a new constraint in discriminating those available models.

Some monitoring campaign of some ULXs has been conducted by using Swift satellite for a couple of years now. It is an important step in attempt to understand the nature of ULXs. If indeed ULXs were supercritical accreting systems, our understanding on their nature combine with our understanding of supercritical accreting system in our Galaxy would be a great contribution to the study of supercritical accreting systems. In collaboration with Professor Chris Done and her colleague at Department of Physics, Durham University, we also attempt to study the spectral variability on ULXs.

実際に行った研究活動、成果など簡潔に記述してください。スペース不足の場合は、用紙を追加してください。また、GCOE への今後の要望があれば記してください。

We decided to analyze the Swift monitoring campaign data of a ULX, Holmberg IX X-1 (HoIX hereafter). The monitoring campaign has been started from December 2008. We analyz available data on Swift archive up to July 2009. The data reduction and spectral fitting was ca out at Department of Physics, Durham University. We attempt to write a join paper and this w still in progress by the time this report is written. The overview of the work is described below.

HoIX X-1, also known as M81 X-1, is located in a dwarf galaxy Holmberg IX (3.4 Mpc). It is als of ULXs that has been widely studied in the past ten years. All the studies, however, use a si hardness ratio to follow the spectral variability. Even when spectral fitting is conducted, at disk plus power law model is used. We, however, model the spectra of HoIX X-1 by using a disk low temperature, optically thick Comptonization. Stobbart et al. 2006 has shown that this det model is required to fit the XMM-Newton data of some ULXs, including HoIX X-1.

We first check the hardness ratio of the whole 75 observational data. The hardness ratio its defined as the ratio between the rate from 1.5 – 10 keV and 0.3 – 1.5 keV. In agreement wit recent study of Kaaret and Feng (2009), we only see a slight hardening in the spectrum a luminosity increases. We, next, define a 5 count-rate ranges between 0 – 0.35 counts/s and c each data within each range to have enough signal to noise to give good spectral constraints finally fit the co-added spectrum of each count-rate range with the model mentioned above.

In contrast to the hardness ratio, we clearly see a complex spectral variability. We only foun spectrum which shows a significant variability below 0.7 keV. However, at higher energies th so much more variability whose nature is still puzzling. Nevertheless, our study is importa order to understand how the spectrum change as the luminosity increases or decreases. In a s our study is a one step progress compared to other previous studies in which spectral variabil investigated from several ULXs of various mass accretion rate. This kind of study possesses se weak points despite worth the attempt since the estimation of mass accretion rate on a system i straightforward at the first place. Furthermore, ULXs may be a heterogeneous class in ter black hole mass as well as inclination angle of the system.

ULXs as heterogeneous class are also supported by the previous studies. There are in genera types of spectral variability. Firstly, those in which the spectrum becomes softer as the lumin increases (similar to low/hard to high/soft state transition in Galactic black hole binaries) secondly, those with the opposite tendency. HoIX X-1 is a representative of the latter. It is impo to study the spectral variability of the former as well, to study ULXs thoroughly which is left future study.