論文の内容の要旨

First detection of the very-high-energy gamma rays from the recurrent nova RS Ophiuchi with the Large Size Telescope prototype of the Cherenkov Telescope Array

（CTA 大口径望遠鏡初号機による回帰新星へびつかい座 RS 星からの超高エネルギーガンマ線放射の初検出）

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Novae are luminous eruptions that arise in cataclysmic variables, triggered by a thermonuclear runaway caused on the surface of the white dwarf when the accreted mass from the secondary exceeds the critical limit. Although they were established as a class of gamma-ray emitters through the observations by the Fermi Large Area Telescope after 2010, the origin of the gamma rays and the maximum energy of the accelerated particles remained uncertain. For answering these questions, the detection of gamma rays from a nova in the VHE regime had been intensely desired.

RS Ophiuchi (RS Oph) is one of the best-known and best-studied recurrent symbiotic novae with a recurrence time scale of about 15 years. The latest outburst of RS Oph in August 2021 brought the first detection of VHE gamma rays from a nova in history, as reported by the High Energy Stereoscopic System (H. E. S. S.) and Major Atmospheric Gamma Imaging Cherenkov (MAGIC) telescopes.

Cherenkov Telescope Array (CTA) is the new ground-based gamma-ray observatory currently under construction. It consists of three kinds of telescopes of different sizes, among which the Large-Sized Telescope prototype for CTA, LST-1, was inaugurated in 2018. Although LST-1 is currently in its commissioning phase, it succeeded in observing the 2021 outburst of RS Oph along with H. E. S. S. and MAGIC. In this work, the study of the gamma-ray emission from the 2021 outburst of RS Oph with the LST-1 observations is presented, as

well as my contribution to establishing the calibration procedure of the LST-1 focal plane camera.

The LST-1 camera consists of 1855 photomultiplier tubes (PMTs), and their gain needs to be calibrated. I contributed to the development and validation of the calibration procedure. The calibration is based on the so-called excess-noise-factor method, and some corrections are introduced to consider the effects of details in charge reconstruction. The stability of the calibration results is examined, and it is shown that the gain estimation is stable within 2¥% against different conditions, which is well below the CTA requirement on the calibration precision. The performance of the PMT signal reconstruction is also validated. Through these efforts, the calibration process of the LST-1 camera is established.

The analysis of the LST-1 observations of the 2021 outburst of RS Oph shows the detection of the outburst, which means that the LST-1 successfully takes part in the first VHE gamma-ray detection from a nova, together with H. E. S. S. and MAGIC. The results are consistent with those from H. E. S. S. and MAGIC. To explore the origin of the gamma-ray emission, the daily spectra are fitted with the hadronic and leptonic models. The results favor the hadronic origin of the emission and indicate that the protons are accelerated up to around 1 TeV.

Lastly, the prospect of nova detection by four LSTs is examined. The simulations suggest that most of the Fermi-detected novae are also detectable by the LSTs, which leads to an approximate expectation of the detection rate, one per three years. It is also notable that some recurrent novae are expected to erupt shortly, among which T Coronae Borealis is the most attractive candidate to explore further details of gamma-ray emission from novae.