【Grant-in-Aid for Scientific Research (S)】

Broad Section B

Title of Project : Identifying the origin of the type-Ia supernova by observations just after the explosion

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Keyword : Type Ia supernova, Progenitor, Explosion Mechanism, Standard Candle, Dark Energy

【Purpose and Background of the Research】

The type Ia supernova (SNIa) provides important heavy elements of the universe such as Iron, and also a good standard candle for Cosmology being used to find acceleration of the expansion of the Universe. But the progenitor of SNIa is not identified yet. Recently we found a SNIa whose explosion was triggered by detonation of a thin Helium layer by observations about half day after its ignition, which shows that a key to unveil the progenitor of SNIa is early phase observations just after the explosion.

There are other studies which imply that SNeIa may have different explosion mechanisms and may be originated from different progenitor systems. Statistical studies of SNeIa in very early phase are promising to classify the ignition mechanisms as well as progenitors of SNIa.

In this study, we aim to obtain high quality observational data of SNeIa with newly developed instruments, and to compare observational results with theoretical models to understand diversity of color and luminosity of SNeIa and to unveil the origin of SNeIa. Simultaneously we make template spectra of SNeIa in Near Infrared wavelengths (NIR) in order to make the SNIa as a standard candle in NIR.

【Research Methods】

We complete the CMOS wide-field camera, Tomo-e, at the prime focus of the 1-m Kiso Schmidt telescope, operated by the University of Tokyo,

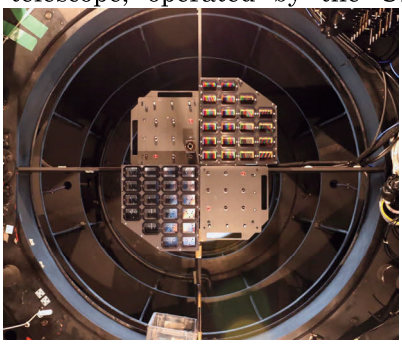

Figure 1. A wide-filed CMOS camera, Tomo-e, being built at the prime focus of Kiso Schmidt. So far, 21 sensors are installed, and more sensors are being installed.

and will use Tomo-e to find nearby SNeIa from their very early phase. Tomo-e will have 84 CMOS sensors and will be the most powerful instrument to find bright supernovae. With repeated 2-hour cadence imaging, Tomo-e can find all SNeIa in the northern sky (Dec. > -20 deg.) brighter than V=19 mag except for very crowded regions. Then we will carry out follow-up observations with a newly developed multi-band camera and an upgraded IFU spectrograph attached to the Seimei 3.8-m telescope, Kyoto University. We will compare multi-band photometry and spectra of more than 30 SNeIa with theoretical models, and will carry out statistical studies. We also make template spectra of about 30 SNeIa in NIR with a few day cadence with NICE, an Echelle spectrograph on the 6.5-m TAO telescope, operated at the world highest site, Atacama, Chile by Univ. of Tokyo.

【Expected Research Achievements and Scientific Significance】

Thus we carry out statistical photometric and spectroscopic studies of more than 30 SNeIa, and understand the progenitor and the explosion mechanism of SNIa. At the same time, a set of NIR spectroscopic template of SNeIa, which enables SNIa to be a standard candle in NIR. Overall, this study will be an important step to understand the origin of SNIa and, in the long run, the origin of the acceleration of the Universe, i.e. Dark Energy.

【Publications Relevant to the Project】

・"A hybrid type Ia supernova with an early flash triggered by helium-shell detonation", Jiang, J., Doi, M., Maeda, K.et al., Nature, 550, pp.80-83. (2017)
・"Photometric properties of intermediate redshift Type Ia supernovae observed by the Sloan Digital Sky Survey-II Supernova Survey", Takanashi, N., Doi, M. et al., MNRAS, 465, p.1274-1288 (2017)

【Term of Project】 FY2018-2022
【Budget Allocation】 147,400 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.ioa.s.u-tokyo.ac.jp/~doi/doi's_project.htm