

京都大学教育研究振興財団助成事業
成 果 報 告 書

令和元年 9月 10日

公益財団法人京都大学教育研究振興財団

会 長 藤 洋 作 様

所 属 部 局 理学研究科

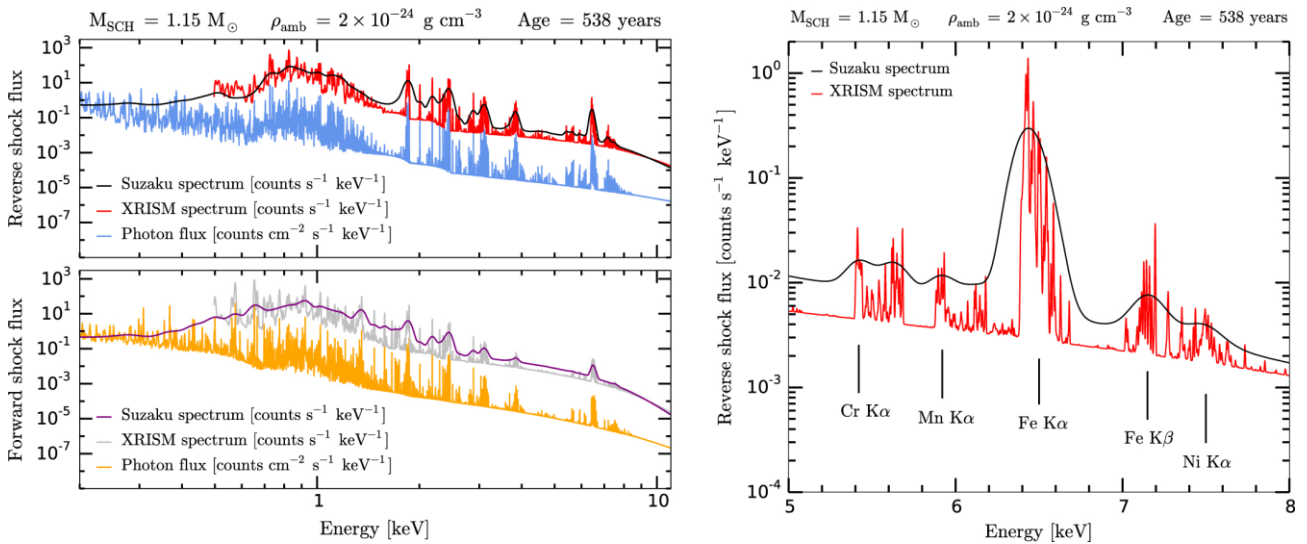
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助 成 の 種 類	平成30年度 ・ 研究活動推進助成			
申請時の科研費 研究 課 題 名	A comprehensive survey of core-collapse supernova remnant models using end-to-end simulations of massive star evolution			
上記以外で助成金を 充 当 した 研 究 内 容				
助成金充当に関 わる共同研究者	(所属・職名・氏名)			
発表学会文献等	(この研究成果を発表した学会・文献等)(selected publications in refereed journals related to this project) H. Martínez-Rodríguez, C. Badenes, S.-H. Lee et al., ApJ, 865, 151, 2018; S. Orlando, M. Miceli, O. Petruk, M. Ono, S. Nagataki, M.A. Aloy, P. Mímica, S.-H. Lee et al., A&A, 622, A73, 2019; H. Yasuda & S.-H. Lee, ApJ, 876, 27, 2019; M. Katsuragawa, S. Nakashima, H. Matsumura, T. Tanaka, H. Uchida, S.-H. Lee et al., PASJ, 70, 110, 2018; (selected presentations related to this project) VHEPU2018, Vietnam; Supernova Remnants II: An Odyssey in Space after Stellar Deaths, Greece, June 2019			
成 果 の 概 要	研究内容・研究成果・今後の見通しなどについて、簡略に、A4版・和文で作成し、添付して下さい。(タイトルは「成果の概要／報告者名」)			
会 計 報 告	交付を受けた助成金額	1,000,000 円		
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今後の使用見込み	275,565			
当財団の助成に つ い て	(今回の助成に対する感想、今後の助成に望むこと等お書き下さい。助成事業の参考にさせていただきます。)			

In the past fiscal year under the support of the Kyoto University Foundation, our international (Japan-US) collaboration has embarked on a new endeavor on understanding the phenomena associated exploding dying stars (supernovae, SNe) and their remnants (supernova remnants, SNRs). We are attempting to connect the observed properties of SNRs in various wavebands to the nature of their progenitor stars as well as their circumstellar environment (CSM), in order to systematically understand the origin of the rich diversity of observed SNRs in the Milky Way and neighbor galaxies.

To do so, we are developing a simulation framework which can seamlessly connect state-of-the-art numerical models of stellar evolution, supernova explosion and nucleosynthesis, and hydrodynamical and plasma evolution in SNRs. We are now in the processing of searching for characteristic observational aspects, such as broadband X-ray spectra, that can help us distinguish SNRs with different progenitor origins and impacts by different surrounding



environments.

Figure 1 - Left: high-resolution synthetic X-ray spectrum of a sub-Chandrasekhar model of Type Ia SNR, comparing the current spectroscopic capabilities of the Suzaku telescope and the near-future XRISM telescope. Right: a zoom-in view of the Fe-K α line emission complex, revealing the detailed structures of the spectrum and its potential of distinguishing progenitor origins.

As an example, we have published a study which investigates the inter-relation among the time-evolving synthetic X-ray spectra, dynamical properties, and the nature of the exploded white-dwarf stars for Type-Ia supernova remnants, and compared our numerical results with existing observational data of Ia SNRs (Martínez-Rodríguez, Badenes, Lee et al., ApJ, 865, 151, 2018). We discovered that the bulk properties of Ia SNRs are mainly dictated by the difference in the surrounding environments of the SNRs rather than the subtle distinctions in the white dwarf explosion (in particular, a sub-Chandrasekhar vs a Chandrasekhar progenitor). However, we also predicted that the soon-coming era of micro-calorimetric spectroscopy realized by next-generation X-ray imaging space telescopes such as XRISM and ATHENA (with superior energy resolutions compared to current instruments such as Suzaku and Chandra) is going to allow for a detailed diagnostic of progenitor origins of Ia SNRs (see Figure 1).

We are now extending the same technique to core-collapse SNRs from exploded massive stars by performing a large-scale survey of hydro models encompassing an extensive array of

different massive star progenitors and CSMs (Jacovich, Patnaude, Lee et al., in prep). The results will be published in a refereed journal in the very near future.

Our results so far have been presented in various occasions, including the international conference on supernova remnant in June, 2019 at Crete, Greece (Supernova Remnants II: An Odyssey in Space after Stellar Deaths), and the American Astronomical Society Meeting.

Finally, we very much appreciate the financial support by the Kyoto University Foundation during the last fiscal year which has been indispensable to the progress of this long-term project. Thanks to this opportunity, our project has been selected for a KAKENHI C starting from the fiscal year of 2019.