Atomic data needs of Lanthanide elements in ejecta of neutron star mergers

Daiji Kato*[1,2], Gediminas Gaigalas[3], Masaomi Tanaka[4]

[1]National Institute for Fusion Science, Toki, Gifu 509-5292, Japan

[2]Dept. of Advanced Energy Engineering Science, Kyushu University, Fukuoka 816-8580, Japan

[3]Institute of Theoretical Physics and Astronomy, Vilnius University, LT-10257 Vilnius, Lithuania

[4]Astronomical Institute, Tohoku University, Sendai, Miyagi 980-8578, Japan

*kato.daiji@nifs.ac.jp

Gravitational waves by a binary neutron star merger have been detected on 2017 August 17 (GW170817 [1]) for the first time. Ejecta from the neutron star merger are expected to contain heavy elements created by the r-process, the rapid neutron-capture process that makes half of all elements heavier than iron [2].

Electromagnetic emission, so called as kilonova, powered by radioactive decays of the synthesized r-process nuclei in the ejecta has also been observed [3]. While properties of the emission are largely affected by opacities in the ejected material, available atomic data for r-process elements are still limited. In this talk, we present new calculations of atomic structure for r-process elements: Se (Z = 34), Ru (Z = 44), Te (Z = 52), Ba (Z = 56), Nd (Z = 60), and Er

(Z = 68) [4]. Due to extremely complicated energy level structure and huge number of transitions, applications of statistical analysis assuming stochasticity of the atomic structures are introduced.

[1] B.P. Abbott et al.: Phys. Rev. Lett. 119 (2017) 161101.

[2] S. Wanajo et al.: ApJ 789 (2014) L39.

[3] Y. Utsumi et al.: Publ. Astron. Soc. Japan (2017) psx118, https://doi.org/10.1093/pasj/psx118.

[4] M. Tanaka, D. Kato, G. Gaigalas et al.: ApJ 852 (2018) 109.