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Understanding nucleosynthesis by Gamma-Ray and AntiMatter Survey (GRAMS)

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The r-process plays a crucial role in understanding the origin of heavy elements. The gravitational wave event GW170817, resulting from a neutron star (NS) merger, is believed to be the source of heavy elements through the r-process (Tanaka et al., 2017). However, direct evidence for the r-process has not been observed yet, which enables us to make a quantitative study of nucleosynthesis, such as the fraction of each element. Although nuclear gamma rays from r-process elements are the ideal tool, the present sensitivity of MeV gamma-ray observations is quite limited for such a purpose.

Gamma-Ray and AntiMatter Survey (GRAMS) is a Japan-US mission for next-generation MeV gamma-ray observation with an enhanced effective area by two orders of magnitude compared to the previous MeV gamma-ray observatory, COMPTEL (Aramaki et al., 2020). Our plan includes a science Pathfinder flight in a few years and a balloon-borne observation in the 2030s, and we finally aim for a satellite mission in the late 2030s. The energy and orientation of the MeV gamma-ray are estimated from the scintillation light and the ionized electron produced by Compton scattering with argon atoms in the detector. The use of liquid argon will enable us to easily increase the effective area of the detector, and the detector will provide all-sky monitoring. Therefore, GRAMS is suitable to obtain direct evidence of the r-process in NS merger.

Now the GRAMS project is in the concept verification stage. A compact detector (about 5 cm $\times$ 5 cm $\times$ 10 cm) is being developed at Osaka University, with functional testing slated to commence this year. Simultaneously, a simplified detector will be launched on a balloon this summer to investigate the safe handling of liquid argon in a balloon-borne setting and assess detector performance. In this presentation, we will introduce the power and status of the GRAMS project.

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