

A next-generation sample return mission to near-Earth object

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The Hayabusa2 brought back samples from the C-type asteroid Ryugu to the Earth. The samples were similar to CI chondrites, which are one of the most primitive meteorites [1-2]. Recent isotope analyses showed that meteorites could be classified into carbonaceous meteorites (CC) and non-carbonaceous meteorites (NC) [3]. Although the NC-CC isotope dichotomy is considered a key for understanding the solar system's formation, their end members are unclear. A possible end member of NC is E-type asteroids, and one of CC is comets. In terms of spectral slope and cometary activity, D-type asteroids and active asteroids are thought to be related to comets. To reveal the end members of the NC-CC dichotomy, these small bodies are target candidates for a future sample return mission.

As a successor of the Hayabusa2 mission, we have considered a next-generation small-body sample return mission. The mission utilizes a spacecraft system composed of a round-trip cruising spacecraft, a surface sampling spacecraft, and several micro-spacecrafts or landers. This architecture would allow us to conduct sampling on more severe surface conditions compared to the Ryugu surface. The target candidates are seven near-Earth objects (E- and D-type asteroids, active asteroids, and comets) orbiting in 1-6 au. We confirmed that they have launch windows in the early 2030s and return windows in the early 2040s.

[1] Yada, T. et al. (2021) Nat Astron. DOI: 10.1038/s41550-021-01550-6. [2] Pilorget, C. et al. (2021) Nat. Astron. DOI: 10.1038/s41550-021-01549-z. [3] Kruijjer, T.S., Kleine, T. & Borg, L.E. (2020) Nat Astron 4, 32-40.

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