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**Hayabusa2#’s exploration to asteroids 2001 CC21 and 1998 KY26 provides key insights into planetary defense**

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**ABSTRACT**

The Hayabusa2 extended mission, nicknamed Hayabusa2# (SHARP: Small Hazardous Asteroid Reconnaissance Probe), started its mission after the Hayabusa2 spacecraft successfully returned in December 2020 to the Earth with Ryugu's samples and released the Sample Return Capsule containing it. Hayabusa2#’s key operations include flying by Near Earth Asteroid (98943) 2001 CC21 and rendezvousing with Near-Earth Asteroid 1998 KY26. The flyby is planned to be in 2026, and the rendezvous will be in 2031. Detailed investigations of these targets enable maturing key knowledge and technologies necessary for planetary defense. This paper reviews the characteristics of these targets and strategies to maximize outcomes from the mission.

The spacecraft will fly by 2001 CC21 at a speed of ~5 km/s in 2026. Given constraints on the spacecraft condition, not designed to perform a flyby operation, operational plans require careful assessments to maximize the proximity observations of this asteroid. The ~700 m diameter asteroid's shape is currently

unknown, though lightcurve observations suggest the asteroid is elongated. While the spin pole is not constrained well, the spin period is about 5.02 h with uncertainties of 0.01 h [1]. The taxonomic class may be L-type, which implies the presence of Calcium-aluminum-rich inclusions (CAI), one of the primitive materials in the solar system [2], although there are studies suggesting an S-type. Therefore, this must be carefully examined. Photometric and spectroscopic observations will strongly constrain this asteroid's properties.

Our rendezvous target, 1998 KY26, is a ~30 m diameter roundish object spinning at a spin period of 10.7 min, which may represent one of the common groups of Near Earth Asteroids in size and composition that give a higher likelihood of threatening the Earth. Radar and optical observations reconstructed this asteroid's shape with high uncertainties and inferred that its surface composition might be similar to that of carbonaceous asteroids [3]. No spacecraft has ever visited such small bodies. Hayabusa2# visiting 1998 KY26 will be the first mission to document its geophysical properties, offering strong insights into what most frequent invaders look like [4].

[1] Pravec et al. (2002), <https://www.asu.cas.cz/~ppravec/newres.txt>.

[2] Binzel et al. (2010), *Meteoritics & Planetary Science* 39, 3, 351-366.

[3] Ostro et al. (1999), *Science* 285, 5427, 557-559.

[4] NAS Planetary Science and Astrobiology Decadal Survey Report 2023-2032 (2022)

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**Comments:**

N/A