Hayabusa2 Extended Mission to rendezvous with Asteroid 1998 KY26: Investigations of an extremely small fast rotator for planetary defense

*Masatoshi Hirabayashi[1], Y. Mimasu[2], N. Sakatani[3], S. Watanabe[4], Y. Tsuda[2], T. Saiki[2], S. Kikuchi[2], T. Kouyama[5], M. Yoshikawa[2], S. Tanaka[2], S. Nakazawa[2], Y. Takei[2], F. Terui[2], H. Takeuchi[2], A. Fujii[2], T. Iwata[2], K. Tsumura[6], S. Matsuura[7], Y. Shimaki[2], S. Urakawa[8], Y. Ishibashi[9], S. Hasegawa[2], M. Ishiguro[10], D. Kuroda[11], S. Okumura[8], S. Sugita[12], T. Okada[2], S. Kameda[3], S. Kamata[13], A. Higuchi[14], H. Senshu[15], H. Noda[16], K. Matsumoto[16], R. Suetsugu[17], T. Hirai[15], K. Kitazato[18]

1. Auburn University, 2. Japan Aerospace Exploration Agency, 3. Rikkyo University, 4. Nagoya University, 5. National Institute of Advanced Industrial Science and Technology, 6. Tokyo City University, 7. Kwansei Gakuin University, 8. Japan Spaceguard Association, 9. Hosei University, 10. Seoul National University, 11. Kyoto University, 12. University of Tokyo, 13. Hokkaido University, 14. University of Occupational and Environmental Health, 15. Chiba Institute of Technology, 16. National Astronomical Observatory of Japan, 17. National Institute of Technology, 18. University of Aizu

Hayabusa2, led by the Japan Aerospace Exploration Agency (JAXA), brought material samples from asteroid Ryugu back to Earth. On December 6, 2020, the Hayabusa2 team successfully collected the re-entry capsule, while the spacecraft departed from Earth, again. As of January 2021, the spacecraft is reported to have no critical issues.

Based on the spacecraft’s healthy condition and remaining fuel, the Hayabusa2 extended mission development team has evaluated the feasibility of an additional mission. Here, we introduce an extended mission in which the spacecraft will explore Asteroid 1998 KY26, a ~30 m - ~40 m in diameter asteroid rotating at a spin period of ~10 m, after a ~10-year cruise phase. Rendezvous operations are planned to detail the physical properties and surrounding environments of this target, one of the smallest elements of small planetary bodies.

In the planned mission schedule, the spacecraft will rendezvous with 1998 KY26 in late 2031. During this cruise phase, the spacecraft may fly by 2001 CC21 in middle 2026. It will approach the asteroid at high speed (~ 5 km/sec) during the flyby, and thus sophisticated guidance, navigation, and control technologies will be necessary. We also plan to conduct long-term monitoring of the zodiacal light and the transits of exoplanets. After two Earth swing-by operations in late 2027 and early 2028, the spacecraft will arrive at the target asteroid. The planned trajectory will need an additional delta-V of 1.09 km/sec, given the 2,900-sec Isp. The distance from the sun is ~1 AU when the spacecraft arrives at this asteroid.

There are key challenges that need to be resolved in Planetary Defense.
Extremely small bodies (especially smaller than 100 m in diameter) are the most common in the solar system and may have a high probability to influence our societies. Ground- and space-based-telescopes still have technical difficulties in observing these asteroids. Therefore, the physical properties of these objects are poorly understood. Successful planetary defense strategies strongly depend on the physical conditions of asteroids. Extremely small asteroids, which may be the largest pieces within rubble pile asteroid elements, will strongly constrain these conditions.
Given the planned observations, the Hayabusa2 extended mission will significantly contribute to advancing science and engineering knowledge about Planetary Defense by exploring an extremely small body.

Finally, we note that the Hayabusa2 extended mission was approved by the science-engineering space exploration mission assessment committee in Japan, which evaluated the scientific and engineering significance of the mission, and is currently waiting for official approval by the government for budgeting. Also, this abstract is also presented at the Planetary Defense Conference in 2021.

Keywords: Asteroids, Planetary defense, Space exploration mission

