Hayabusa2: Proximity science operation around asteroid Ryugu

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The *Hayabusa2* spacecraft will arrive at a C-type near-earth asteroid (162173) Ryugu (1999 JU_3) on June or July 2018 to conduct detailed remote-sensing observations, *in-situ* landing observation by small landers, space impact experiment, and sample acquisition from the surface. Through deciphering memories recorded on the asteroid, *Hayabusa2* will increase our knowledge of the material mixing and transfer processes in the early solar system, mineral-water-organic reactions on a planetesimal, and dynamical processes such as impact and tidal shaking[1]. The spacecraft developed by Japan Aerospace Exploration Agency (JAXA) was launched on 3 Dec. 2014 by the H-IIA Launch Vehicle, performed an Earth swing-by on 3 Dec. 2015 to set it on a course toward its target. We can get the asteroid image by onboard camera ONC-T about three month ahead of the arrival.
Hayabusa2 carries a sampler and four onboard remote-sensing instruments: a multi-band optical imager (ONC-T), a laser altimeter (LIDAR), a near infrared spectrometer covering 3-μm absorption band (NIRS3), and a thermal infrared imager (TIR). It also has three small rovers of MINERVA-II and a small lander MASCOT (Mobile Asteroid Surface Scout) developed by DLR in cooperation with CNES. Further, *Hayabusa2* has impact experiment devices, which consist of a small carry-on impactor (SCI) excavating underground materials and a deployable camera (DCAM3) to observe the ejecta curtain. The interdisciplinary research using the data from these onboard and lander’ s instruments and the analyses of returned samples is the key to the success of the mission.
One of the most important issue of the proximity operation is the landing-site selection (LLS) for sample aquisition (by "touch and go") and landers. Using a high-resolution 'Ryugoid' shape model imitated a ~900 m diameter C-type asteroid body covered with natural craters and bourders, *Hayabusa2* project performed an integrated dry-run training for the LLS process from April to September 2017. *Hayabusa2* Science Team (answerers) first reconstracted shape models from ONC-T images taken from a spacecraft on a calculated orbit after a plan of real Hayabusa2 proximity operation (July-August 2018) produced by questionnaire givers. Then the answerers analysed 7-band ONC-T images, TIR thermal images, NIRS3 point spectral data, and LIDAR ranging time sequence data, and produced scientific proxy maps important for scientific evaluation of landing site candidates. After theses data and maps we evaluated, for each landing site candidates, water content, amount of organic matter, degree of space weathering, sizes of surface particles, and expected surface temperature during sample aquisition. Further, in order to estimate safety of the spacecraft during "touch and go", answerers also made size-frequency distribution of boulders in each landing site candidate, by which we can evaluate number density of dangerous boulders with diameter as small as a few tens of cm. Finally, Science Team selected principal and secondary candidate sites for sample aquisition and lander landing sites. I will present a key stategy of real LSS.

[1] S. Watanabe et al. 2017, Space Science Reviews 208, 3-16. DOI 10.1007/s11214-017-0377-1

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