Novel method for analyzing ejecta curtain growth of impact crater formed on regolith layer: Implication for impact phenomena made by Hayabusa-2 Small carry-on impactor

*Kazuma Matsue, Koji Wada, Masahiko Arakawa, Sayaka Tsujido

1. Graduate School of Science, Kobe University, 2. Planetary exploration research center

Impact cratering is recognized as an universal phenomenon in the formation and evolution process of the Solar System. The scaling laws for impact cratering are necessary in order to study the evolution of planetary surfaces caused by the impacts of small bodies. By using the scaling laws, we can apply experimental results of cm-sized craters formed in the laboratory to km-sized craters formed on the planetary bodies (e.g., Housen et al., 1983). However, it is necessary to study the gravity effect on the crater formation process. Then, Hayabusa-2 equips a Small Carry-on Impactor (SCI) to launch a copper projectile on the asteroid Ryugu (Saiki et al., 2016). We will observe the crater formation process and the ejecta curtain with a Deployable Camera 3 Digital (DCAM3-D) (Ishibashi et al., 2016, Ogawa et al., 2016). One of the scientific purposes of the ejecta curtain observation by DCAM3-D is to determine the scaling law for the ejecta velocity distribution on Ryugu (Arakawa et al., 2016). However, it is difficult to deduce the relationships between the ejection velocity and the ejection distance from the successive images of the ejecta curtain. Thus, we are studying to construct the scaling law of the ejecta velocity distribution (Tsujido et al., 2015, Matsue, JPGU 2017), and more, we advocated a new simple theory predicting the ejecta curtain geometry called "Ejecta Curtain Growth (ECG) analysis method" (Arakawa et al., 2016). We can estimate the ejection velocity of the ejecta particle at each initial position using simple equations of ballistic motion, then we obtain an ejecta velocity distribution. Then, we compared the result of the ejecta particle tracking velocimetry (PTV) method with that of ECG analysis method on the quartz sand target (Matsue, JPGU 2017). Finally, we applied the ECG analysis method to the real scale SCI experiments conducted on the ground (Wada et al., 2014) and succeeded to obtain the ejecta velocity scaling law.

Keywords: Ejecta curtain, Hayabusa-2 SCI, Ejecta velocity distribution