Is the Crater Diameter Ruled by Gravity? Experimental Verification of Gravitational Scaling Law of Craters

Hashimoto, Kohshi (School: Otemae Senior High Scool The Evening Course)

I investigated crater formation on planets and satellites by making a unique instrument to control terrestrial gravity. During crater formation, the crater diameter D and surface gravity geff are known to be theoretically related by the gravitational scaling law D ? geff-0.25. However, the experimental verification of this law is still insufficient due to the technical difficulties associated with changing gravity on the ground. Results of previous experiments conducted at the NASA Ames Research Center (1977) gave D ? geff -0.165 ± 0.005, and results by MG Lab gave D ? geff 0.004 ± 0.003. Both of these results are significantly different from the theoretical prediction. The purpose of this project is to clarify the relationship between the crater diameter and surface gravity. To control the gravity inside a capsule, I created a microgravity generator enabling controlled free fall of the capsule and a gravity control apparatus made from an Atwood pulley system. This system enables the stable control of gravity for approximately 0.5 seconds as the capsule falls. I placed a target pool of glass beads, two high-speed cameras, and an electric gun inside the capsule. As the capsule fell, a bullet automatically fired into the glass beads formed a crater on their surface. Using the data from observations made under various gravitational values, I determined that the crater diameter and the gravity inside the capsule are related as D ? geff -0.246 ± 0.009. This experimental result is in agreement with the gravitational scaling law. The next step is to clarify the process of crater formation under other gravitational values, which is important for clarifying the formation of planets and exoplanets and is indispensable for understanding the history of our planet.

Awards Won: