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Crater rays in impact experiments and numerical simulations

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Crater rays, which often adjoin the craters on the surfaces of the planets and satellites, appear also in laboratory impact experiments. Formation mechanism of such crater rays has been considered so far but not clear. Here, we carry out impact experiments with granular targets and observe the pattern formation in ejecta, taking consecutive images of ejecta by a high-speed camera, and final ray-patterns around craters. Also, we numerically investigate two-dimensional pattern formation process of granular materials using a discrete element method (DEM) simulation. Moreover, we analyze the crater rays on the surface of the Moon, using the satellite data of Kaguya.

Based these results, we find the characteristic features of the ray formation mechanism as,

1. Crater rays are not always straight in the radial direction; they complexly twine each other (intertwine).
2. Granular materials in the ejecta do not collide elastically each other during their flights.

We quantitatively compare the results of the experiments, numerical simulations, and satellite data analysis and investigate some scaling-laws about the relations between the ray patterns and the impact conditions such as the impactor size and velocity, the size of target granular particles, and gravity.

Keywords: crater ray