Ray systems in granular cratering

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In classical experiments of granular cratering, a ball dropped on a smooth bed of grains ends up within a crater surrounded by a uniform blanket of ejecta. We show that such a uniform blanket of ejecta changes to a ray system, or set of radial streaks of ejecta, where the surface of the granular bed includes undulations. By carrying out numerous experiments and computational simulations thereof, we ascertain that the number of rays in a ray system $\propto D/\lambda$, where D is the diameter of the ball and λ the wavelength of the undulations. Further, we show that the ejecta in a ray system originates from valleys located in a narrow annulus of diameter D with center at the site of impact. The impacting ball creates a hemispherical shockwave, whose interaction with the surficial valleys engenders the ray system. Our findings may help shed light on the enigmatic ray systems that ring many impact craters on the Moon and other planetary bodies.

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