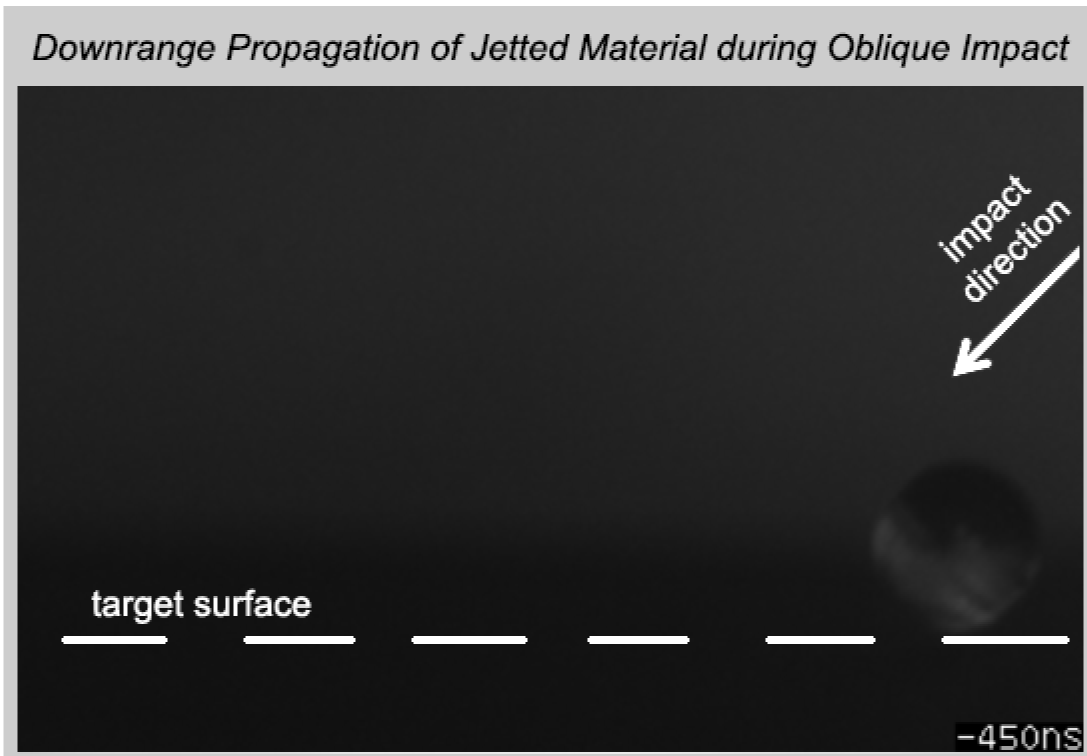
Impact Jetting: Very Quick Looks at Jet Velocities

Ultrafast imaging of high-velocity experimental impact collisions are allowing new measurements of the ejection velocities of jetted material. Kosuke Kurosawa and colleagues at the Planetary Exploration Research Center (PERC) at the Chiba Institute of Technology in Japan, the Japan Aerospace Exploration Agency (JAXA), and the University of Tokyo used a high-speed video camera (100 nanoseconds/frame rate) equipped with ultrafast imaging technology to gather data during oblique impacts of spherical projectiles.



Selected frames from Kurosawa *et al.* (2015) *JGR:Planets*, v. 120, p. 1237-1251, doi: 10.1002/2014JE004730 (jgre20404-sup-0001-MovieS1).

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A selection of high-speed images of an experimental impact shot at the Planetary Exploration Research Center of Chiba Institute of Technology in Japan. Timesteps appear in the lower right corner in nanoseconds. The projectile is a 4.8 millimeter-diameter sphere made of polycarbonate. It hit the aluminum target plate at an impact angle of 45 degrees. The impact speed in this experiment was 6.91 kilometers/second. As the projectile hit the target, it generated the growth of a complex cloud of jetted material. Kurosawa and colleagues measured the jet velocity as 18.9 ± 0.5 kilometers/second. This image sequence ends with the growth of an ejecta curtain.

Impact jetting describes the ejection at high velocities of shock-melted and vaporized materials at the interface between an impactor and a target, initiated at the earliest stage of collision. See the image sequence above for an example of impact jetting during penetration of a polycarbonate sphere into an aluminum target plate. The high-speed images allowed Kurosawa and colleagues to measure the distance of the leading edge of the jet at sequential timesteps as it moved out. They determined the maximum velocity of the jetted material in this experiment as 18.9 ± 0.5 kilometers/second, which is lower than predicted from standard theory based on previous studies of colliding metal plates. The lower value may be due to decaying shock pressure. Kurosawa and coauthors propose a new formulation to calculate jet velocity based on ***thermodynamics***–using the equations of state of realistic materials.

These experimental results complement recent numerical modeling of impact jetting as applied to the formation of chondrules (see **PSRD** article: ***Ancient Jets of Fiery Rain***) and have implications for understanding impact jetting on Titan, the largest moon orbiting Saturn.

See:

Kurosawa, K., Nagaoka, Y., Senshu, H., Wada, K., Hasegawa, S., Sugita, S., and Matsui, T. (2015) Dynamics of Hypervelocity Jetting During Oblique Impacts of Spherical Projectiles Investigated via Ultrafast Imaging, *Journal of Geophysical Research–Planets,* v. 120, p. 1237-1251, doi: 10.1002/2014JE004730. [***abstract***]

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