Temperature evolution and scaling in plasma generated by hypervelocity impact

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Abstract. One effect of meteoroid impact on planetary surfaces, for impacting bodies of sufficient mass and speed, is a brief flash of light in the visible or infrared range. In addition to the basics physics questions relating to the impact process, observation of light flash provides a remote diagnostic for impact events and subsequent surface modification. For example, in the case of the Moon, impact-generated light has been observed associated with both Leonid and Perseid meteoroids.

We present experimental studies of the visible light flash generated by hypervelocity dust grain impacts on solid surfaces. Micron-sized iron spheres are accelerated to speeds between 1 and 50 km/sec at the new electrostatic dust accelerator at the Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS). Time-resolved, multi-wavelength measurements of the impact flash permit investigation of cooling of the impact-generated plasma cloud over time, while a large ensemble of particle events allow scaling investigation of the peak observed temperature with velocity. We find (1) measurable cooling of the impact-generated cloud on 1-10 microsecond timescales, and (2) temperature scaling over the range of 2500K to 6000K, saturating at higher velocities, consistent with earlier work by Friichtenicht[1] and Eichhorn.[2]

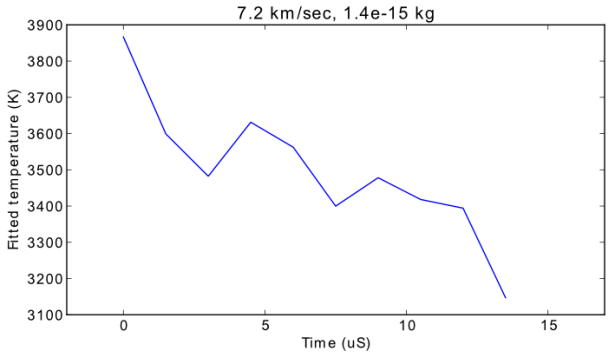

Figure 1: Temperature evolution of cloud generated by 7.2 km/sec impact of iron on tungsten

In addition to the work performed at the CCLDAS electrostatic accelerator, future studies are planned at the NASA Johnson Space Center light gas gun facility, to investigate these effects with particles of substantially higher mass.

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[1] J.F. Friichtenicht. *Investigations of high-speed impact phenomena.* NASA Contr. No. NA Sw-936 (1965)
[2] G. Eichhorn. *Analysis of the hypervelocity impact process from impact flash measurements.* Planet. Space Sci. 24, 771 (1976)