

Rocks, Shocks and Asteroids: The Importance of Being Fractured

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ABSTRACT

Many of the fundamental problems of current interest in national security and planetary science involve impact and fragmentation, typically studied through large-scale computational simulations. Such approaches require fundamental data on the strength of hard but brittle materials and analytical models for massive dynamic failure processes. We attempt to address these issues through fundamental high-strain-rate experiments, high-speed visualization, and theoretical and computational modeling of failure processes.

We use ultra-high-speed photography (exposure times as short as 20 nanoseconds) to observe the dynamic failure processes in brittle solids, and correlate the high-speed photographs with time-resolved measurements of the stresses in the specimen. Next, we use similar experiments to examine the strength and failure of meteorites. Based on these results and analytical models for dynamically interacting cracks, we construct a scaling model for the strength and failure of brittle solids under impact loading. We have begun to explore the implications of this model for armor ceramics, impact cratering (e.g. the simple to complex crater transition on Mars and Mercury), and the disruption of incoming asteroids.



K.T. Ramesh is the Alonzo G. Decker Jr. Chair in Science & Engineering at Johns Hopkins University. His research interests are in nanostructured materials, high strain rate behavior and dynamic failure of materials, the dynamics of human tissues, and planetary scale impact problems. Prof. Ramesh received his doctorate from Brown University in 1987. After a short stint as a postdoctoral fellow at the University of California, San Diego, he joined the Department of Mechanical Engineering at Johns Hopkins in 1988, becoming Department Chair from 1999-2002, Director of the Center for Advanced Metallic and Ceramic Systems in 2001 and Director of the Hopkins Extreme Materials Institute in 2012. He has published one book, *Nanomaterials: Mechanics and Mechanisms* (Springer) and threatens to write another. Finally, he is an avid amateur astronomer.