ASTEROID INTERIORS

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The interiors of asteroids remain the subject of inference, based on surface observations and on measurements of density. This talk will begin with an overview of what has been learned over the past 20 years regarding internal structures, from the perspective of spacecraft and groundbased radar observations, theoretical modeling, and small-scale laboratory experiments. It will finish with an assessment of what might be learned prior to direct exploration of interiors, and prospects for the latter summarizing findings from the first Workshop on Spacecraft Reconnaissance of Asteroid and Comet Interiors (Santa Cruz, CA, October 2006).

One recent theoretical development, is how asteroid surface morphologies – crater statistics in particular – serve as expressions of the seismic properties of asteroid interiors. Asteroid craters may allow us to measure, to first order, how an asteroid responds to collisions and other high energy events through a quick examination of its largest craters. A first order analysis suggests that asteroids have a higher catastrophic disruption threshold than previously established, because their stress wave attenuation is lower than previously thought.

The critical crater diameter D_{crit} is defined as the minimum crater diameter on an asteroid whose formation disrupts, through distal shock and seismic effects, all previous craters D_{crit}.This threshold is computed by applying crater scaling relations and peak particle velocity attenuation relations. If the largest distinct crater observed on an asteroid is typically at or near this threshold size, it follows from this analysis that small asteroids (e.g. 25143 Itokawa) can have no sizable craters, relative to their diameter, while large asteroids (e.g. 253 Mathilde) are likely to have hemisphere-spanning craters.

Because D_{crit} can approach or even exceed the size of the target, the largest asteroids like Mathilde are likely to be saturated with hemisphere-spanning craters up until the size that the asteroid is a geologically active and gravitationally relaxing planet. This is because craters smaller than D_{crit}, however gigantic they might appear, do not broadcast globally.

Stress wave velocities on known asteroids, as parameterized by the model, are found to decay with the 1.3 power of distance for most asteroids (circles below plot the largest identified crater on each asteroid, while curves plot the parameterized stress attenuation). This is much less attenuative than strong shocks. This is consistent with expectation, because disturbances capable or destroying crater rims on asteroids are of very low particle velocity, and thus require stress waves lower in amplitude than typical lunar regolith cohesion. This is in contrast with most models for asteroid catastrophic disruption, which rely upon stronger attenuation or upon hydrocodes tuned to energetic blast events, assume much higher stress attenuation.? These models over-estimate particle velocity attenuation and thus over-estimate the threshold for catastrophic disruption Q^*_D.