Title: Dynamic Fragmentation, Asteroid Impacts and Meteorites from Mars

Abstract:

Meteorites from Mars and the Moon were first recognized in the 1980's. We now know that these rocks were blasted off their parent planets by high-speed impacts of asteroids. When an asteroid slams down onto the rocky surface of a planet at speeds exceeding the speed of sound, shock waves spread out from the impact site. Rock directly underneath the impact site is raised to pressures and temperatures that melt or vaporize it, but rocks adjacent to the surface rebound in tension as they are accelerated up and away from the impact site. Some of this material falls back onto the surface of the planet, creating long lines of secondary craters radiating away from the impact, but other fragments are accelerated to more than escape velocity and may eventually land on Earth or even be ejected into interstellar space. The mechanics of this process is now becoming clearer and the consequences are far-reaching. Rocks ejected from close to the surface escape strong heating and it is possible that living organisms—microbes—could travel between planets in such rocky "spaceships". Ejecta from Mars may be present in the soil of its tiny moon Phobos, waiting to be picked up by future sample return efforts like last year's ill-fated Russian Phobos-Grunt mission. A current challenge is estimation of the size of planetary ejecta fragments as a function of the size and speed of the impacting asteroid. A mystery presently focuses on Mercury's craters, whose secondary craters are ten times larger, for their parent crater size, than those on Mars or the Moon. Is the Mercurian crust so much stronger? Do the higher speed impacts on Mercury paradoxically produce larger fragments than the slower impacts on Mars or the Moon? There is still ample room for fundamental discoveries about how rocks break under high strain rates and at planetary size scales.