Exploring Main Belt Asteroids

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Abstract

Terrestrial planet formation in the main asteroid belt was interrupted when growing protoplanets became sufficiently massive to gravitationally perturb the local population, causing bodies to collide with increased energy, thus ending accretion and commencing fragmentation and disruption. Few of these protoplanets are thought to have survived unshattered (e.g., Ceres, Vesta, Pallas), leaving a main belt population dominated by fragments of fragments, and significantly depleted of mass as a consequence of dynamical scattering. Yet, these fragments retain a record of the early steps of planet formation and evolution, as well as a record of early solar system conditions and the primordial composition gradient in that region. By exploring main belt asteroids through groundbased observations and spacecraft, modeling and theoretical work, we seek ultimately to recover this information. A single mission to a single target is not sufficient to address, in isolation, these questions. They require a foundation of robust, broad, and continuing groundbased, theoretical, and modeling programs. Such work is funded at a small fraction of a typical mission cost through the NASA Research and Analysis Program. Therefore, within the context of planetary decadal study recommendations to NASA, highest priority needs to be given to maintaining and growing a healthy R&A program over the next ten years and beyond. Missions also have an important role to play. An Earth orbiting remote sensing mission needs to be considered as a means of collecting important data for a large fraction of all main belt asteroids above a sub-kilometer diameter (while also realizing synergistic benefits to astrophysics). Missions to specific main belt targets can provide important new insights and leverage new understanding of existing data, models, and theories, but target definition (and corresponding instrument complement) is critical and must be based on our existing knowledge of these very diverse objects. Technological innovations may increase the cost effectiveness of future missions, such as solar electric propulsion (which enables rendezvous with multiple targets) and microsatellite technology (which may allow a large number of flyby targets by using many microsatellites).