FURTHER TESTS OF THE PLANETESIMAL SHOCK MODEL FOR CHONDRULE FORMATION.

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Introduction: Gas dynamic shock waves in a low-temperature nebula are currently considered to be a plausible mechanism for providing the repetitive transient heating events that were apparently responsible for chondrule formation (e.g., [1]). Possible meteoritic constraints on the sources of chondrule-forming shocks include: (1) isotopic evidence that chondrule formation most probably began 1-1.5 Myr after the formation of CAIs and continued for several Myr; (2) coexistence of chondrules in chondrites with products of later parent-body processes (e.g., igneous rock fragments); and (3) inferences that chondrule formation regions were large (more than several hundred km across) but also relatively localized to explain observed differences in properties of chondrules from different chondrite groups.

One class of nebular shocks that can potentially satisfy the above constraints is shocks generated by planetesimals passing through Jovian resonances, assuming that Jupiter formed ~ 1 Myr after CAIs [2,3,4]. Included are both planetesimal bow shocks produced by bodies ejected into eccentric orbits and impact vapor plume shocks produced by high-velocity collisions between planetesimals. Previous estimates for the efficiency of potential chondrule production by this mechanism [4] have relied on orbital simulations for ``resonant'' planetesimals that considered only individual test bodies evolving sunward in the presence of gas drag and Jupiter's perturbations [5]. Results showed that relatively high eccentricities ($e > 0.3$) are typically achieved. In the present work, we employ an improved planetesimal accretion and orbital evolution code that includes the damping effects of collisions and mutual gravitational scattering between embryos.

Discussion: A population of 240 bodies with diameters between 600 and 1400 km is distributed between 2 and 4 AU, interacting with a background of ~ 4 Earth masses of small bodies in that region. Such a population is plausible for the primordial asteroid belt region prior to removal of most large bodies through mutual gravitational perturbations into outer planet resonances [6,7]. A symplectic N-body integrator is applied to calculate the orbital evolution of the large bodies. For our initial simulations, it is assumed that Jupiter remains on a fixed orbit (i.e., its present observed orbit). First results for integration times up to 5000 years yield a few bodies with eccentricities as large as 0.25 near the 2:1 resonance. Simulations for longer integration times are in progress and simulations accounting for possible radial migration of Jupiter due to gravitational interaction with the protoplanetary disk are planned. Consequences of results obtained to date for potential chondrule formation efficiencies via the planetesimal shock mechanism will be presented at the conference.

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