AN IMPACT ORIGIN FOR CHONDRULES.

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Background: The origin of chondrules, the mm-scale previously molten droplets that give chondritic meteorites their name, has been one of the most profound mysteries in Meteoritics. Chondrules are some of the earliest solar system solids and contain information about conditions in the very early solar system [1]. Chondrules, which were abruptly melted in seconds or minutes and remained molten for hours to days [2], formed ~0-5 Myr after Calcium Aluminum rich Inclusions (CAIs) [3,4]. Of the many proposed chondrule formation mechanisms, the idea that chondrules formed from dust aggregates melted by shocks in the solar nebula is the most rigorously tested [5,6]. However, recent chemical analyses of chondrule olivine, together with Na vapor pressure considerations indicate that dust enrichments and total pressures must have been orders of magnitude higher than background nebular conditions [7,8]. Based on their equilibrium calculations, Fedkin and Grossman [7] argue that chondrules must form in "impact-generated plumes". But the plausibility of an impact origin for chondrules has not been demonstrated computationally.

Our Proposal: Here, we demonstrate by numerical simulation that during accretionary collisions between protoplanets, the process of impact jetting creates massive sprays of mm-scale chondrules which experience cooling rates of 10-1000 K/hr based on a radiative cooling code. Using a hydrocode to model impacts and a Monte Carlo accretion code, we estimate the total number, scales and velocities of chondrule-forming impacts. We find that impacts produce 10^{22} kg of chondrules during the first 5 Myr of planetary accretion. Production by impacts on larger accreting planetesimals and accmumulation on smaller bodies created the precursors of the chondritic meteorites that are today found in the asteroid belt.

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