The Flyby Model for Chondrule Formation

WILLIAM HERBST [1] & JAMES P. GREENWOOD [2]

[1] Astronomy Department, Wesleyan University, Middletown, CT 06459 USA wherbst@wesleyan.edu

[2] Earth & Environmental Sciences Department, Wesleyan University, Middletown, CT 06459 USA jgreenwood@wesleyan.edu

Chondrules and the chondritic meteorites preserve one of the oldest records of solar system history available for study in our labs, yet decoding the information they hold has proven difficult. While a 'nebular' environment for chondrule formation was favored in the last century, consistent evidence for an environment with a high density of solids has suggested a 'planetary' environment. Current 'planetary' models for chondrule formation, such as impact splashing and impact jetting, do not account for complementarity, nucleosynthetic complementarity, multiple heating events, or sintering/formation of chondritic meteorites. It is also not clear how well current impact models for chondrule formation deal with apparent close proximity of Type I and II chondrules during heating events.

The flyby model for chondrule formation can satisfy most of the current constraints imposed on chondrule formation from study of chondrites[1,2]. This model proposes that chondrules formed from the heating of pre-existing dust/ice aggregates during close flybys of magmatically-active planetesimals in the early solar system. The dust/ice aggregates are heated by radiative heating from exposed lava on the planetesimal surfaces. In our most recent contribution[2] we explore the heating of dust as a function of grain size, distance from the planetesimal, limited extent of magma ocean coverage, as well as consider the cases of circular, elliptical, and hyperbolic orbits. Capture of dust in circum-planetesimal orbits can also allow for multiple heating of chondrule precursors. Our model is currently predicated on the heating of the planetesimals via decay of ^{26}Al. If a hot Jupiter were present at the proper time and place in the solar system, it could likewise serve as a radiative heat source for flyby chondrule formation, with only small modifications to our model.

The flyby model imposes very strict heating and cooling regimes for chondrule precursor materials, thus providing a method for testing the model through laboratory heating experiments. We will report on the experimental reproduction of chondrule textures using the symmetrical heating and cooling paths of dust on close flybys of molten planetesimals.

[1]Herbst & Greenwood (2016) *Icarus,* **267,** 364.

[2]Herbst & Greenwood (2017) submitted to *Icarus*.

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