The Two Main Hypotheses for Chondrule Formation Have Serious Problems:

**Nebular Hypothesis**
Chondrules are dust blebs suspended in nebular gas that partially melt when the gas is heated by some mechanism.

**Problems:**
- At chondrule formation time (~1-3 Myr) the gas is cold. An *ad hoc* heating mechanism is required.
- Chondrules form at densities of solids much higher than can exist in nebulae dominated by gas (Alexander et al. 2008 Science *320*, 1617.).
- Complementarity suggests that the formation of bulk meteorites accompanies chondrule formation. (Palme et al. 2015 Earth & PlanSciL *411*, 11.)

**Planetary Hypothesis**
Chondrules form in the ejecta from collisions of planetesimals.

**Problems:**
- There is no strong evidence from theory or observation that chondrules can actually form in such a manner.
- Some chondrules show evidence of repeated heating events. How is that possible by this mechanism? (Ciesla 2005 ASP Conf. Series 341.)
- Complementarity suggests that the formation of bulk meteorites accompanies chondrule formation. (Palme et al. 2015 Earth & PlanSciL *411*, 11.)

**A New Hypothesis**
Chondrules are dust blebs within pre-meteorite aggregates (e.g., “rubble piles”) that partially melt during close fly-bys of planetesimals with incandescent lava on their surfaces.

**Advantages:**
- Temperatures and cooling rates required to form chondrules are easily and naturally achieved by this mechanism (see Figure).
- Epoch of chondrule formation is set by the incubation time for $^{26}$Al within planetesimals (~1 Myr) and its turn-off after a few half-lives.
- Complementarity satisfied since the same heating and compression event that forms chondrules can form bulk meteorites.

The calculation is shown for 10 km radius planetesimal but the heating/cooling relation is independent of the size of the planetesimal.