Chronology of CAI's and Chondrules: From Supernova-induced Collapse of the Protosolar Cloud to the epoch of Jupiter Formation in an evolving solar nebula

Douglas N.C. Lin[1,2], Matthias Gritschneder[1,2], Munan Gong[3], Stephen Murray[4], Clement Baruteau[1,5], Qingzhu Yin[6], [1]Astronomy and Astrophysics, University of California, Santa Cruz, [2]Kavli Institute for Astronomy and Astrophysics, Peking University, Beijing, China, [3]Dept of Physics, Tsinghua University, Beijing, China [4]Livermore National Lab, Livermore, CA, [5] Applied Mathematics Cambridge University, UK and [6]Geology, University of California, Davis

CAI's and chondrules are made of highly refractory material which appear to be among the earliest objects condensed in the solar system. Decay products of radioactive isotopes provide evidence that the age spread of the CAI's is no more than 20 ky. They are accompanied by chondrules which appear to have undergone flash heating and partial melting around 2 Myr after the condensation of the CAI's. Based on these data, we revisit the supernova-induced collapse scenario for the formation of the Sun and the solar nebula. We show that a cold clump of $10M_{\odot}$ can withstand the heating of a massive star at a distance of 5pc before it evolves off the main sequence. Its super nova ejecta provides sufficient enrichment of 26Al to conteminate and momentum impluse to trigger a rapid implosion of the cloud. With little angular momentum, the collapsing fragment forms a hot compact disk where presolar grains evaporate, CAI's and chondrules condense. Micron-size refractory grains are advected well beyond the snow line by the spreading gas in a viscously evolving disk. Mm-size CAI's and chondrules diffuse to a few AU. When Jupiter formed after 2 My, it induces the formation of strong shock waves. If early dynamical instability can lead to sufficiently large eccentricity (0.3-0.4), chondrules may experience episodes of flash heating when they pass through shock waves near Jupiter. This scenario not only provides a comprehensive chonology of the refractory grains but also place a strong constraint on the time scale for gas giant planet formation.