The Role of the Astrophysical Environment. J. J. Hester[1], J. Bally[2], J. P. Williams[3,] and Steve Desch[1] [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287; jhester@asu.edu, steven.desch@asu.edu, [2]Center for Astrophysics and Space Astronomy, University of Colorado, 389 UCB, Boulder, CO 80309; bally@casa.colorado.edu, [3]Institute for Astronomy, Univeristy of Hawaii, 2680 Woodlawn Dr., Honolulu, HI 96822; jpw@ifa.hawaii.edu

The astrophysical significance of studies of chondrites lies in what they can tell us about the Sun's birth environment, the early structure and evolution of the Solar System, and the effect of the one on the other. For much of the history of the study of chondrites, the assumption has been made that the Sun and Solar System formed in relative isolation in a dark cloud, such as that seen in Taurus Aurigae. With the discovery of the decay products of live ^{60}Fe in CAIs, however, this assumption became implausible. The only astrophysically sensible source for this short-lived radionuclide (SLR) is nucleosynthesis and subsequent mass loss from one or more nearby massive stars that must have formed close to (or probably somewhat before) the time of the Sun's formation. This result unambiguously places the origin of the Sun in the violent interior of a rich cluster, such as the Orion or Carina nebulae, where it was exposed to very rapidly evolving conditions characterized by high temperatures, strong shocks, intense ultraviolet radiation, stellar winds, supernovae, and other energetic phenomena associated with such environments.

With this change in basic understanding, there are a number of fundamental issues that must be addressed.

(1) Cosmochemical studies of meteorites provide a wealth of information about not only SLRs, but also a host of stable isotopes whose abundances might have been influenced by nearby massive stars. Interpretation of these meteoritic results requires a careful study of the various nucleosynthetic sites where these isotopes might form.

(2) How were newly synthesized nuclei transported from the interiors of massive stars into the young Solar System? Relevant issues here include the formation efficiency of dust in supernovae and Wolf-Rayet winds, the modes by which enriched gas or dust became mixed in with the Sun's protoplanetary disk, the relative time scales associated with enrichment and evolution of the solar nebula, and spatial inhomogeneity of supernovae ejecta and other products of stellar mass loss. It takes little more than reference to the extremely clumpy and chemically inhomogeneous enecta in the Cas A supernova remnant to make the point that arguments about environment based on the assumption of homogeneous isotropic ejecta must be viewed with caution.

(3) Having noted that meteoritic constraints on the details of the Sun's birth environment are poorly understood, there are still arguments that can be made about the richness of the cluster in which the Sun formed, the timing between formation of the Sun and formation of the massive stars, and how common systems like our own are likely to be. This is specifically relevant to the question of whether there were multiple injection events for SLRs, as suggested by recent analyses of ^{26}Al and ^{60}Fe data.

(4) How does low-mass star formation in rich clusters differ from isolated star formation, and what effects did that environment have on the evolution of the Sun's protoplanetary disk and the early Solar System? The rapid evolution of the region around massive stars can both trigger star formation and terminate infall onto stellar disks. Intense ultraviolet radiation truncates disks to a fraction of the size seen in regions such as Taurus, substantially shortens the lifetime of the gaseous component of the disk, but may actually promote planetesimal growth. Frequent encounters between young planetary systems in a cluster environment can have dramatic effects on the dynamics of those systems, and can even mix material from one system into another. Decay of SLRs provided the principle source of power to melt and bake out planetesimals in the early Solar System, suggesting that the properties of planets may depend sensitively on the amount and timing of injection of SLRs.

In this talk we will address a subset of these questions, specifically as they relate to establishing the chronology of the early Solar System.