Wednesday, Apr. 23, 544 Campbell Hall, Noon - 1:00pm

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"Al/Mg Isotope Evidence for the Formation of Refractory Inclusions in the Protoplanetary Disk—
*Time scales and Conditions of the Early Solar System" ***

Astronomical observations of active star-forming regions and young stars together with hydrodynamic models for disk formation guide our understanding of how the Solar System ought to have formed. Meteorite studies, in particular the study of refractory calcium aluminum rich inclusions (CAIs), record the earliest conditions in our Solar System. Despite the fact that CAIs are ancient (e.g., 4567±2 million years old) and contain the highest abundances of short-lived radionuclides of any solar system material they are not pristine nebular condensates. The textures, mineralogies, and compositions of CAIs are complex and likely reflect substantial reprocessing. These processes imply substantial temperature and pressure changes during CAI evolution. Hydrodynamic disk evolution calculations suggest that heating of early solar system materials could have occurred during turbulent transport through a hot central region of the protoplanetary disk at heliocentric radii of < 2.5 AU, or as a consequence of transient heating by shockwaves as the objects spiraled toward the nascent Sun. Changes in partial pressures of rock-forming elements in the solar nebula are thought to reflect variations in evaporated dust abundance. How CAIs record the effect of these temperature and pressure regimes and in particular how their extinct 26Al-26Mg chronologies were effected, remains poorly understood.*

In this talk I will explain how Al-Mg isotope ratio measurements can be used to place constraints on when and how CAIs formed and that there is a direct link between their isotopic compositions and inferred astrophysical setting(s). To study this primitive record, I obtained in situ measurements of 27Al/24Mg, 25Mg/24Mg, and 26Mg/24Mg by laser ablation multi-collector plasma source mass spectrometry comprising core-to-rim traverses across five CV3 CAIs. The CAIs exhibit several distinctive Mg isotopic zoning profiles and varying abundances of daughter products of the short-lived radionuclide 26Al. The characteristic Mg isotope profiles appear to correspond to distinct 26Al-26Mg chronologies. Model calculations based on these measurements support two general types of CAI evolution: 1) early evaporation of molten CAIs within an environment of low partial pressure of Mg (PMg) and low total pressure (~PH) and 2) later reheating at high or low PMg that modifies the original Mg isotopic pattern in the object. Modifications to the Mg isotope ratios during reheating occurred in the solid-state. This two-stage evolution explains a great deal about the complexities of the 26Al-26Mg* system in these objects (e.g., abundance of canonical and scarcity of supracanonical 26Al/27Al0 values). It also explains the growth of Wark-Lovering rims on CAIs. The rapid time scales (102 to 104 years) of reheating based on the rate of Mg isotope diffusion are consistent with those required to achieve resetting of the 26Al-26Mg* system.*