From grains to planetesimals in evolving protostellar disks.

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We model the properties of meteorites and protostellar disks in the context of the new planet-formation paradigm that planets and their building blocks may have migrated extensively. We suggest that CAIs condensed, with little age spread in a hot compact nebula formed by the infall of turbulent gas. Hydrodynamic drag led to the accumulation of meter-size particles near the inner boundary disk boundary beyond the stellar magneto- sphere where the first generation planetesimals and proto- planetary embryos formed. Earth-mass embryos migrated outwards to and stalled at a few AU's. They promoted the accumulation of later generation grains and planetesimals. In the solar nebula, embryos becomed cores of gas giants. Strong perturbation by emerging Jupiter and Saturn led to the wide-spread episodic melting and re-condensation of chondrules. In less massive disks, super-Earth embryos formed, and blocked the migration of grains and planetesimals to produce transitional disks. Super-Earths migrate to their present-day compact orbits during the disk depletion.

Electronic Spin Transitions of Iron and Geoelectrons in Earth's Mantle

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Based on a pyrolitic compositional model, the lower mantle is mainly made of ferropericlase, aluminous silicate perovskite, and calcium perovskite. Silicate perovskite transforms into silicate post-perovskite structure just above the core-mantle region, the D" layer. The existence of iron in the lower-mantle minerals can affect a broad spectrum of the minerals' physical and chemical properties. In this presentation, I will address recent results and current understanding on the pressure-induced electronic spin-pairing transitions of iron and their associated effects on physical properties of host phases in lower-mantle minerals [1]. The spin crossover of Fe^{2+} in ferropericlase occurs over a wide pressure-temperature range extending from the middle part to the lower part of the lower mantle. Furthermore, a high-spin to low-spin transition of Fe^{3+} in the octahedral site of perovskite occurs at pressures of 15-50 GPa [2]. In post-perovskite the octahedral-site Fe^{3+} remains in the low-spin state at the pressure conditions of the lowermost mantle. These changes in the spin and valence states of iron as a function of pressure and temperature have been reported to affect physical, chemical, rheological, transport properties of the lower-mantle minerals. These effects of the spin transition can thus significantly affect our understanding of the deep Earth. I will present and evaluate the consequences of the transitions in terms of their implications to deep-Earth geophysics, geochemistry, and geodynamics [1-3].

The electrons of ferrous and ferric iron ions that occupy some of the lattice sites in mantle minerals become slightly polarized in the presence of the Earth's magnetic field. Using recent deep-Earth geophysics and geochemistry results, we have developed a model of the polarized electron spin density within the Earth. We have examined possible long-range spin-spin interactions between these spin-polarized geoelectrons and the spin-polarized electrons in recent particle physics experiments [4]. Such information might eventually help reconcile seismic observations and mineral physics data with geochemical models.

[1] Lin *et al.*. (2013) *Rev. Geophys.* (in press). [2] Lin (2012) *Am. Miner.* **97**, 592-597. [3] Lin *et al.*. (2013) *Am. Miner.* **97**, 583-591. [4] Hunter *et al.*. (2013) *Science* **339**, 928-932.

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