Geophysical Research Abstracts
Vol. 13, EGU2011-6457, 2011
EGU General Assembly 2011

Formation of giant planets: episodic impacts vs. gradual core growth

Christopher Broeg and Willy Benz
Space and Planetary Sciences, University of Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland (broeg@space.unibe.ch)

We study giant planet formation in the core accretion scenario. In this scenario, a solid core of refractory elements has to be formed to trigger the compactification of the gaseous envelope. To form a gas giant planet, typical core sizes of about 15 Earth masses have to be accumulated before significant envelope build-up can commence. This is problematic because it is difficult to build up such a large core while there is still nebula gas available.

This core accretion process has been studied extensively in the past. In all cases, continuous accretion of solids has been applied: assuming planetesimals are much smaller than the target core, they can be treated as a continuum of particles. In the oligarchic growth regime, however, mass ratios of impactor and target can be quite large, e.g. 1/10. Therefore we decided to study the thermal effect of such massive impacts in the growth phase of the planetary embryo.

To model this scenario, we developed a new numerical code that solves the standard equations of stellar structure in the quasi-hydrostatic case on a self-adaptive 1-dimensional grid using an implicit BDF for the time evolution. The independent variable is the radius. This allows straight-forward treatment of mass accretion and mass loss. A large planetesimal impact is simulated by a Gaussian peak of the core accretion rate of a given width, which sets the timescale of the impact. We then study the thermal response of the envelope.

Our results show that such impacts can trigger gas accretion for otherwise sub-critical cores for a given average core accretion rate. We suggest that giant planets can be formed with smaller cores or higher core accretion rates than what is currently assumed.