The Formation of Terrestrial Planets from the Direct Accretion of Pebbles

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A radical new scenario has recently been suggested for the formation of giant planet cores that reports to solve this long-standing problem. This scenario, known as *pebble accretion*, envisions: 1) Planetesimals form directly from millimeter- to meter-sized objects, the *pebbles*, that are concentrated by turbulent eddies (Cuzzi+ 2008, AJ 687, 1432; Johansen+ 2007, Nature 448, 1022) and then gravitationally collapse to form 100 — 1000 km objects. 2) These planetesimals quickly sweep up the remaining pebbles because their capture cross sections are significantly enhanced by aerodynamic drag (Lambrechts & Johansen 2012, A&A 544, A32; Ormel & Kobayashi 2012, AJ 747, 115). Calculations show that a single 1000 km object embedded in a swarm of pebbles can grow to $\sim 10\, M_\oplus$ in less than 10^4 years.

These short timescales present a problem in the terrestrial planet region because it took many tens of millions of years for the Earth to form (Touboul+ 2007, Nature 450, 1206). However, recent full-scale simulations of core formation have shown that the single planet simulations described above do not accurately represent how planetary embryos accrete as a result of pebble accretion (Kretke & Levison 2013, DPS 45, #415.11). Thus, here we will present preliminary results of a study of pebble accretion in the terrestrial planet zone.