The Jupiter levee: connecting pebble accretion in the outer disc to terrestrial planet formation

M. Lambrechts[1] (michiel@astro.lu.se), S. A. Jacobson[2], A. Morbidelli[2], A. Johansen[1]

(1) Lund University, Lund, Sweden; (2) Observatoire de la Côte d'Azur, Laboratoire Lagrange, Nice, France

Abstract Beyond the iceline icy dust grows by coagulation and the pebbles that are formed drift inwards on short time-scales. When reaching the water ice line, the icy component of the pebbles sublimates and the refractory dust is deposited in the terrestrial planet formation zone. A significant fraction of the pebbles never cross the iceline, but form a planetary core via pebble accretion within $\lesssim 10^6$ yr. When this planet, corresponding to Jupiter in the Solar System, reaches a mass of about $20\,\mathrm{M_E}$, it gravitationally creates a pressure bump outside its orbit. This perturbation of the gas disc acts as a levee, shielding the terrestrial embryos from more solids drifting inwards during the remainder of the gas disc life-time. We investigate the impact of the early flux of chondrule-like material on the terrestrial embryo population, before this flow is terminated by the Jupiter levee. The chondrule flux skews the embryo population, such that the outer embryo is larger than the inner, through a filtering effect where the outer embryos accrete from the chondrule flux feeding the inner embryos. When the Jupiter levee emerges, the embryo size distribution is frozen to one where the outer embryo is approximately Mars-sized and the inner one Mercury-sized. This scenario agrees with the fast formation of Mars, which here coincides with Jupiter reaching the critical core mass, and creates a favourable situation for the secular gravitational evolution leading to the formation of the terrestrial planets.