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Accretion of terrestrial planets from a compact planetesimal disk

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Remnant planetesimals might have played an important role to reduce enhanced orbital eccentricities of the terrestrial planets formed by giant impacts. However, it is not clarified how much small planetesimals exist in the giant impact phase, because simulations of planetary accretion in the runaway growth and giant impact phases have been conducted rather independently. Here we report results of direct N-body simulations through formation of terrestrial planets beginning from a compact planetesimal disk. Fixing the total mass and angular momentum to the values for the current terrestrial planets, we vary the width of the initial planetesimal disk (0.01-0.5AU) and the number of planetesimals (1000-5000). The runway phase is simulated with the parallel tree-code PKDGRAV (Richardson et al. 2000), up to 100,000 yrs with adopting artificially enhanced radii. The giant impact phase is simulated with the hybrid symplectic code Mercury (Chambers 1999) up to 200Myr. We find that in most of the cases a planetesimal disk results in three planets with similar size, although we sometimes obtain two planets for an initially very narrow disk. Since sufficient amount planetesimals remain even after giant impacts between protoplanets, orbital eccentricities of final planets are as small as those of the current Earth and Venus if the initial width is 0.5AU and the initial number of planetesimals is ≥ 3000. There is a weak correlation between the initial width of a planetesimal disk and the final separation of planets.