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Terrestrial planet formation considering various binary star configurations

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To date there have been already 724 binary star systems discovered, which inhabit at least one planet. Most studies that have investigated the late stage of terrestrial planet formation in binary stars considered planar configurations, which might be accurate for tight binary stars. However, for wide binary stars it is assumed, that the inclination between the two stars is randomly distributed. Thus, a possible misalignment between the planet forming disk and the secondary star has to be taken into account. We investigate the evolution of a planetesimal-planetary embryos disks, consisting of 2000 planetesimals and 25 planetary embryos, in different misaligned binary star configurations. In the late stage of terrestrial planet formation (after the gas phase), the gravitational interactions of the disk objects dominate. To study all the gravitational interactions in a reasonable time, we apply our GPU parallelized N-body code GANBISS and compute the dynamical evolution of the disks, where the planetary embryos grow to terrstrial-like planets via perfect inelastic collisions. As collisions among planetary embryos and planetesimals have in reality a more diverse outcome, we perform post-processing analysis of all collisions that occur during the N-body simulations, by making use of an analytic model. Our full N-body approach of embryo-planetesimal disks indicate mainly two results in the dynamical evolution of the disk: (i) In misaligned configurations planetary embryos undergo an inward migration due to dynamical friction and collisions, leaving space in the outer part of the disk for an asteroid-belt like structure. (ii) The planetary embryos align onto the inclination of the secondary with small variations due to dynamical friction and collisions, except in highly inclined configurations (inclination of the secondary $i_b = 45^\circ$) in the outer regions of the disk, where the variations of the inclination of the embryos are larger. Comparing the collision outcomes between planar and inclined configurations, we find a strong increase of the destructive collisions, especially for planetesimal-planetesimal collisions in inclined binary stars.

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