

Space Studies of the Earth-Moon System, Planets, and Small Bodies of the Solar System (B)
Planetary Formation: From Dust to Giant Exoplanets (B0.5)

FORMATION AND GROWTH OF EMBRYOS OF THE EARTH-MOON SYSTEM

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Galimov and Krivtsov [1] made computer simulations of the formation of the embryos of the Earth and the Moon as a result of contraction of a rarefied condensation. The angular momentum needed for such contraction could not be acquired during formation of the condensation from a protoplanetary disk. Using the formulas presented in [2], we obtained that the angular momentum of the present Earth-Moon system could be acquired at a collision of two rarefied condensations with a total mass not smaller than $0.1M_e$, where M_e is the Earth mass. In principle, the angular momentum of the condensation needed for formation of the Earth-Moon system could be acquired by accumulation only of small objects, but for such model, the parental condensations of Venus and Mars could also get the angular momentum that was enough for formation of large satellites. Probably, the condensations that contracted and formed the embryos of the terrestrial planets other than the Earth did not collide with massive condensations, and therefore they did not get a large enough angular momentum needed to form massive satellites. The embryos formed as a result of contraction of the condensation grew by accumulation of solid planetesimals. The mass of the rarefied condensation that was a parent for the embryos of the Earth and the Moon could be relatively small ($0.02M_e$ or even less), if we take into account the growth of the angular momentum of the embryos at the time when they accumulated planetesimals. There could be also the second main collision of the parental rarefied condensation with another condensation, at which the radius of the Earth's embryo condensation was smaller than the semi-major axis of the orbit of the Moon's embryo. The second main collision (or a series of similar collisions) could change the tilt of the Earth to its present value. For large enough eccentricities of planetesimals, the effective radii of proto-Earth and proto-Moon were proportional to r (where r is the radius of a considered embryo), and at the growth of the mass of the Earth's embryo by 10 times, the mass of the Moon's embryo increased by a factor of 1.43 and 1.31 at the ratio k_d of the density of the growing Moon to that of the growing Earth equal to its present value ($k_d=0.6$) and for equal densities ($k_d=1$), respectively. For the case of small relative velocities of planetesimals, effective radii of the embryos are proportional to r^2 , and at the growth of the Earth's embryo mass by 10 times, the Moon's embryo mass increased by a factor of 1.051 and 1.044 at $k_d=0.6$ and $k_d=1$, respectively. [1] Galimov E.M., Krivtsov A.M.: Origin of the Moon. New concept. / De Gruyter. Berlin. 2012. 168 p. [2] Ipatov S.I.: Mon. Not. R. Astron. Soc., 2010, vol. 403, pp. 405-414.