MIGRATION OF DUST FROM THE ORBIT OF PLANET PROXIMA CENTAURI C

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Introduction: Migration of dust particles in the Solar System was studied by several authors. I studied migration of asteroidal, cometary and trans-Neptunian dust particles [1-3]. Similar to those calculations I calculated the migration of dust particles in the Proxima Centauri planetary system. The Bulirsh-Stoer code from [4] was used for integrations. The relative error per integration step was taken to be less than 10^{-8}. The gravitational influence of the star (with a mass equal to 0.122 of the solar mass) and two planets: *b* (a_b=0.04857 AU, e_b=0.11, m_b=1.17m_E, m_E is the mass of the Earth) and *c* (a_c=1.489 AU, e_c=0.04, m_c=7m_E) was taken into account. The particles were excluded from integration when they collided with the star or the planets or reached 500 AU from the star. The Poynting-Robertson drag, radiation pressure, and star wind drag were taken into account. The ratio of star wind drag to Poynting-Robertson drag was considered to be 0.35. The ratio β between the radiation pressure force and the gravitational force varied from 0.0002 to 1. For the silicate particles in the Solar System, such values of β correspond to particle diameters *d* between 2500 and 0.5 microns; *d* is proportional to 1/β. For water ice at ρ=1 g/cm^3, *d* is greater by a factor of 2.4.

Initial orbits of dust particles were located near the orbit of planet *c*. In each calculation variant, initial semi-major axes a_o of orbits of 250 planetesimals were in the range from a_{min} to a_{min}+0.1 AU. In different variants, the values of a_{min} equaled to 1.4 or 1.5 AU. Initial eccentricities e_o of orbits of planetesimals equaled to 0.02. Initial inclinations of orbits of the particles were equal to e_o/2 rad.

Results of calculations: For β between 0.004 and 1, the results of calculations are presented in the Table. The times *T* (in Myr) of evolution of disks, the number N_b of particles that collided with planet *b*, and the number N_c of particles that collided with planet *c* are mainly smaller for greater β. At 0.004≤β≤0.1, more particles collided with inner planet *b* than with a greater planet *c*. At such values of β, dust particles are effective for delivery of matter to planet *b*. In the Solar System, silicate particles with 0.004≤β≤0.1 correspond to diameters from 3 to 120 microns. At β≥0.4 the fraction of particles collided with planets was small or zero, and most of particles were ejected into hyperbolic orbits. At 0.004≤β≤0.1, most of particles collided with the star, with maximum of N_{star} at β=0.04.

During the first million years at 0.0002≤β≤0.002, the fraction of ejected particles was less than 0.1, and the fraction of particles collided with planet *c* was less than 0.04. For such time *T*=1 Myr, the fraction of particles collided with planet *b* was about 0.02 at a_{min}=1.4 AU and 0.001≤β≤0.002. It was zero in other variants of calculations at 0.0002≤β≤0.002. Migration of bodies with such values of a_{min} and e_o was considered in [5]. For comparison, at *T*=1 Myr the values of N_{ej} were equaled to 7 and 12 (at a_{min}=1.4 AU and a_{min}=1.5 AU) and N_b=0. These values did not differ much from the values at 0.0002≤β≤0.002. For bodies at *T*=1 Myr, the values of N_c were equaled to 68 and 82 (at a_{min}=1.4 AU and a_{min}=1.5 AU) and they were greater by a factor of several than for particles at β≥0.0002. The difference was caused by that the additional forces moved particles from the orbit of planet *c*.

Table. The times *T* (in Myr) of evolution of disks, the number N_{ej} of particles that reached 500 AU from the star, the number N_{star} of particles that collided with the star, the number N_b of particles that collided with planet *b*, and the number N_c of particles that collided with planet *c* for several values of β. First numbers of *T* and *N* in lines are for a_{min}=1.4 AU, second numbers are for a_{min}=1.5 AU. The values of N_{ej}, N_{star}, N_b and N_c are presented for a whole considered time interval *T*.

β	0.004	0.01	0.04	0.1	0.4	1
T, Myr	7.6; 8.1	3.8; 4.6	2.9; 1.6	0.9; 1.1	0.4; 0.8	0.0003
N_{ej}	44; 50	20; 27	6; 8	11; 23	236; 233	250
N_{star}	158; 147	196; 193	237; 231	231; 217	13; 15	0
N_b	38; 49	30; 24	4; 8	6; 5	0; 1	0
N_c	10; 4	4; 6	3; 3	2; 5	1; 1	0

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References: [1] Ipatov S.I., Mather J.C., Taylor P.A. (2004) *Annals of the New York Academy of Sciences* 1017:66-80. https://doi.org/10.1196/annals.1311.005. http://arXiv.org/format/astro-ph/0308450. [2] Ipatov S.I., Mather J.C. (2006) *Advances in Space Research* 37: 126-137. https://doi.org/10.1016/j.asr.2005.05.076. http://arXiv.org/format/astro-ph/0411004. [3] Ipatov S.I. (2010) *Proceedings of the International Astronomical Union*, IAU vol. 5, Symposium S263, pp. 41-44. https://doi.org/10.1017/S174392131000147X. http://arxiv.org/abs/0910.3017. [4] Levison H.F., Duncan M.J. (1994) *Icarus* 108:18-36. [5] Ipatov S.I. (2023) *Meteoritics & Planetary Science* 58: https://doi.org/10.1111/maps.13985.