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Accretion Process in Comets

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The calculations show that under the physical conditions existing probably in Oort's cometary cloud the process of accretion is completely insufficient for explaining the existence in comets of the dust layer of the observed capacity. In the most favourable case the comet of the mass of 10^{16} gm is able to "capture" only about 10^2 gm of interstellar dust, while the mass of the dust layer actually observed in comets is ranged between 10^6 to 10^{13} gm including extreme cases.

I. Introduction

This paper deals with the process of accretion as a theoretically possible mechanism for the origin of the surface dust layer in a comet. My considerations are based on the existence of OORT's cloud of comets and his hypothesis of the origin of this cloud (OORT 1950).

The problem can be divided according to two criteria as follows:

(I) According to the character of motion of the comet relative to the material of accretion.

(II) According to the spatial density distribution of the material of accretion.

As known, the rate of accretion may be in dependence on time t given as follows (LYTTLETON 1956)

$$\frac{\mathrm{d}M_{\underset{\circ}{\psi}}}{\mathrm{d}t} = 4\pi G^2\, M^2_{\underset{\circ}{\psi}} \,.\, D \,.\, V^{-3}_{\underset{\circ}{\psi}}\,, \tag{1}$$

where $M_{\underset{\circ}{\psi}}$ is the mass of the cometary nucleus, G the universal constant of gravitation, D the spatial density of the medium, where the accretion takes place, and $V_{\underset{\circ}{\psi}}$ the rectilinear velocity of the comet's nucleus relative to the medium. Formula (1) neglects the mutual gravitational interaction among the particles of medium and assumes that the medium density does not affect the comet's motion. Photometrical data show that for no comet – as far as no rapid desintegration takes place – the mass of the dust layer is comparable with the nucleus' mass, so that $M_{\underset{\circ}{\psi}}$ on the right side of equation (1) may be considered constant. After integration we obtain the total mass of the product of accretion by a comet in the course of time from t_1 till t_2:

$$\Delta M^{+}_{\underset{\circ}{\psi}} = 4\pi G^2 M^2_{\underset{\circ}{\psi}} \int\limits_{t_1}^{t_2} \frac{D(t)}{V^3_{\underset{\circ}{\psi}}(t)}\,\mathrm{d}t\,. \tag{2}$$

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2. Criterion (I)

I assume that particle motions in the medium where the accretion process takes place are – relative to the Sun – completely random and zero on the average, i.e. the corresponding velocity vectors are distributed homogenously within a sphere. Then the average comet's velocity relative to the medium is equal to the comet's orbital velocity. In this case, however, the arising angular momentum should be taken into account (LYTTLETON 1956), due to which particles do not fall on the comet's nucleus, but orbit round it with the higher velocity the greater is the angular velocity $\omega_{\text{☄}} = \frac{V_{\text{☄}\,\mathrm{transv.}}}{r}$. If the linear rotational velocity about the nucleus, given by the expression

$$4\omega_{\text{☄}}\, G^2 M_{\text{☄}}^2\, R_{\text{☄}}^{-1}\, V_{\text{☄}}^{-4}$$

($R_{\text{☄}}$ is the actual semi-diameter of the comet's nucleus) is in excess of the escape velocity, then no accretion occurs at all. The requirement for the latter velocity to be higher than the former leads to the following condition for the heliocentric distance:

$$\frac{r}{2a} < 1 - 2^{-5/6} \cdot \left(\frac{\pi}{3}\right)^{1/12} q^{1/4}\, M_{\text{☄}}^{2/3}\, M_{\odot}^{-3/4}\, \varrho_{\text{☄}}^{1/12}\, n^{-1/12} \left(1 - \frac{q}{2a}\right)^{1/4} \tag{3}$$

where n gives what part of the total volume of the comet's nucleus if filled by the material of density $\varrho_{\text{☄}}$; it is of low importance due to the power with which it stands in equation (3). If I put typical values: $q = 4.7 \,.\, 10^{12}$ cm, $M_{\text{☄}} = 10^{16}$ gm, $M_{\odot} = 2 \,.\, 10^{33}$ gm, $\varrho_{\text{☄}} = 3$ gm cm^{-3}, $n \approx 1$, I get

$$\frac{r}{2a} < 0.9999998.$$

This condition is fulfilled for any hyperbolic orbit. For not to be fulfilled for an elliptical orbit, the semi-major axis of such an orbit should be more than 4 parsecs, which is absurd. The angular momentum of the "captured" material is consequently not high enough to prevent from the accretion process.

Criterion (I) is then based on the character of motion of the comet relative to the Sun on time scale of the length of existence of the solar system. I shall consider three cases as follows:

(A) The comet is a member of OORT's cloud and in the past it has passed at least twice the perihelion in a nearly same (i.e. elliptical) orbit, which will be called hereinafter the "original" orbit.

(B) The comet is a member of OORT's cloud, but since its origin it comes for the first time to the vicinity of the Sun.

(C) The comet is of an interstellar origin, it does not belong to Oort's cloud. It approaches the Sun for the first time in a hyperbolic orbit, having itself extricated from the sphere of action of another star.

The analysis of cases (A) and (C) will be based on the assumption that during a single approach of the comet to the Sun (or to another star) complete exhaustion of the dust layer in the comet's nucleus takes place (generally, during a few returns is more likely). This assumption is supported by photometric, spectral and other observations made hitherto. Hence, I assume that in the course of the observed comet's return to the Sun the comet can "dispose" of the material produced by the process of accretion since the preceding apparition near the Sun or another star.

Whether the star, near which the comet passed in the past, has or has not in its sphere of action a cloud similar to OORT's cloud is an unessential question, since the existence of such a cloud appears through a factor of 2, which is assumed in the following computations.

In case (B) I apply a schematical model closely connected with OORT's consideration: let a comet be a fragment of a decayed planet (between Mars and Jupiter), which due to planetary perturbations has left the inner part of the planetary system, and due to stellar perturbations has started to orbit round the Sun somewhere in the forming OORT cloud. For the sake of simplicity I assume the orbit has been circular. Let the time interval corresponding to this stage of the comet be equal to Δt years. Approximately, it is the lag from the time of decay of the hypothetical planet, as far as it took place at least 10^9 years ago. The upper limit may be identified with the age of the solar system ($\approx 10^{10}$ years). Later, due to another stellar perturbation, a new orbit of the comet has been formed, which from the view-point of my considerations is in any of the three cases the latest stage of the "development" of the comet's motion. It passes current to design this orbit as the comet's original orbit.

3. Criterion (II). Accretion formula

As for criterion (II), I consider two extreme cases. Firstly, I assume that the products of decay of the hypothetical planet between Mars and Jupiter are not only bodies of dimensions of the order of 10^5 cm, but a cloud of fragments of various dimensions of a certain frequency distribution between 10^{-6} and 10^5 cm in diameter. All of them having dimensions $\leqslant 10^5$ cm are the material for the accretion process. OORT (1950) does not exclude a possibility of existence of such a system, even when he does not require it for his hypothesis. Let the space density of interstellar matter be negligible in comparison with the space density of the "decay" material scattered into space due to gravitational effects by planets, and let, finally, the dependence of the space density of the "decay" material in OORT's "generalized" cloud on the heliocentric distance be independent of the dimension of its constituents. In his working model of cometary cloud, OORT found on the basis of certain considerations function $\left(\frac{r_0}{r} - 1\right)^{3/2}$ for the space concentration of comets, where r_0 is the outer boundary of the cloud. According to OORT, this expression must not be extrapolated to $r < 40{,}000$ a.u., since the cometary cloud does not approach the Sun closer than to a distance of about 25,000 a.u. On the assumptions accepted, the space density of the material for the accretion process may be written as follows:

$$\left.\begin{array}{c} D(r) = D_{50\,000} \, . \, 3^{-3/2} \left(\frac{r_0}{r} - 1\right)^{3/2}, \quad r_0 = 200{,}000 \text{ a.u.} \\ (\text{for } 40{,}000 \text{ a.u.} \leq r \leq 200{,}000 \text{ a.u.}) \\ D(r) = 0 \\ (\text{for } r < 40{,}000 \text{ a.u. and } r > 200{,}000 \text{ a.u.}) \end{array}\right\} \qquad (4)$$

The space concentration of comets in a distance of 50,000 a.u. is found by OORT:

$$D_{\underset{\circ}{\psi}} = 5.7 \,.\, 10^{-5} \text{ comets per (a.u.)}^3 = \tag{5}$$
$$= 1.7 \,.\, 10^{-28} \text{ gm} \,.\, \text{cm}^{-3} \,.$$

Since dynamical considerations exclude the case of a more massive original planet than the Earth is, and since, in accordance with OORT, only about 1/30 out of the total mass present in the region of minor planets could form a cloud of comets in remote heliocentric distances, it is likely that the total space density inside OORT's "generalized" cloud is of the order of (5), so that D_{50000} cannot be in order higher than (5).

The accretion formula has, on the assumptions mentioned above, the form of:

$$\left.\begin{array}{l}
\text{Case (A)} \\
\Delta M^{+}_{\underset{\circ}{\psi}} = 1.15 \,.\, 10^{40}\, r_0^{3/2} \left(\dfrac{M_{\underset{\circ}{\psi}}}{M_\odot}\right)^2 D_{50000}\cdot I_1(r_1, r_2),\ \dfrac{1}{a} > 0 \\
\text{Case (B)} \\
\Delta M^{+}_{\underset{\circ}{\psi}} = 1{,}15 \,.\, 10^{40}\, r_0^{3/2} \left(\dfrac{M_{\underset{\circ}{\psi}}}{M_\odot}\right)^2 D_{50000} \Big[I_1(r_1, r_2) + 3.85 \,. \\
\qquad \cdot 10^{-13} (GM_\odot)^{1/2} \left(1 - \dfrac{a}{r_0}\right)^{3/2} \Delta t \Big],\ \dfrac{1}{a} > 0 \\
\text{Case (C)} \\
\Delta M^{+}_{\underset{\circ}{\psi}} = 1.15 \,.\, 10^{40}\, r_0^{3/2} \left(\dfrac{M_{\underset{\circ}{\psi}}}{M_\odot}\right)^2 D_{50000} \,.\, I_1(r_1, r_0),\ \dfrac{1}{a} \leq 0
\end{array}\right\} \tag{6}$$

where

$$I_1(x, y) = \int_{\frac{1}{2}x}^{\frac{1}{2}y} s^{1/2} \left(1 - \frac{2s}{r_0}\right)^{3/2} \left(1 - \frac{q}{2s}\right)^{-1/2} \left(1 - \frac{s}{a}\right)^{-3/2} \left[1 - \frac{s}{a}\left(1 + \frac{q}{2s}\right)\right]^{-1/2} ds, \tag{7}$$

q' is the aphelion distance, $r_1 = 40\,000$ a.u., and $r_2 = \min(q', r_0)$. Distances are in a.u., density in gm cm^{-3}, time in years, and mass results in gm.

Secondly, I consider that the space density of the material in OORT'S "generalized" cloud is negligible when compared with the dust space density, D_∞, in interstellar space, the latter being assumed to be constant.

The accretion formula is then:

$$\left.\begin{array}{l}
\text{Case (A)} \\
\Delta M^{+}_{\underset{\circ}{\psi}} = 2.12 \,.\, 10^{40} \left(\dfrac{M_{\underset{\circ}{\psi}}}{M_\odot}\right)^2 D_\infty \,.\, I_2(q, q'),\ \dfrac{1}{a} > 0 \\
\text{Case (B)} \\
\Delta M^{+}_{\underset{\circ}{\psi}} = 2.12 \,.\, 10^{40} \left(\dfrac{M_{\underset{\circ}{\psi}}}{M_\odot}\right)^2 D_\infty \Big[I_2(q, q') + 1.08 \,. \\
\qquad 10^{-12} \cdot (GM_\odot)^{1/2} a^{3/2} \Delta t \Big],\ \dfrac{1}{a} > 0 \\
\text{Case (C)} \\
\Delta M^{+}_{\underset{\circ}{\psi}} = 2.12 \,.\, 10^{40} \left(\dfrac{M_{\underset{\circ}{\psi}}}{M_\odot}\right)^2 D_\infty \,.\, I_2(q, r'),\ \dfrac{1}{a} \leq 0
\end{array}\right\} \tag{8}$$

where

$$I_2(x, y) = \int_x^y r^2 \left(1 - \frac{r}{2a}\right)^{-3/2} \left(1 - \frac{q}{r}\right)^{-1/2} \left[1 - \frac{r}{2a}\left(1 + \frac{q}{r}\right)\right]^{-1/2} \mathrm{d}r \qquad (9)$$

and r' is the radius of the sphere of action of the Sun.

When deriving (8) I assumed again that particle-velocity vectors were relative to the Sun randomly distributed, on the average being zero, i.e. that the interstellar-matter medium was captured and captivated by the Sun when orbiting round the centre of Galaxy. Our knowledge on the kinematic structure of the close regions of the Galaxy, however, shows that the objects belonging to Population I – and interstellar dust does belong – move in space with a velocity of about 20 km per sec relative to the Sun, so that capturing and captivating, if any, should be far from to be perfect. Values $\Delta M_{\circ}^{\mathrm{v}}$ from (8) thus represent the upper estimate for the accretion rate. In case (C) I assumed, moreover, that the comet's motion relative to the material of accretion had equaled to its orbital motion with velocity $V_{\circ}^{\mathrm{v}}$ since the time of crossing the boundary of the Sun's sphere of action, and that the same process taking place in the Sun's sphere of action had occurred when the comet had moved in the sphere of action of the preceding star. Accepting OORT's estimate for the average density of 0.020 star per (parsec)^3, we get a value of 2.1 parsec for the average radius of the Sun's sphere of action. Hence, the maximum semi-major axis of a cometary orbit completely lying inside the Sun's sphere of action should not be in excess of 200,000 a.u.

4. Mass losses in comets. The balance

To study the balance of the total amount of dust in the surface layer of a comet nucleus, a total mass loss during the exhaustion process of the dust layer must be determined as well.

If the total mass of dust particles present in the coma at a given moment, is equal to $\mathfrak{M}(t)$, the mass of the particles expelled from the whole surface of the dust layer during an infinitesimal interval of time, dt, is equal to

$$\frac{\mathfrak{m}(t)}{\tau(t)}\,\mathrm{d}t$$

and the total mass loss of the dust from the moment of the comet's entry into the Sun's sphere of action (or from the aphelion passage) till the next perihelion passage is:

$$\Delta M_{\circ}^{\bar{\mathrm{v}}} = \int_t^T \frac{\mathfrak{m}(t)}{\tau(t)}\,\mathrm{d}t\,, \qquad (10)$$

where t is the moment corresponding to q' or r', T is the moment of the comet's perihelion passage and τ is the average "life-time" of dust particles in the cometary atmosphere. Mass $\mathfrak{m}$ may be determined from photometrical data (Sekanina 1962) and the "life-time" of a particle is defined as the interval from the moment of its expulsion from the dust layer till the moment of the particle's zero-ordinate:

$$\tau = 2^{1/2} \frac{g(r)}{\Gamma(r)}, \tag{11}$$

where $g(r)$ is the initial particle velocity and $\Gamma(r)$ effective acceleration affecting on the dust particles in the cometary atmosphere region. We can write

$$g(r) = g_0 \, r^{-\alpha/2},$$

α is the exponent derived c. g. by MARKOVICH (1959), and

$$\Gamma(r) = \frac{GM_\odot \,(1 + \mu)}{r^2},$$

$1 + \mu$ is the repulsive acceleration on particles in units of the Sun's gravitation acceleration. If further denote the radius of the average dust particle as ϱ and the ratio between the real and effective radii of minute particles as $\Phi(\varrho)$, and if I take into account that

$$\frac{1 + \mu}{\Phi(\varrho)} \varrho \equiv 1.78 \,.\, 10^{-5} \text{ cm},$$

the loss-mass equation (10) comes finally to the following form, being at the same time the lower estimate for the total mass of the dust layer in the comet:

$$\Delta M^{-}_{\underset{\circ}{\Psi}} = 3.20 \,.\, 10^4 \, s \left[A_0 \, g_0 \left(1 + \frac{1}{k}\right)\right]^{-1} (GM_\odot)^{1/2} \, 10^{-0{,}4 \, H_0} \, I_3 \,(q, r_3) \,. \tag{12}$$

Here s is the mass density of captured particles, A_0 their albedo, k the ratio between dust- and gas-radiation constituent and H_0 the absolute magnitude of the comet. Integral I_3 is of the form of

$$I_3 \,(q, r_3) = \int\limits_q^{r_3} r^{\frac{1}{2}(1 + \alpha) - \eta_d(r)} \left(1 - \frac{q}{r}\right)^{-1/2} \left[1 - \frac{r}{2a}\left(1 + \frac{q}{r}\right)\right]^{-1/2} \mathrm{d}r \,, \tag{13}$$

where $r_3 = \min\,(q', r')$ and η_d is the parameter of the dust coma (SEKANINA 1962). Density is expressed in gm cm^{-3}, velocity in cm . s^{-1}, distances in a.u. and mass results in gm.

If the dust layer in "new" comets originates due to the accretion process, the total mass loss of dust, $\Delta M^{-}_{\underset{\circ}{\Psi}}$, per orbit should be less or at utmost equal to the total mass of the captured dust:

$$\Delta M^{+}_{\underset{\circ}{\Psi}} \geq \Delta M^{-}_{\underset{\circ}{\Psi}} \,.$$

5. Numerical results. Conclusions

To apply the above considerations numerically, the following constant values were used:

$$\begin{aligned} q &= 0.32 \text{ a.u.}, \\ G &= 6.67 \,.\, 10^{-8} \text{ CGS}, \\ M_\odot &= 2 \,.\, 10^{33} \text{ gm}, \\ r_0 &= 2 \,.\, 10^5 \text{ a.u.}, \\ \alpha &= 0.28, \end{aligned}$$

$$M^{\Psi}_{\circ} \approx 10^{16}\ \text{gm},$$
$$\Delta t = 10^{10}\ \text{years},$$
$$g = 10^{5}\ \text{cm} . \text{s}^{-1},$$

and function η_d as derived in my earlier paper (SEKANINA 1962), while a few combinations were selected for the other quantitites, namely for A_0, s, H_0 and k.

The mass-loss rate is in wide range independent of the major axis of the orbit. The results are given in Table 1.

Table 1

Comet mass loss (per orbit) in dependence on the nucleus albedo, mass density, absolute magnitude and ratio of dust to gas

A_0		$\Delta M^{\Psi}_{\circ}$					
		$H_0 = 5^m$			$H_0 = 10^m$		
		$k = 0.01$	$k = 0.1$	$k = 3$	$k = 0.01$	$k = 0.1$	$k = 3$
0.02	$s = 0.1$	$9.5 . 10^{9}$	$8.7 . 10^{10}$	$7.2 . 10^{11}$	$9.5 . 10^{7}$	$8.7 . 10^{8}$	$7.2 . 10^{9}$
	$s = 3$	$2.8 . 10^{11}$	$2.6 . 10^{12}$	$2.1 . 10^{13}$	$2.8 . 10^{9}$	$2.6 . 10^{10}$	$2.2 . 10^{11}$
	$s = 8$	$7.6 . 10^{11}$	$6.9 . 10^{12}$	$5.7 . 10^{13}$	$7.6 . 10^{9}$	$6.9 . 10^{10}$	$5.7 . 10^{11}$
0.1	$s = 0.1$	$1.9 . 10^{9}$	$1.7 . 10^{10}$	$1.4 . 10^{11}$	$1.9 . 10^{7}$	$1.7 . 10^{8}$	$1.4 . 10^{9}$
	$s = 3$	$5.7 . 10^{10}$	$5.2 . 10^{11}$	$4.3 . 10^{12}$	$5.7 . 10^{8}$	$5.2 . 10^{9}$	$4.3 . 10^{10}$
	$s = 8$	$1.5 . 10^{11}$	$1.4 . 10^{12}$	$1.1 . 10^{13}$	$1.5 . 10^{9}$	$1.4 . 10^{10}$	$1.1 . 10^{11}$
0.7	$s = 0.1$	$2.7 . 10^{8}$	$2.5 . 10^{9}$	$2.0 . 10^{10}$	$2.7 . 10^{6}$	$2.5 . 10^{7}$	$2.0 . 10^{8}$
	$s = 3$	$8.1 . 10^{9}$	$7.4 . 10^{10}$	$6.1 . 10^{11}$	$8.1 . 10^{7}$	$7.4 . 10^{8}$	$6.1 . 10^{9}$
	$s = 8$	$2.2 . 10^{10}$	$2.0 . 10^{11}$	$1.6 . 10^{12}$	$2.2 . 10^{8}$	$2.0 . 10^{9}$	$1.6 . 10^{10}$

Table 2

Accretion ability of a comet in the medium with "Oort's" distribution of space density of the material

$\frac{1}{a}$ (a.u.)$^{-1}$	$\Delta \overset{+}{M}{}^{\Psi}_{\circ} / D_{50000}$ (cm^3)		
	(*A*)	(*B*)	(*C*)
$+0.0000250$	$2.42 . 10^{25}$	$2.50 . 10^{25}$	
$+0.0000143$	$3.46 . 10^{25}$	$3.52 . 10^{25}$	
$+0.0000100$	$1.24 . 10^{21}$	$4.10 . 10^{23}$	
0.0000000			$1.21 . 10^{20}$
-0.0001000			$5.30 . 10^{19}$
-0.0010000			$0.83 . 10^{17}$

Table 3
Accretion ability of a comet in the medium with a constant space density of the material

$\frac{1}{a}$ (a.u.)$^{-1}$	$\Delta M^{+}_{\underset{\circ}{\psi}}/D_{\infty}$ (cm^3)		
	(*A*)	(*B*)	(*C*)
+0.0000250	6.84 . 10^{25}	6.90 . 10^{25}	
+0.0000143	6.42 . 10^{26}	6.44 . 10^{26}	
+0.0000100	2.68 . 10^{27}	2.68 . 10^{27}	
0.0000000			1.14 . 10^{22}
−0.0001000			6.36 . 10^{19}
−0.0010000			8.13 . 10^{17}

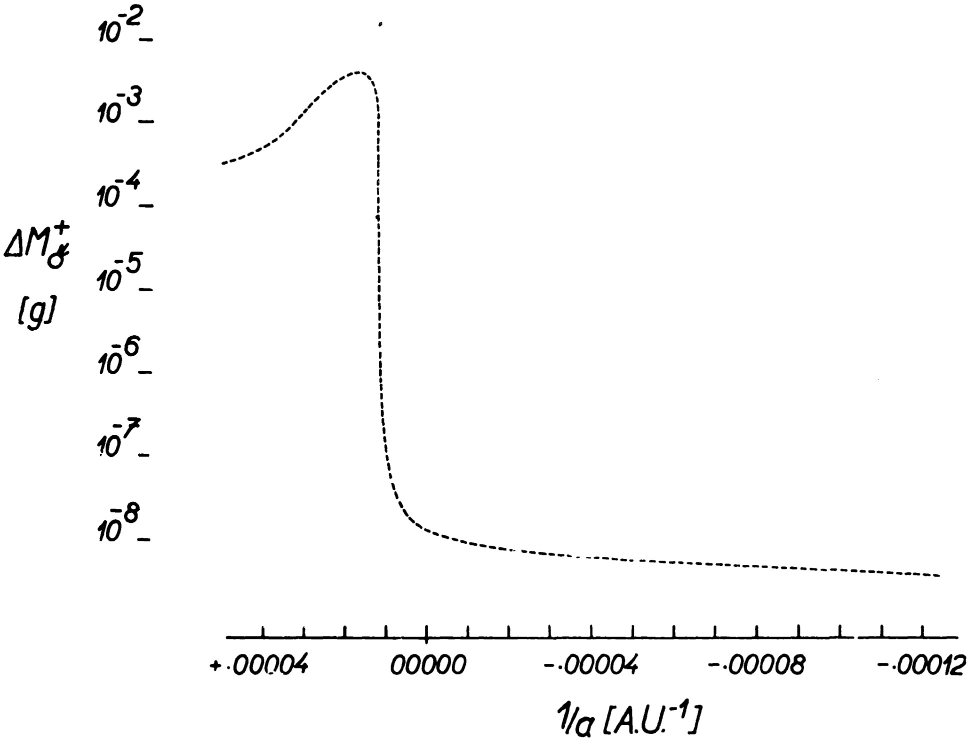

Fig. 1. *Dependence of the comet's accretion ability on the semi-major axis of its orbit* (*for* $D_{50000} = 10^{-28}$ gm|cm^3).

The accretion rate described by the ratio of $\Delta M^{+}_{\underset{\circ}{\psi}}/D_{50\,000}$ or of $\Delta M^{+}_{\underset{\circ}{\psi}}/D_{\infty}$ is given in Tables 2 and 3. The dependence of the total mass of caprured material, $\Delta M^{+}_{\underset{\circ}{\psi}}$, on the semi-major axis of the orbit is for $q = 0.32$ a.u. and $D_{50\,000} = 10^{-28}$ gm . cm^{-3} presented in Fig. 1.

The following conclusions can be arrived at on the basis of the analysis performed:

(I) Since the most probable space density of dust in interstellar space amounts to about 10^{-26} gm . cm^{-3}, the contribution to the mass of the layer due to accretion should always be less than 10^2 gm and, consequently, the process of accretion must be considered as absolutely insufficient for explaining the origin of the dust layer in the comet.

(II) The both models of the space distribution of the stuff of accretion show that comets moving in elliptical orbits should be exposed to stronger process of accretion than those with hyperbolical orbits. In the case of "OORT'S" density distribution the comet moving in the orbit with the semi-major axis of 62,500 a.u. has the maximum "ability" for accretion, while in the case of the constant space density of the interstellar medium this point is shifted towards the more elongated orbits.

(III) The calculations further show that as far as the mentioned limit for the "accretion ability" is not reached the influence on the accretion rate of the stage, when the comet persists at remote heliocentric distances, is almost negligible. However, if the given limit is exceeded, the effect becomes decisive.

(IV) A comparison of results from Tables 2 and 3 shows that – owing to formulae (8) giving the upper estimate for $\Delta M^{+}_{\underset{\circ}{\psi}}$ – there exists an agreement within a order between both series of $\Delta M^{+}_{\underset{\circ}{\psi}}$ given by equations (6) and (8), consequently, the accretion capability of a comet is of a relatively little sensibility to the character of the relative space-density distribution of the material of accretion. Greater differences appear to be only at distances of about $1 \,.\, 10^5$ a.u.

(V) Both the accretion rate and the exhaustion-process rate were computed without knowledge on the dust particle dimensions. Cosequently, the ascertained results are independent of the particle dimensions and no special assumption on the character of the particle frequency distribution in OORT'S cloud had to be made regarding the dimensions of particles.

(VI) The low efficiency of the accretion process results from a rough consideration, that even if the age of the comet were equal to the age of the solar system it must have moved relative to the material of accretion with a velocity of about 10^{-2} cm . s^{-1} to be possible to explain the ascertained mass of the dust layer in the comet of 10^{16} gm.

(VII) In view of what has been found, a process connected with the cometary interior structure and based on release interaction between gas and solid constituents of the nucleus should be considered responsible for the existence of the dust layer, the later being formed on account of the mass of the comet's nucleus.

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Akreční proces v kometách

Souhrn

Za fyzikálních podmínek panujících pravděpodobně v Oortově oblaku komet kolem sluneční soustavy se proces akrece ukazuje jako naprosto nedostatečný k vysvětlení existence prachové vrstvy komet pozorované mohutnosti. Kometa o hmotě 10^{16} g je v nejpříznivějším případě schopna „polapit" jen asi 10^2 g mezihvězdného prachu, zatím co hmota prachové vrstvy u pozorovaných komet nevybočuje ani v krajních případech z mezí 10^6 až 10^{13} gramů.

Процесс аккреции в кометах

Резюме

Вычисления показывают, что в физических условиях вероятно существующих в кометном облаке Оорта процесс аккреции является вполне недостаточным дня объяснения в кометах существующего слоя пыли наблюдаемой мощности. В самом благоприятном случае комета массой в 10^{16} гр. способна «захватить» не более 10^2 гр. межзвездной пыли, тогда как масса пылевого слоя наблюдаемых комет заключена в крайних пределах 10^6 — 10^{13} граммов.