ORIGINS OF COMETS: THE HYPOTHESIS OF RELICT RESERVOIR OF COMETARY BODIES (CB) AS UNITARY STORE OF COMETS OF THE SOLAR SYSTEM

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ABSTRACT. Solar system comets come from a relict reservoir of cometary bodies (CB). The reservoir consists of two components of common origin, but highly different spatial, dynamical and kinematical characteristics:
1. Dynamically stable on cosmogonic time-scale component formed by Kazimirchak-Polonskaya (K.-P.) belts laying between giant planets (GP) and beyond Neptune (including the Kuiper Belt). The component extends up to the unknown boundaries of the zone of primordial planetesimals formation and (thanks to CB collisions pushing the CB away from the zone of stability) provides us with periodic comets (with the exception of almost all the parabolic ones).
2. Swarm of dissipantes moving on Brown-type trajectories; at present the swarm may be of a size of no more than 100 ps, but expand diffusing "into the Galaxy", and provide, thanks to statistically inevitable returns of part of the CB to the Sun, "quasiparabolic" comets, including: a) elliptic quasiparabolic; b) nondistinguishable from parabolic; c) slightly hyperbolic comets. The CB that populate the nearest belt (the one between the orbits of Jupiter and Saturn) must be as bright as 23 - 24th magnitude and consequently, in principle, observable.
Key Words: cosmogony; comets; cometary relict reservoir.

Cosmogonic premises

1. It had been Schmidt's cosmogonic theory that had first considered the formation of cometary bodies (CB) as part of general process of planetogenesis - the CB had originated in the ample cool outer regions of primordial planetesimal disc. Still, in the frame of the same theory the following concept was developed: the zones of instability between the orbits of the giant planets (GP) not only amplified but merged as the planets grew; consequently, practically all the CB were driven away from the GP zone "out into the Galaxy"; only about 1of CB remained, because of stellar perturbations, and formed the Oort cometary cloud (OC) - the present comets supplier.

2. The statement of "general ejection", however, has not been proved as yet. Even its author (B.Yu Levin, 1949, 1976) did allow for the existence of certain number of "non-observable" asteroid-like bodies (e.g. cometary bodies) in the GP zone. Similar assumptions were made by several other authorities in asteroid-cometary problematic (D.Ya.Martynov, A.Delsemm, A.N.Simonenko, K.I.Churyumov, etc.). At the beginning of 1980th L.Kresak has shown from a theoretical standpoint that ring-shaped zones of dynamically stable minor bodies motion exist in front of, between and beyond the GP zones. As early as 1970th E.I. Kazimirchak-Polonskaya has proved that short-period comets drift to their observed orbits precisely from the belts laying between the GP (N.A.Beljaev has named those stores of comets "K.-P. Belts"). K.-P. herself had assumed that comets find their way to the belts through "gradual diffusion" from the Oort Cloud.

3. However, this method of replenishing the K.-P. belts with comets meets grave theoretical difficulties. The same is true in respect to practically all the other hypothesis for the origins of the CB that evolve to short-period orbits from the K-P Belt. (These are as a rule, alternative in respect to each other: comets capture from the OC and giant molecular clouds, ejection by volcanos on GP satellites or by explosions of the satellites frozen hydrospheres, etc.) Sagdeev has thus summarized the situation: "The problem of comets origins remains unsolved. ... To solve it, we must, in the first place, bring comet substance down to the Earth" (Sagdeev, 1989). Here is a clear recognition of the fact that the theory for comets origins has come to a dead end.

4. We arrive to the conclusion that the difficulties of cometary cosmogony developed in the frame of Schmidt's general cosmogony that has so successfully worked out a huge number of CB at the planetesimal disc, originate out of the statement, erroneous in principle, of the "total ejection" of CB out of the GP zone by

gravitational perturbations from GP. What does the cometary cosmogony gain by dropping that arbitrary statement?

Periodic Comets.

1. The K-P Belts obtain their cosmogonic base. All the other explanations of the existence of the Belts (as well as the short-period comets origins) become superfluous.

2. The CB remaining on stable orbits since the Solar System was formed, were affected by Solar radiation, Solar and stellar wind, cosmic radiation, etc., lost volatile elements from their thick (but later thinned) outer layers and formed a very dark silicon-metal crust with certain organic admixture. Parts of the crust are stricken away through statistically inevitable collision between CB. CB "shacking" (up to complete destruction) and shock perturbations of CB orbits also take place. A CB may jump all of a sudden on a "cometary" orbit of short perihelion distance or be thrown on a non-cometary-type orbit traversing one of the zones of strong perturbations near a GP orbit. Further dynamical evolution of such CB orbits is evident.

3. Similar phenomena take place, in particular, at the area extended from beyond Neptune through all the zone of dynamically stable relict CB reservoir up to the borders, unknown to us, of the zone of planetesimals formation.

So then, by dropping the "total ejection" statement, we gain an explanation, free from usual difficulties and paradoxes, of periodic comets origins (with the exception, at present, of the quasiparabolic ones). Yet, our approach is valid for the quasiparabolic comets as well.

Quasiparabolic comets.

1. The statement of general (not total!) ejection of CB from the GP zone (up to 10 exp 30 g, 10 exp 14 - 10 exp 15 CB) at the time of GP formation is one of the fundamental deductions of Schmidt's cosmogonic theory. The mechanism of the ejection permits to assume an extremely small value of the energy excess of an average ejected CB (the velocity at infinity v 0.1 km/s). The full energy h of such a CB may undergo brusque changes through stellar perturbations, up to changing the sign. The CB that would get an h¡0, return to elliptical heliocentric orbits (no matter the heliocentric distance of the CB), and, if perturbed no more, reach into the vicinity of the Sun.

The motion of the CB through perturbing media must have, under the exposed condition, a Brown-like character. The swarm of CB as a whole would expend, diffuse, and decelerate with time in right proportion with the square root from t (t being the time of ejection, e.g. the age of the Solar System).(But: see (Radzievskij, 1954)).

2. In accordance with the Polya theorem (Feller, 1967) separate members of such a swarm are to return to "the source" (e.g. the Sun) with an asymptotic probability of 0.35. Such a CB moving along the cometary orbit would be interpreted as a slightly hyperbolic (h¿0) or near-parabolic (h¡0) elliptic comet. (All the CB of sufficiently small module h wood be described as non-distinguished from parabolic comets).

So, both the types of quasiparabolic comets (including those non-distinguished from parabolic) may be explained on the base of the practically established "theoretical fact" of general ejection of CB from the GP zone at the epoch of Solar System formation.

Summing up: All the assemble of the observed Solar System comets may easily be explained qualitatively if we assume the existence of a relict CB reservoir consisting of two spatial-dynamic components of the same age, but of different character: 1. Dynamically stable component extended from the zone of PG on to the limits of the region of planetesimals formation; 2. Cloud of ejected CB that diffuses "into the Galaxy" (kinematically analogous to the Schiaparelli Swarm).

Observational aspects of the problem

1. The galactic cometary cloud is composed of repeatedly overlapped diffuse cometary clouds of separate stars. The average fraction of "native comets" in a local Opic cometary cloud - in the neighborhood of any given star, the Sun, for example, is very small. Still, we know of no "alien" comet as yet, may be, because the "native comets", having extremely small energy (velocities) in respect to the Sun are strongly focused by its gravitational field.

2. The "observational proves of the existence of the OC are just a misinterpretation: OC is thought to be the home place of all the observed objects belonging really to the "Schiaparelli Swarm"). In fact, there is no further need in the existence of OC.

3. The short-period comets we observe come from Solar System relict cometary reservoirs (in all probability, mostly from the Jupiter-Saturn belt). Consequently, we can ascribe certain characteristic parameters to the CB: a size d of 1 - 3 km (Churyumov, 1996), and an albedo A, probably not exceeding 0.04. It follows, that the CB of the middle of the belt (the expected CB highest abundance zone) should be as bright as 23 - 24th magnitude, that is, in principle, accessible to observations. The relict reservoirs of the Solar System CB may be discovered...

References

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