EPSC Abstracts
Vol. 5, EPSC2010-833, 2010
European Planetary Science Congress 2010

Planetary Cosmogony of the Solar System: the origin of meteoroids and meteorites

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Abstract

The origin of meteors is not still known well. Ordinary meteors are observed as members of meteor streams [1], but nearly half of them is not connected with any stream and seems to be sporadic [2]. There is an opinion that all of the sporadic meteors are remnants of population of exhausted meteor streams [3], and about 400 of so called "weak meteor streams" were recently detected and catalogued [4]. Most of meteor streams seem to be formed by comets since their total or partial destruction. There are several observations that prove this process [5], and for many meteor streams possible parent comets were fixed.

Physically distinct conception of meteor streams as born by comets means that meteors may be real indicator of comets' pre-history. There are three main hypotheses on comet's origin: 1) they are captured from interstellar media, or 2) they were ejected from other members of the Solar system, and 3) they were formed with the rest bodies of the Solar system at the very beginning of its history [6, 7]. The last idea seems to be most preferable, as it does not contradict (as the eruptive hypothesis does) to the observed data that confirm the stability of meteoritic bombardment for the last 4 billion years. And it does not postpone the problem of comet nuclei genesis to the interstellar media, as the capture hypothesis does.

The simplest scenario for comet nuclei formation is primitive condensation of proto-planetary matter into snowballs of various volatility's with addition of refractory dust particles that are named "planetesimals" [8] as building breaks for larger planet formation. When we discuss the problem of comet nuclei, we have to take in account two obvious facts: proto-stellar nebulae consist of various chemical elements in forms of gas or dust particles of sub-micron dimensions, so comet nuclei have to contain no meteoritic materials like metallic or stone mouldings, that are common to meteor streams. It is obvious that it is impossible to imagine physical processes chain that would results in melting of iron and silicates inside comet nuclei without total evaporating of its volatility's. So we come to the conclusion that an intermediate process must be included to the scenario of the comet origin. At the same time this intermediate process has to take place under conditions at the very beginning of the Solar system history.

We know only one process that leads to the melting of refractory matter as well as to its separation by physical density. This process is heating of interiors of large planets by their radioactivity. So we may suppose that there was a large planet in the Solar system that was formed and destroyed some time before the initial conditions in proto-planetary nebula were radically changed. This is well-known conception of Olbers' planet destruction (later named "Phaeton" by S.Orlov), that is shared by many mineralogists and rejected by many celestial mechanics.

The conception of lost planet seemed to be unacceptable when there was no natural mechanism for total destruction of whole planet. Obviously, the internal energy (e.g. of radioactive elements) is very hard to keep undiluted until moment of disaster. This rock may be easily overcame if suppose that necessary energy was brought from outside. Say, direct collision of moon-mass body at velocity about 100 km/s has kinetic energy that is above gravitational energy of an Earth-like planet [9].

A new cosmogony proposed by author [3] bases on idea that formation of planets takes place at pre-solar stage of evolution of protostellar/proto-planetary nebula. Fast building of large planets resulted in accumulation of short-live radioactive isotopes in their interiors. The nuclear decay heated planetary interior. Material of inner parts was melted and stratified. Even now our Earth has very thin hard shell and heated to the melting interiors, - after 4,5 billion years since its creation. If such

"liquid" planet was collided by large planetezimal lost by another star (with kinetic energy about 4·1032 J), it had to be destroyed into number of moldings totally.

It seems that former planet of our Solar system (Olber's planet, or Phaeton) was destroyed about 4,5 billion years ago [3]. Fragments of internal parts of the planet remain on orbits close to the former planet's one, and produce The Main Asteroids Belt. The other moldings had to be ejected toward different directions, including periphery of solar system. The last ones may be individual bodies as well as swallows of tiny fragments, - some drops were dispersed into tiny mouldings by internal pressure like volcanic bombs. They produced lot of compact swarms, that crossed proto-planetary disk and heaped up its snowflakes that preserved beyond giant planets' orbits. So they grew, gathered together and produced planetesimals with number mouldings inside. As most material of these bodies was gathered of particles on circle-like orbits, they obtained slightly elliptical orbits. They became population of the Kuiper Belt as well as of other belts between large external planets. These planetesimals strongly differ from the planetesimals of the first, initial formation. Second generation of planetesimals preserve Phaeton's mouldings inside deeply frozen snow of volatility's [10].

It is obvious that both types of planetesimals can become comets if they come close to the Sun. As a comet, they would behave themselves equally, producing tails and losing their material by time. The main difference between them will be seen in meteor streams that they produce. Decayed as comets, the planetesimals of the first generation can produce short-living icy particles with miserable addition of refractory pebbles. These particles must have bulk density about 1 g/cm3, and their strength must be low too. As life time of ice-form volatiles is extremely short at distance 1 a.e. from Sun, there cannot be any meteor streams produced by comet nuclei of the first generation.

As for planetesimals of the second generation, their remnants will consist of the same icy particles, and besides that lot of hard heavy particles with density above 2.5 g/cm3, and with high strength. These particles are long live because they are massive and resist solar radiation forces as well as because they are refractory and do not evaporate for any time. So it is clear that meteor streams studying allow understanding nature of former comet nuclei and the history of our Solar system.

The work supplied by RFBI grants 02-02-16207, 06-02-16365 and 06-02-08313.

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