EPSC Abstracts
Vol. 9, EPSC2014-56, 2014
European Planetary Science Congress 2014

The final stage of the formation of groups of asteroids

T. Abdulmyanov
Kazan State Power Engineering University, Kazan, Russia (abdulmyanov.tagir@yandex.ru / Fax: +7-843-5624356)

Abstract

This paper is about the final stage of the formation of Trojan asteroids. Comparison of the two distributions of the Trojan asteroids and distribution of the Ceres ring asteroids shows a significant difference in their planar components. The main reason for this difference could be a fast accumulation of gas and dust particles in the final stage of the formation of asteroids.

1. Introduction

In the ring of asteroids, according to the results of observations, are combined tens of thousands of large and small bodies. Is the emergence of the asteroid belt in planetary systems a regular occurrence in the formation and evolution of planetary systems, or the accidental result of catastrophic collisions? Results of studies to date, can not give a definite answer to this question. What the evolutionary processes occur in the asteroid belt at the moment? In particular, whether there is currently a slow accumulation of the Trojan asteroids and the formation of a single planetesimal or Trojan asteroids slowly dissipate, leaving the stable Lagrange point? Classification of asteroids by their chemical composition shows [4] that in the central part of the asteroid belt (about 2.7 AU) located mainly asteroids class M, metallic asteroids. In the outer part of the belt (about 3.2 AU) carbonaceous asteroids are located in the inner part of the belt (about 2.5 AU) - silicate asteroids. According to this classification, the ring has a special distribution of asteroids, which more dense asteroids in the central part of the ring. Such a distribution could be the result of the influence of wave perturbations, which could act on the early evolution of proto-planetary disk [1]. Rapid compression of the proto-star clouds at the initial stage of the evolution of the Solar system and more moderate compression in the later stages could lead to the formation of surface wave disturbances of the proto-planetary disk [1, 2]. The circular wave actions could generate such fragments of the proto-planetary disk, where the density of gas and dust particles will be smaller than in the other regions of the proto-planetary disk. In order to compared the densities of this rings, it is considered the proto-planetary rings of planets whose mass is equal to the modern masses of the planets of the Solar system.

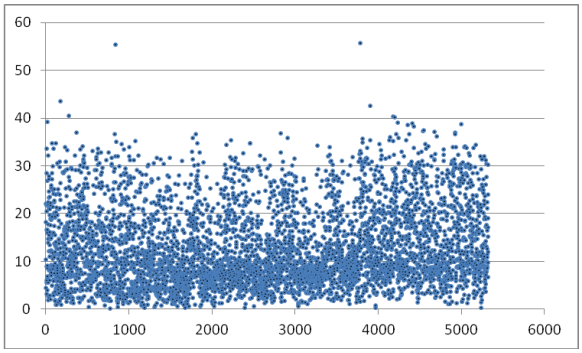
2. The average density of the asteroid ring

Simulation of surface perturbations of the proto-planetary disk shows [1] that the compression process will form shock waves, which will affect the gravitational instability in the proto-planetary disk. The result of such wave actions can be explained by solving the problem of the wave equation [1]. According to the solution of the boundary problem, areas of low density in the proto-planetary disk can occur as a result of multiple actions of waves on one and the same region of the disk. The results of calculation of the density of rings for the planets in the Solar system with modern masses shows [2] that the density of rings for large planets range are from $7.97 \cdot 10^{-13}$ g/cm^3 for Mars and to $3.92 \cdot 10^{-10}$ g/cm^3 for Jupiter. However, the density of rings for Ceres and Pluto are, respectively, $5.46 \cdot 10^{-16}$ g/cm^3 and $4.5 \cdot 10^{-16}$ g/cm^3. Comparison of the results of these calculations show that the density of rings for large planets on orders greater than the density of rings for small planets. Consequently, in the asteroid belt could not be formed a large planet due to critically low density of gas and dust particles in the zone of the asteroid belt. Resonant perturbations and other reasons could also prevent the formation of a large planet in the asteroid belt. However, their influence could be crucial.

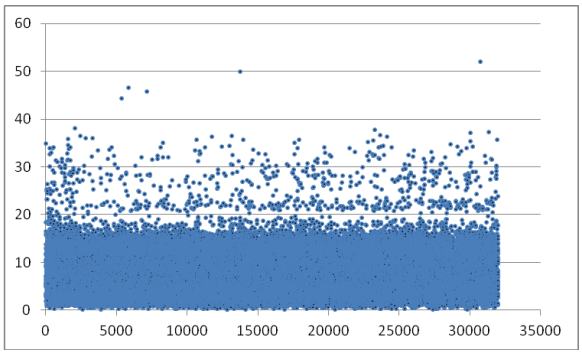
3. The final stage of the formation of groups of asteroids

According to the research [5], accumulation of gas and dust particles occurs under the condition of

gravitational instability $\delta F_g > -\delta F_\rho$. Because the process of initial accumulation of gas and dust particles occurs over hundreds of thousands of years, it can be concluded that, while there was no apparent dominance of the forces δF_g or $-\delta F_\rho$. That is, always maintain the balance of the main forces: $\delta F_g \approx -\delta F_\rho$. In this case, many external mechanisms of influence, including wave perturbations occurring during compression proto-star clouds will affect the gravitational instability [2]. Wave disturbances could be the cause of the redistribution of gas and dust particles in proto-planetary disks. Under certain distributions [3] will arise long-period libration centers long before the advent of planetesimals.



a)



b)

Figure 1: The orbital inclinations of asteroids in the diagrams (i°, n) with the semi-major axes: a) 5 AU ≤ a ≤ 5.3 AU; b) 2.55 AU ≤ a ≤ 2.98 AU; i - inclination of the asteroid's orbit, n - number of the asteroid.

The initial accumulation of gas and dust particles and the formation of the first bodies could occur in these centers. After that, as a result of the rapid accumulation [3] will be disappeared flat component of the proto-planetary rings. This scenario is explains the reason for the predominance of the spatial component of Trojan asteroids. Figure 1 shows the distribution of asteroids with semi-major axes 5 AU ≤ a ≤ 5.3 AU from the directory of Orbit Update MPEC. According to Fig. 1a flat component of these asteroids (h = 5.202·sin2.6º = 0.236 AU) almost tipped Jupiter. At the same time, distribution (Fig. 1b) of asteroids with semi-major axes 2.55 AU ≤ a ≤ 2.98 AU (Ceres ring) flat component densely populated asteroids. The spatial distributions of the asteroids in Fig. 1a - 1b are reach inclinations of 20º to 30º. The linear dimensions of the rings height will be respectively h_1 = 5.202·sin20º = 1.78 AU and h_2 = 2.766·sin20º = 0.946 AU. According to the wave model of proto-planetary rings formation [1], the spatial components of asteroids belt was formed simultaneously with the formation of planetesimals.

4. Summary and Conclusions

Comparison of the distribution of the Trojan asteroids and distribution group ring of asteroids Ceres shows a significant difference in their plane components: a flat ring component Ceres denser compared to the flat component Trojans and Greeks, Jupiter. The main reason for this difference could be a fast accumulation of gas and dust particles in the zone of Jupiter, the dominant body in the final stage of the formation of asteroids.

References

[1] Abdulmyanov T. R. Origin of proto-planetary rings in the Solar system. EPSC. Abstracts. Vol. 8, EPSC2013-720, University College London 08 – 13 Sept. 2013, London, UK.

[2] Abdulmyanov T. R. Evolution of proto-planetary rings in the Solar system. EPSC. Abstracts. Vol. 8, EPSC2013-722, University College London 08 – 13 Sept. 2013, London, U K.

[3] Abdulmyanov T. R. Formation and growth of the Solar system bodies in the early stages of its evolution. 45-th LPSC. March 17 – 21, 2014, Woodland, Texas, USA.

[4] Margot J.L., Brown M.E. A Low-Density M-type Asteroid in the Main Belt. Science. V. 300 (5627), P. 1939 – 1942.

[5] Safronov, V. S.: Evolution of the proto-planetary cloud and formation of the Earth and other planets, English translation NASA TT F-677, 1972.