HYPOTHETICAL EVOLUTIONS OF SHORT-PERIOD COMETS

V. BATLLO
Bureau des longitudes, 0707 CNRS
77 avenue Denfert Rochereau, F.75014 Paris

1. Description of the scenario

The hypothetical model of capture I consider is as follows: a comet with an initial conic orbit, meets close to one of its vertices an outer planet and generates one or several little comets (crossing of the Roche limit) with an elliptic orbit.This initial vertex always remains one of the vertices of the captured orbit by the Solar System. Even if there is a discontinuity of all the orbital elements during a very short time of the capture, I assume that the orbital plane is unchanged during the capture, as indeed was the case for Brooks 2 in 1886 (see Belyaev et al., 1986) or will be for Gehrels 3 in 2300 (see Carusi et al., 1985). After this first decisive step, the "new" comets may be subject to some other captures by jovian planets during their evolution with the same scenario. All these hypotheses allow to find particular numerical results for 142 comets whose current orbital elements were found in the Marsden catalog or given by P. Rocher, but I shall only give several examples in the following section.

2. Numerical results

There are three kinds of comets whose aphelion distance is near a planet since the first encounter, which were, before the capture, nearly-parabolic (Wirtanen: e=1.001, q=5.14), hyperbolic (Shoemaker Levy 4: e=1.137, q=4.96) or had an initial aphelion distance beyond the Pluto orbit (Finlay: e=0.893, q=5.53, Q=97.96). Also, there are in this category, two other kinds of comets which were respectively subject to the joint action of the two planets Jupiter-Saturn (Hartley 1, Mueller 3) and Saturn-Uranus (Faye, Shoemaker 4) before the first capture. After the first encounter and the capture

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by the Solar System, some comets have still changed of group once (Temple 2: Neptune, Jupiter) or even twice (Gunn: Neptune, Uranus, Jupiter).

There are a group of comets which remained in the neighbourhood of a planet during a more or less long time, with a nearly-circular orbit before recovering an elliptic orbit: for Jupiter: Ashbrook Jackson, Russell 1 and Tritton; for Saturn: Kowal Vavrova. There exist some comets which "always" belong to the same planet group: for Jupiter: Borrelly and Wolf; for Saturn: Iras and Tuttle. Finally, let us consider the case of comets which directly came from the neighbourhood of Neptune and Pluto. Hence, they have not the same origin as the other comets since they had neither an hyperbolic or quasi-parabolic initial orbit, nor an initial orbit beyond the Pluto orbit. An explanation can be found in the paper written by S.K. Vsekhsvyatskij and A.S. Guliev (1981). The three comets are Daniel (Pluto, Uranus, Saturn, Jupiter), Grigg Skjellerup (Neptune, Uranus, Jupiter) and Peters (Neptune, Saturn).

After each change of the orbital elements during an encounter with the same planet, three comets become rectilinear. These comets are for Jupiter, Machholtz; for Neptune, Pons Brooks; for Pluto, de Vico.

3. Conclusion

All these numerical results show that there are several possible origins for the short-period comets. They can have an hyperbolic or nearly-parabolic initial orbit (22%). Some others have an initial orbit beyond the Pluto one (29%), that could prove the hypothetical existence of the Kuiper Belt. The study of the previous part also show that some comets were originated in the neighbourhood of a planet or "always" belong to a particular jovian planet group. The joint action of two great planets (Jupiter-Saturn and Saturn-Uranus) generates two groups of comets whose aphelion distance was located between the two respective planets orbits before the first capture (36%). The last case regards the rectilinear comets which also belong to the same planet group. What is the origin of these last three kinds of comets? This question must be studied and developed.

References

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