Looking for a primordial fingerprint in known Long Period Comets

Arika Higuchi (1), Marc Fouchard (2), Takashi Ito (3) and Lucie Maquet (2)

(1) RISE Project Office/NAOJ, Mitaka, Tokyo, Japan (higuchi.arika@nao.ac.jp)
(2) LAL-IMCCE, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC Univ. Paris 06, Univ. Lille., 1 Impasse de l’Observatoire, F-59000, Lille, France (marc.fouchard@obspm.fr,lucie.maquet@obspm.fr)
(3) CfCA/NAOJ, Mitaka, Japan (tito@cfca.nao.ac.jp)

Abstract

Looking in details to some statistical properties of the known long period comets, we emphasize that a fingerprint of the existence of a massive scattered disk extended until few thousands of astronomical units from the Sun is detected. This disk consists in the most inner part of the actual Oort cloud, and should be almost primordial, i.e., it should have been formed by planetary scattering during the youth of the solar system.

1. Introduction

In a previous study [1], large simulations of the evolution of the Oort cloud revealed that a memory of the initial shape of the Oort cloud was present in the statistical properties of the observable comets. In the present work, known observed comets have been used in order to see if we can detect any fingerprint of such memory in their statistical properties. In Section 2 we briefly explain our method applied to observational data. Section 3 is devoted to our preliminary results and we give our conclusion in Sec. 4.

2. Methods

The Warsawa catalogue of long period comets [3] is used for our study. For each comet in the catalogue such that its original semi-major axis $a > 10^4$ au and its perihelion distance is smaller than 5 au, we do the following.

- Built a sample of 200 clones using the error bar on the original orbital energy;
- Each clone is propagated backward until its previous perihelion passage considering the full Galactic tides but not the passing stars. From now on we will consider only the orbital parameters at the previous perihelion passage.
- Built 200 distributions of $\cos i_E$ and $\Omega_G$ where $i_E$ is the ecliptical inclination and $\Omega_G$ is the galactical longitude of the ascending node, where each distribution is obtained picking at random a clone for each comet.
- Use the mean and standard deviation of this 200 distributions to retrieve some statistical properties of the flux of long period comets.

3. Results

![Figure 1](image-url)

Figure 1: Location of the comets in the Warsaw catalogue with original semi-major axis greater than $10^4$ au in the $(\Omega_G, \cos i_E)$ plane. See text for details.

Figure 1 shows the location of the comets in our sample in the $(\Omega_G, \cos i_E)$ plane. The color point is indicative of the range of the perihelion distance. Four different ranges are considered: $q < 10$ au (R1) in blue, $10 < q < 19$ au (R2) in magenta, $19 < q < 31$ au (R3) in green and $q > 31$ au (R4).
in red. Consequently R1 should contain mainly creepers (Kaib and Quinn or not), R2 and R3 mainly KQ jumpers or jumpers, and R4 mainly jumpers (see [1] for a detailed explanation of the different classes of observable comets).

On Fig. 1 one notes that the comets are more concentrated along the line $i_G \approx 90^\circ$ (thin black line on the Fig. 1 since the galactic tides are stronger for such galactical inclination [2]. Also, the repartition in the plane depends on the range of the perihelion distance considered.

Figures 2 and 3 show the distribution of $\cos i_E$ and $\Omega_G$ respectively for the four different ranges.

4. Conclusions

- R1: no preference for inclination. But, for $\Omega_G$ the distribution observed could be the results of the systematically decreasing of $\Omega_G$ (initially close to 180° in the proto disk like hypothesis) valid for creepers and KQ-creepers [2, 1].
- R2 & R3: strong preference for prograde orbit, even for $i_E$ close to zero for R3, and $\Omega_G$ distribution peaking to value slightly smaller than 180°. Consistent again with an origin from a massive scattered disk close to the ecliptic extended to few thousands astronomical units from the Sun.
- R4: from [2], $i_E$ distribution should peaked toward 27° and 152°, which is indeed observed.

The preference for prograde orbits could come from some KQ-jumper that may be present in this sample.

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References