EPSC Abstracts
Vol. 13, EPSC-DPS2019-1432-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Looking for a primordial fingerprint in known Long Period Comets

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Abstract

Looking in details to some statistical properties of the known long period comets, we emphasis 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 Ω_G where i_E is the ecliptical inclination and Ω_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

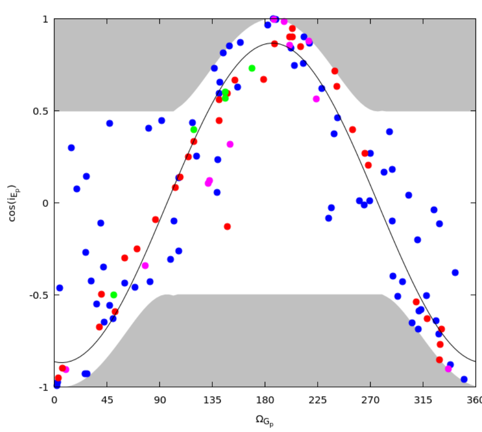

Figure 1: Location of the comets in the Warsaw catalogue with original semi-major axis greater than 10^4 au in the $(\Omega_G, \cos i_E)$ plane. See text for details.

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 $i_G \approx 90°$ (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 Ω_G respectively for the four different ranges.

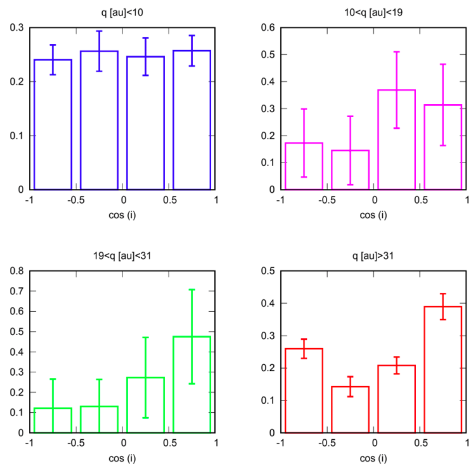

Figure 2: Distribution of $\cos i_E$ for the four different ranges of q. See text for details.

4. Conclusions

- R1: no preference for inclination. But, for Ω_G the distribution observed could be the results of the systematically decreasing of Ω_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 Ω_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.

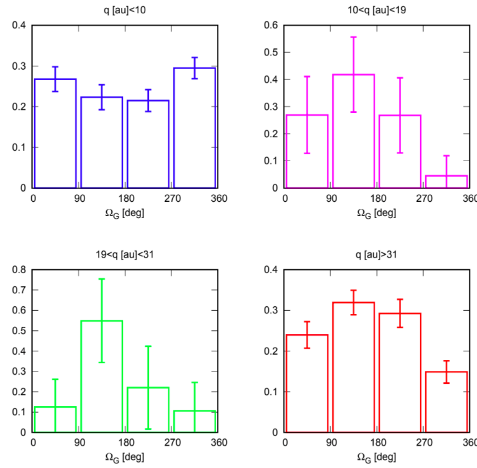

Figure 3: Distribution of Ω_G for the four different ranges of q. See text for details.

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

Acknowledgements

This work was supported by the Programme National de Planétologie (PNP) of CNRS/INSU, co-funded by CNES.

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