What do long period comets tell us about the Oort cloud ?

Marc Fouchard*[1], Arika Higuchi[2], and Ito Takashi[3]

[1]IMCCE – Université de Lille - Sciences et Technologies – France
[2]Faculty of Sciences, Kyoto – Japon
[3]Center for Computational Astrophysics, NAOJ, Tokyo – Japon

Résumé

The Oort cloud is the furthest outskirt of the solar system extending to the heliocentric distance of several 10 000 au and
remains the last region where none object has been ever detected at that distance. Thus, all our knowledge about the Oort cloud are
deduced from the long period comets.
Our aim is precisely retrieving all the information that might be hidden in the orbital distribution of the long period comets. This
leads to making a constraint not only on the present shape of the Oort cloud but also on its initial shape 4.5 Gyr ago. This obviously
has direct implication on the scenario proposed for the formation of the Oort cloud.

We have considered three different databases of long period comets. From the distribution of some specific orbital elements
we tried to highlight the presence of some typical features of an Oort cloud that was initially close to the ecliptic plane and with the
perihelion close to the orbit of the giant planets. Such investigation is performed using two numerical synthetic models corresponding
to two extreme cases : first, the DISC model considers an initial shape aligned with the ecliptic plane and perihelion close to the giant
planets, and second, the ISOT model, that considers a fully isotropic shape.

Through the analysis of the cometary orbital elements stored in the databases and its comparison with the synthetic models
results, we found a dynamical fingerprint in the orbital distribution of the currently observed long period comet that indicates the
initial shape of the Oort Cloud is closer to a flat disk rather than an isotropic one. However, agreement between the observational
data and our synthetic models is not extremely good. This shows that the long-term dynamical evolution of the Oort cloud cannot be
simply resumed by any of our synthetic models.
An initial shape of the Oort cloud close the the planar disk means that planetary scattering must have been crucial
during the formation of the Oort cloud. The fact that some features are still detectable after

*Intervenant

4.5 Gyrs, implies some limitation on the
role of external solar system effects as the one caused by giant molecular clouds and also on the effects caused by the stellar cluster
surrounding the solar system when it was just formed.