Resident Time of the Oort Cloud New Comets in Planetary Region

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In the mid-20th century, a Dutch astronomer Jan Hendrik Oort predicted the existence of a spherical cloud of comets within 10^3 to 10^4 au from the Sun based on the fact that the distribution of orbital inclination of long period comets is nearly isotropic. This is the Oort Cloud. Although the existence of the Oort Cloud has become a consensus thanks to the accumulation of observation data and the progress of theoretical studies, no objects have yet been detected that unambiguously show the full structure of the Oort cloud. Unlike the study of the major planets, for which there is a wide variety of observational evidence, the reality of the Oort Cloud and comets originating from it (new comets) is not clear due to a lack of observational data. However, comets originating from the Oort Cloud are definitely arriving in planetary regions, and some of them have reached the vicinity of the Earth and have been observed. We followed the dynamical evolution of the new comets by numerical simulations based on new dynamical models of the Oort Cloud [1].

We describe the result of our numerical orbit simulation which traces dynamical evolution of new comets coming from the Oort Cloud. We combine two dynamical models for this purpose. The first one is semi-analytic, and it models an evolving comet cloud under galactic tide and encounters with nearby stars. The second one numerically deals with planetary perturbation in the planetary region. Although our study does not include physical effects such as fading or disintegration of comets, we found that typical dynamical resident time of the comets in the planetary region is about 10^8 years. We also found that the so-called planet barrier works when the initial orbital inclination of the comets is small. A numerical result concerning the temporary transition of the comets into other small body populations such as transneptunian objects or Centaurs is discussed.

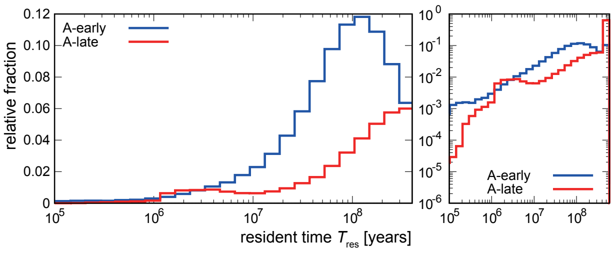

Figure 2: Distribution of the resident time T_res of the comets. The vertical axis of the left panel is on a linear scale, while that of the right panel is on a logarithmic scale. The vertical axis is normalized in both the panels so that the total value becomes unity for each period.

Reference

[1] Ito, T., Higuchi, A.: 2024, *Planetary and Space Science*, **253**, 105984.

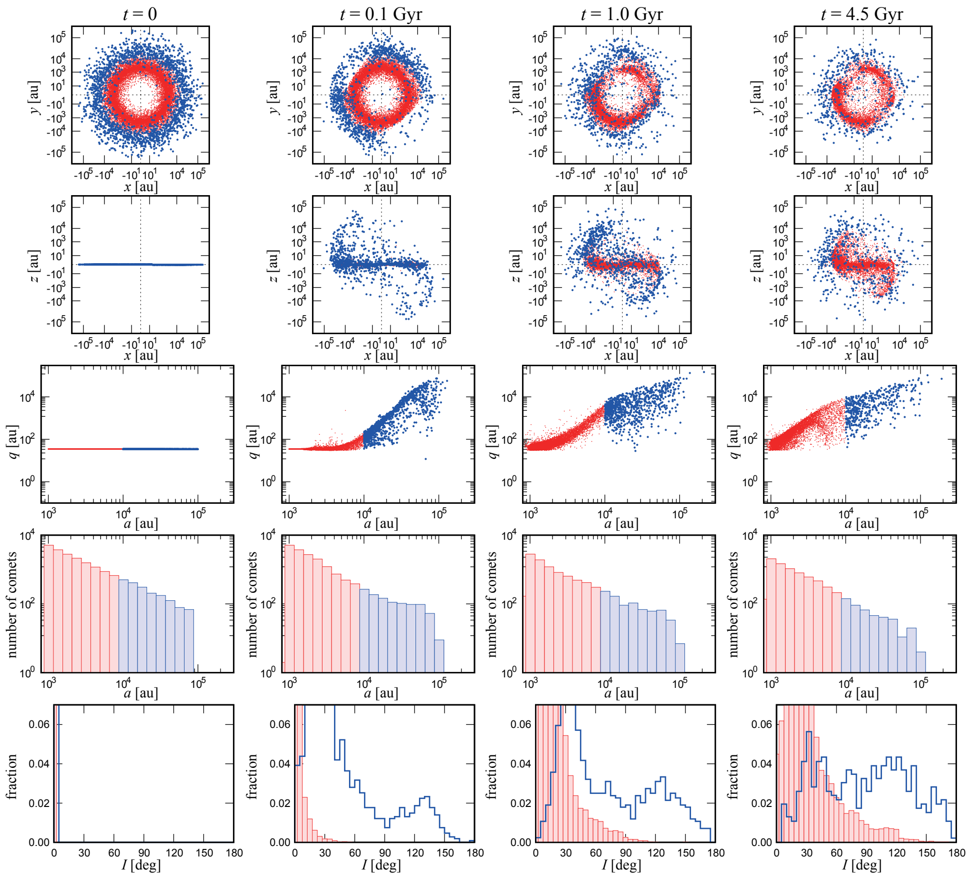

Figure 1: Example snapshots of the comet cloud evolution under the a star set. Top row: spatial distribution of the comets seen from the north (i.e. projected on the (x,y) plane). The (x,y) plane corresponds to the current ecliptic, and the x-axis is directed toward the current vernal equinox. The objects with semimajor axis $a <$ 10,000 au are plotted in red in all the panels, while other objects ($a \geq$ 10,000 au) are plotted in blue (we drew the blue dots slightly larger than the red dots). Second top row: spatial distribution of the comets seen from the current ecliptic (along the (x,y) plane). Third top row: scatter plots of semimajor axis a and perihelion distance q of the objects. Fourth top row: absolute number distribution of semimajor axis a of the comets. Bottom row: fractional distribution of orbital inclination I of the comets.