A Unified Theory for the Effects of Stellar Perturbations and Galactic Tides on Oort Cloud Comets

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We examine the effects of passing field stars on the angular momentum of a nearly radial orbit of an Oort cloud comet bound to the Sun. We derive the probability density function (PDF) of the change in angular momentum from one stellar encounter, assuming a uniform and isotropic field of perturbers. We show that the total angular momentum follows a Levy flight, and determine its distribution function. If there is an asymmetry in the directional distribution of perturber velocities, the marginal probability distribution of each component of the angular momentum vector can be different. The constant torque attributed to Galactic tides arises from a non-cancellation of perturbations with an impact parameter of order the semimajor axis of the comet. When the close encounters are rare, the angular momentum is best modeled by the stochastic growth of stellar encounters. If trajectories passing between the comet and sun occur frequently, the angular momentum exhibits the coherent growth attributed to the Galactic tides.

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