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Modelling the Distribution of Comets in Extrasolar Systems

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Abstract

In the last years observations of absorption lines in spectra of stars varying on short time scales accumulate. Scientists refer to these findings as features caused by objects evaporating material on their orbit close to the star and thus call them comets in exo planetary systems – *exocomets*.

The aim of our investigation is to find a statistical model for the scattering of small objects which shows the most probable whereabouts of these objects after the gravitational interaction with planets.

We discuss the effect of different forces acting on the comets, as there is gravitational influence of the galactic tide and passing stars. We also compare the scattering process with and without migration of the giant planet.

We found Kuiper belt and Oort cloud like structures depending on the mass, orbit, and migration of the giant planet as well as on the mass of the central star and the initial distribution of planetesimals.

1. Introduction

Although it is still not yet clear, if the observed short term absorption variations in the profile lines are caused by analogues of comets, the theory is based on the knowledge about the Solar System. In the Solar System comets are remnants from the planet formation process, as there are asteroids. During the phase of planet formation these small objects have undergone gravitational scattering by the planets and been ejected to the outer rims of the Solar System onto highly eccentric orbits with huge values for semi-major axis. These objects reside in the Kuiper belt and the Oort cloud in the Solar System, occasionally disturbed by gravitational influence of the galactic tide or (probably in former times) the passing of a star which bring them close to the inner Solar System again. Close encounters with the giant planets can take care of exchange of angular momentum and lead to short periodic orbits with smaller resulting eccentricity.

2. The Model

The setup includes a Sun, a Jupiter-like planet and a disk of planetesimals (testparticles) distributed between 0.4 to 40 au. The testparticles have initially very small eccentricities ($0 \leq e \leq 0.1$) and inclinations ($0° < i < 2°$).

The integrations are performed with the *Mercury*-code.

We run computations with and without the influence of the galactic tide and passing stars.

Due to interaction of the Jupiter with the gaseous disk still present in the early planetary system the giant planet migrates and interacts gravitationally with the disk of planetesimals [1, 2].

Our computations include runs with and without migration of the giant planet in order to compare the scattering outcome.

As a consequence of the interaction of the giant planet with the planetesimals the small objects are scattered either inward or outward. The outward scattered objects will form analogues to the Kuiper belt respectively the Oort Cloud in our Solar System.

In order to apply the described method to extrasolar planetary systems we varied the mass of the central star and mass and orbit of the giant planet in reasonable ranges obtained from observations.

3. Summary and Conclusions

The created cometary reservoirs are different depending on the initial conditions of the integrated systems. Semi-major axis, eccentricity, perihel, aphel, inclination and orbital period after 2Gyr of integration of each testparticle are measured and statistics are made by comparing the outcomes of the computations with different acting forces. Additionally the influence of the migration of Jupiter on the outcome of the scattering process is examined by performing integrations with and without migration of the massive planet.

The gained knowledge can be used to generate a general model for the formation of cometary reservoirs in extrasolar systems with respect to the system architecture which can be used to predict the location of cometary reservoirs in extrasolar systems.

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References

[1] Papaloizou, J. C. B., & Larwood, J. D. 2000, MNRAS, 315, 823

[2] Dones, L., Weissman, P. R., Levison, H. F., & Duncan, M. J. 2004, Star Formation in the Interstellar Medium: In Honor of David Hollenbach, 323, 371