Evolution of orbits of Trans Neptunian Objects in the Galactic Potential

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Recently many distant Trans Neptunian Objects (TNOs) have been discovered. The range of their semi-major axes is in 100 AU to near 1000 AU.

Owing to the increasing number of the distant TNOs, the statistical properties of their orbits become clear. One of their characteristic properties is reported by Batygin and Brown (2016, AJ, 151). They reported a clustering of orbital elements of distant and eccentric TNOs. They found that the directions of periherions of TNOs with large semi-major axes and high eccentricities are clustering.

They argue that the clustering is explained by the 9th planet. But the 9th planet has not been discovered yet. There may be another reason for the clustering.

The Solar System is in the Galaxy. The Galactic gravitational field is rarely taken into account in the study of dynamical evolution of the Solar System. One of the reason may be its estimated weakness. It is weak if the Galaxy is regarded as a sphere. However the Galaxy is not a sphere. It is composed of a disk and a bar or spiral arms. If we consider such a structure, its gravitational field is not weak. And it is not known how it affects the orbital evolution of TNOs.

In this study, we numerically integrated the evolution of TNO's orbits in a galaxy model which mimics the potential field by the Galactic disk. We found that the Galactic potential causes large variations in orbital elements of TNOs. We also found that the direction of perihelion tends to turn towards the Galactic Center.

Our result suggests that the clustering of distant TNOs's orbits is caused by the Galactic Field.

It also suggests that the structure and dynamical evolution of the Galaxy has affected the orbital and dynamical evolution of planets and small objects in the Solar System and, therefore, the importance of the study of evolution of the Solar System in the more realistic Galaxy model.

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