Proceedings of the Lunar and Planetary Laboratory Conference XII, June 4-5 2009

Dynamical Pathways to the High-Perihelion Scattered Disk

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The scattered disk objects (SDOs) are a population of minor planets with semi-major axes beyond 50 AU and perihelion distances in the range 30-40 AU whose origin is related to gravitational scattering by Neptune. A small number of known objects, including Sedna, have semi-major axes and perihelion beyond 50 AU. These have been more difficult to understand within current models of the origin of dynamical structure in the Kuiper belt, and various types of 'external perturbations' (passing stars, encounters with large planetesimals, exotic modes of planetary migration) have been suggested. Here we reconsider whether this population may be explained within the dynamics of the known solar system. Numerical simulations show that over gigayear timescales some SDOs can evolve their perihelion distance beyond the 30-40 AU range under the action of the perturbations of the giant planets alone. Such evolution occurs by means of the Kozai secular resonance facilitated by high inclinations and mean motion resonances. Objects following these paths spend very long times in orbits of large perihelion and large semi-major axis. Previously the combination of mean motion resonances and Kozai dynamics has only been shown to operate at smaller semi-major axes (and therefore closer resonances), leaving the high-perihelion objects with larger semi-major axes as anomalous. Our current investigation finds that this mechanism operates over a much wider range of distant resonances which provide pathways to the high-perihelion scattered disk. We discuss the possibility of explaining several of the known high-perihelion SDOs using this mechanism.