Geophysical Research Abstracts,
Vol. 11, EGU2009-4072-2, 2009
EGU General Assembly 2009

Formation of the Resonant Populations in the Kuiper Belt

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Kuiper belt objects (KBOs) have most of their orbits within a thick disk outside that of Neptune as they are located around heliocentric distances in the range 35-50 AU. On the basis of their orbital elements KBOs can be grouped into distinct dynamical classes, namely the classical, the resonant, and the scattered ones. Resonant KBOs are trapped in mean-motion resonances with Neptune, mainly 3:2 orbital period resonance at 39.4 AU. The same resonance is also occupied by Pluto. In contrast, only a few KBOs are claimed to be associated with the inner 5:4 and 4:3 resonances (34.9 and 36.4 AU, respectively) and the outer 2:1 resonance (47.7 AU). Some other weak resonances are also clearly observed, for instance, 5:3 and 7:3 resonances (42 and 44 AU). Jiang & Yeh (2004, 2007) have proposed gas-drag-induced resonant capture in a protostellar disk analogous to the primordial solar nebula as a mechanism able to explain the dominant 3:2 resonant population observed in Kuiper belt objects. de La Fuente Marcos & de La Fuente Marcos (2008) further investigated the drag-induced mechanism numerically. Our significant contribution is just a hydrodynamic theory derivation of results obtained in Jiang & Yeh (2004, 2007) and de La Fuente Marcos & de La Fuente Marcos (2008) numerical simulations. The possibility of angular momentum and mass transport arising in the solar nebula at outer Lindblad orbital resonances is discussed. We show that the gas-drag-induced resonant process may lead to the formation of relatively narrow, ~ 0.2 AU, KBO rings. The number of KBOs captured into the 3:2 resonance may become a very large fraction of all objects, consistent with the observational results.

The work was funded through the Israel Science Foundation, the Israeli Ministry of Immigrant Absorption, and by the Theoretical Institute for Advanced Research in Taiwan.