Resonance and Capture of Jupiter Comets

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A number of Jupiter comets such as *Oterma* and *Gehrels 3* make a rapid transition from heliocentric orbits outside the orbit of Jupiter to heliocentric orbits inside the orbit of Jupiter and vice versa. During this transition, the comet is frequently captured temporarily by Jupiter for one to several orbits around Jupiter. The interior heliocentric orbit is typically close to the 3:2 resonance (three revolutions around the Sun in two Jupiter periods) while the exterior heliocentric orbit is near the 2:3 resonance (two revolutions around the Sun in three Jupiter periods).

An important feature of the dynamics of these comets is that during the transition, the orbit passes close to the libration points L_1 and L_2. The points L_1 and L_2 are two of the five equilibrium points for the restricted three-body problem for the Sun-Jupiter system. Amongst the equilibrium points, L_1 and L_2 are the ones closest to Jupiter, lying on either side of Jupiter along the Sun-Jupiter line.

We conclude that studying the libration point invariant manifold structures for L_1 and L_2 is a starting point for understanding the capture and resonance transition of these comets. The recently discovered heteroclinic connection between pairs of unstable periodic orbits (one around the L_1 and the other around L_2) has significant implications for the aforementioned resonance transition and temporary capture of Jupiter comets.

The stable and unstable invariant manifold "tubes" associated to libration point periodic orbits, of which the heteroclinic connections are a part, act as conduits in the phase space transporting material to and from Jupiter and between the interior and exterior of a Jupiter's orbit. Temporary capture and collision orbits such as comet *Shoemaker-Levy 9*'s can be modeled via these dynamical channels. This is joint work with W. Koon, M. Lo, and J. Marsden.