

Connecting interacting galaxies with manifolds

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Abstract. It is well known that the interaction between two disk galaxies generates tidal spiral arms and a connection in the form of a bridge. Here we address the question of the formation of tidal arms and bridges from a dynamical point of view. We model the bridges and tails observed in interacting galaxies using the invariant manifolds associated to the Lyapunov orbits of the Lagrangian points of the galactic system, when the two galaxies are considered as two point masses in a circular orbit.

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1. Modelling bridges and tails with manifolds

We model the two interacting galaxies as two point masses and we study the motion of the stars using the Restricted Three Body Problem, i.e. the two mass points are bound and circle around their center of mass. The two galaxies rotate counter-clockwise around their center of mass at a constant angular velocity. When we make the problem nondimensional, we are left with only one free parameter which is the mass ratio of the two galaxies: m_2/m_1 .

In the rotating frame, the system has five equilibrium points, three of them are saddle points aligned with the two galaxies ($L_{1,2,3}$), while the other two are on a line perpendicular to the previous one and they are linearly stable ($L_{4,5}$). For the mass ratio range characteristic of interacting galaxies (see Fig. 1 for two mass ratios), the manifolds around L_2 and L_3 represent the tails of the interacting galaxies (in blue and red, respect.), while manifolds around L_1 represent the bridge (in green). The Lagrangian points are marked by asterisks and they are labelled accordingly, while the concentric circles are centered on the two galaxies and have 5, 10 and 15kpc radii.

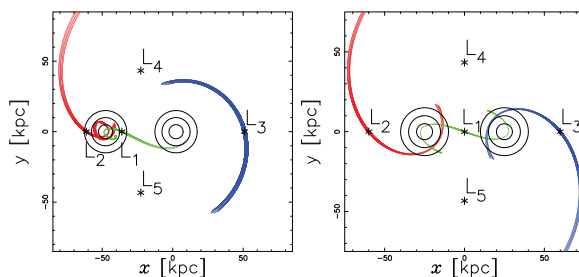


Figure 1. The bridge (green) and tails (red & blue) for 1:20 (left) and 1:1 (right) mass ratios.