bar pattern speed, and we obtain invariant manifolds of different shapes, i.e., two spiral arms, outer rings whose principal axis is perpendicular to the bar major axis (R_1 rings), outer rings whose principal axis is parallel to the bar major axis (R_2 rings), and in few cases, the two types of outer rings together (R_1R_2 rings).

2. MAIN CHARACTERISTICS OF THE INVARIANT MANIFOLDS

The orbits trapped by the manifolds are closely related to the instability of the equilibrium point, and as it increases, the global shape of the galaxy changes from being a closed R_1 ring to open spiral arms to R_2 and R_1R_2 rings. So the time it takes and orbit to perform a revolution and to have the global shape, also depends on the instability of the equilibrium point, being the spiral arms faster, of the order of 3–4 bar revolutions, and the rings slower to form, of the order of 6–8 bar revolutions (Romero-Gómez et al. 2006).

The circulation of the stars along the manifolds is also different depending on whether the global morphology is a ring or spiral arms (Athanassoula et al. 2010). The circulation in the case of R_1 rings is closed, i.e., once the star is trapped by the manifolds, it will stay there forever. The spiral arms case is different. First, the circulation is along the spiral arms, which makes it different from the density wave theory. Secondly, the stars trapped by the manifolds originally come from the inner parts of the bar or from the outer parts of the disc and are trapped by the manifolds when the bar is forming, circulating from the inner parts towards the outer parts of the disc.

Finally, the effect of the gas on the orbits trapped by the manifolds is tested in Athanassoula et al. (2010). We simulate the shocks of the gas by making the particle lose a fraction of kinetic energy at random positions during the integration. The effect on the global morphology is that the thickness of the spiral arm or ring decreases, i.e., we obtain thinner structures.

3. THE INVARIANT MANIFOLDS AND THE INNER PART OF THE GALAXY

Here we present the preliminary results of computing the invariant manifolds to a galactic potential originally set to describe the Milky Way (Romero-Gomez et al., in preparation). We use a composite inhomogeneous prolate bar (Pichardo et al. 2004), PMM04. We first consider only the Galactic bar in the potential, and then we modify this by adding the

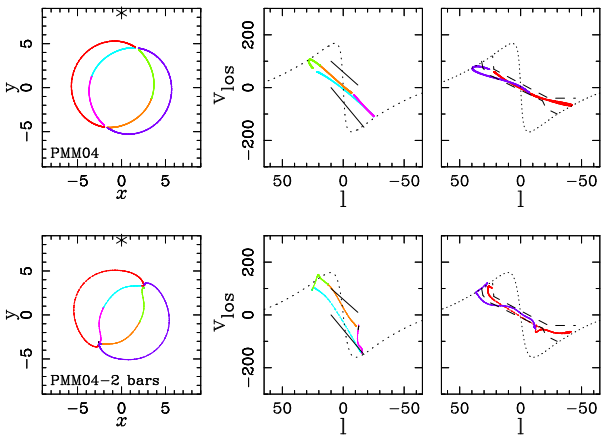

Fig. 1. Longitude-velocity diagrams. Top panel: single bar case. Bottom panel: the case with the 2 bars at an angular separation of 20°. The Sun is located on the y-positive axis (marked with an asterisk) and the Galactic bar is located at 20° from the Sun – Galactic Center direction. The bar pattern speed is 45 km s^{-1} kpc^{-1}.

Long bar. We use the same parameters as the ones selected by the authors and we compute the orbits trapped by the manifolds and the galactic longitude – line-of-sight velocity diagram, (l, v). In the first columns of Figure 1, we show the orbits in the (x, y) plane, each colour representing a part of the structure. In the middle panel, we plot only the (l, v) diagram of the inner branches, while in the right panel, we plot the kinematics of the outer branches. The solid and dashed lines in both panels mark the observational constraints, the 3 kpc arm and the Galactic Molecular Ring, respectively. Note that the case with only one bar, it does not reproduce well the 3 kpc arm, while when the Long bar is introduced, the inner branches become more elongated and the velocities better reproduce the observed features.

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