Constraints on the Galactic bar with RAVE

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Abstract. We derive the pattern speed of the Galactic bar from the analysis of the kinematics of the Hercules stream at different Galactocentric radii with RAVE, assuming that Hercules is caused by the bar. We find a well constrained pattern speed of $\Omega_{\rm b} = 1.98^{+0.04}_{-0.08}\Omega_0$, where Ω_0 is the local circular frequency.

Keywords. Galaxy: disk, evolution, kinematics and dynamics

Dehnen (2000) proposed that the Hercules stream is due to the effects of the Outer Lindblad Resonance of the bar. We model analytically the kinematic properties of Hercules as a function of position in the Galaxy and the bar's properties. Assuming a rotation curve of the form $v_{\rm c} = v_0 R^\beta$, we find that the azimuthal velocity of the Hercules gap is:

$$v_{\phi,{\rm OLR}}(R) \approx a\, v_0\, (R/R_0)^\beta\, \frac{1+\beta}{1-\beta} \left[1 - \frac{\Omega_{\rm b} R}{v_0 (R/R_0)^\beta} \frac{1}{1+\sqrt{(1+\beta)/2}} \right] - (b+c\,\beta-1)\, v_0\, (R/R_0)^\beta$$

where R_0 is the Galactocentric radius, v_0 the circular velocity at the Sun, $\Omega_{\rm b}$ the bar's pattern speed and a, b and c are parameters that depend on the bar's orientation ϕ_b.

We use data from the RAVE survey (Steinmetz *et al.* (2006), Antoja *et al.* (2012)) to measure the azimuthal velocity of the Hercules gap $v_{\phi,{\rm OLR}}$ as a function of R (Fig. 1). We find that this velocity decreases with radius consistent with our analytical predictions of Eq. above. Our best fit model provides new constraints for the bar's pattern speed which we find to be $\Omega_{\rm b} = 1.98^{+0.04}_{-0.08}\Omega_0$. This is consistent with previous determinations (Gerhard 2011). This determination is not very sensitive to the assumed Galactic parameters (such as the peculiar motion of the Sun), or to biases in distance. Assuming $R_0 = 8.05\,{\rm kpc}$ and $v_0 = 238\,{\rm km\,s^{-1}}$, this corresponds to a pattern speed of $58.5^{+1.0}_{-2.4}\,{\rm km\,s^{-1}kpc^{-1}}$.
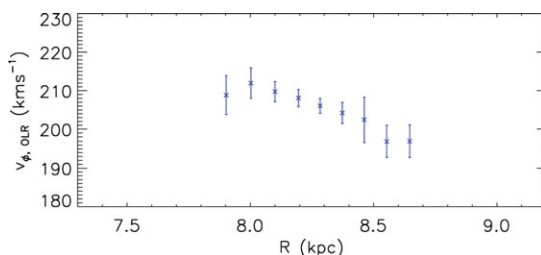

Figure 1. Position of the Hercules gap as a function of R for the RAVE data.

References

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