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Measuring the Milky Way Potential with the Phase Snail in a Model Independent Way (poster pitch)

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The vertical phase-space spiral (snail) is a direct sign of dis-equilibrium of Milky Way's disc. Nevertheless, the wrapping of the phase snail contains the information of the vertical potential. We propose a novel method to measure the vertical potential utilizing the intersections between the snail and z/V_z axes, for which we know the maximum vertical heights (Z_{max}) or the maximum vertical velocities ($V_{z,max}$) of the oscillating stars. Using a refined linear interpolation method, we directly obtain (Z_{max}, $\frac{1}{2}V_{z,max}^2$) for these snail intersections to constrain the vertical potential profile empirically. Our method is model independent since no assumptions about the shape of the phase snail or the vertical potential have been made. We find the snail binned by the guiding center radius (R_g) stands for a vertical potential shallower than that of the snail binned by a same Galactocentric radius (R). We apply an empirical method to correct this difference. We measure the snail intersections in several R_g bins within $7.5 < R_g < 11.0$ kpc for Gaia DR3, and apply the interpolation method to obtain potential measurements at several vertical heights. The potential at the snail intersections, as well as the following mass modeling are consistent with the popular Milky Way potentials in the literature. For the R_g-binned phase snail in the Solar neighborhood, the mass modeling indicates a local dark matter density of $\rho_{\rm dm} = 0.0150 \pm 0.0031\ {\rm M}_\odot\ {\rm pc}^{-3}$, consistent with previous works. Our method could be applied to larger radial ranges in future works, to provide independent and stronger constraints on the Milky Way's potential.

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