Predicted trends in Milky Way bulge proper motion rotation curves: future prospects for *HST* and LSST

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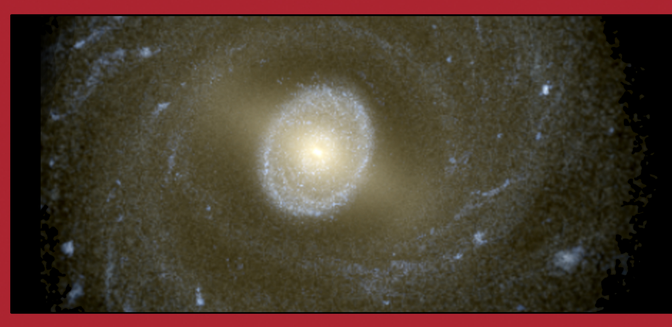
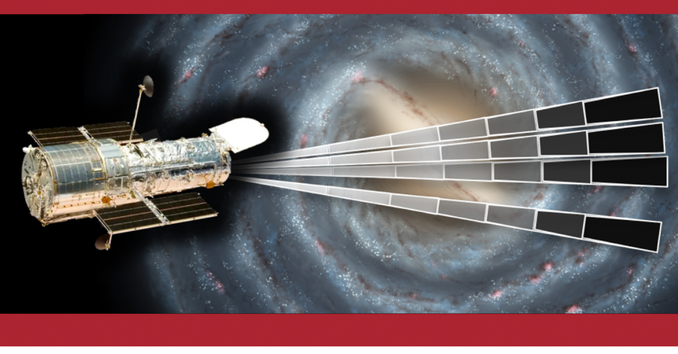
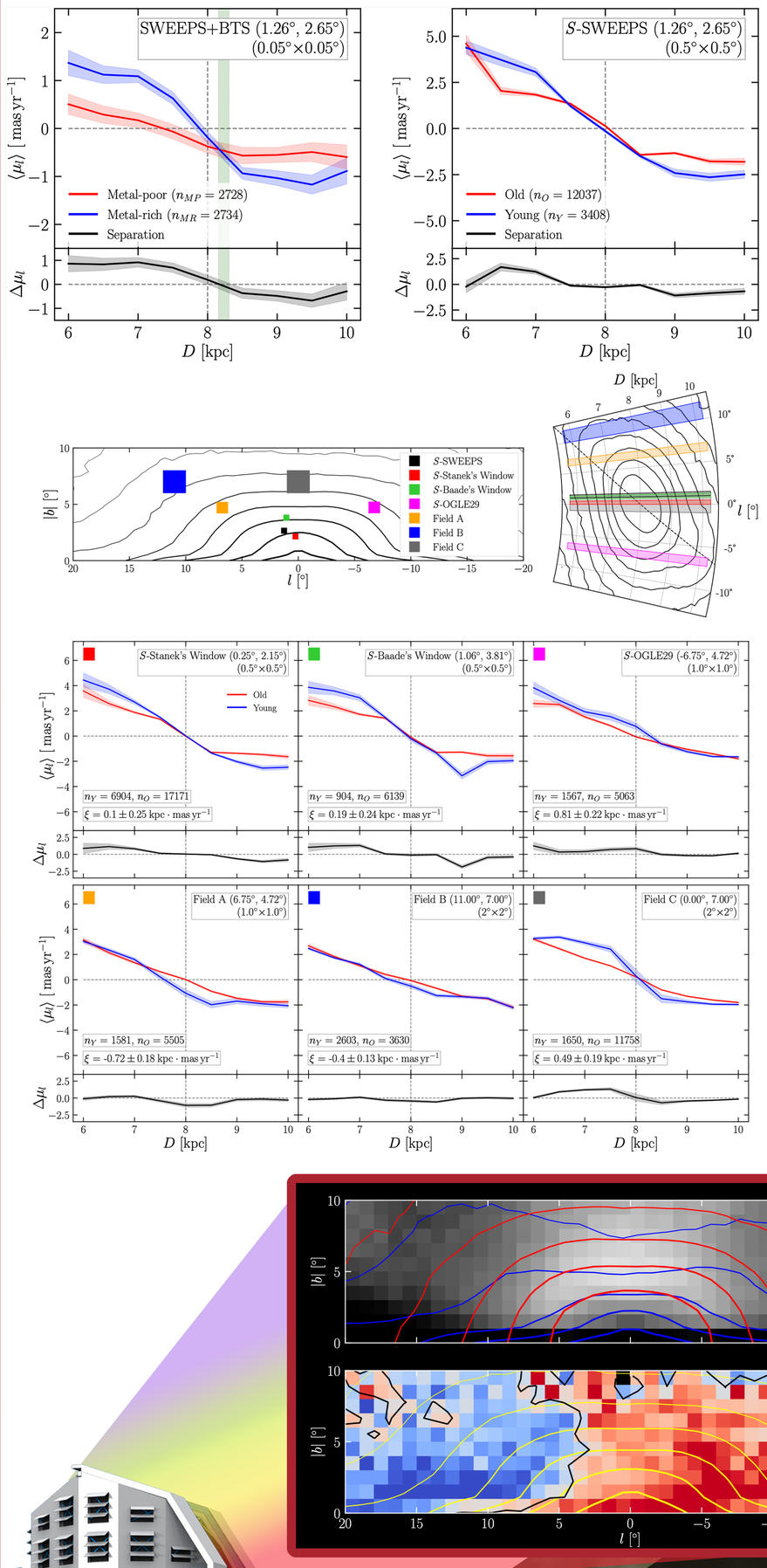


We use an N-body+smoothed particle hydrodynamics simulation of an isolated barred galaxy to study the age dependence of bulge longitudinal proper motion (μ_l) rotation curves.



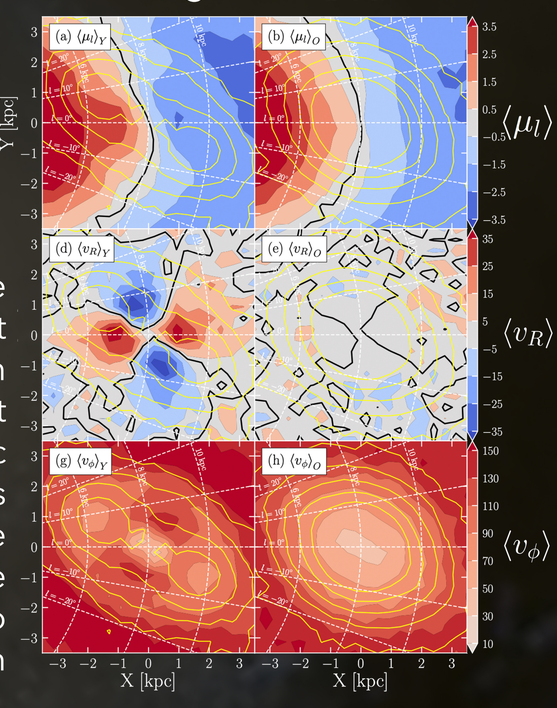


We show that close to the minor axis ($|l| \sim 0°$) of our model, the relatively young stars rotate more rapidly than the old stars, as found by Clarkson *et al.* (2018) with the *Hubble Space Telescope (HST)* in the Milky Way's (MW's) bulge for metal-rich and metal-poor stars respectively. This behaviour would be expected also if the MW were barred or unbarred.

At longitudes away from the minor axis, a different behaviour emerges. Because younger stars trace a strong bar, their galactocentric radial motions dominate their longitudinal proper motions (μ_l) leading to a reversal in the sign of μ_l. This results in a rotation curve with forbidden velocities (negative μ_l at positive longitudes, and positive μ_l at negative longitudes). The old stars, instead, trace a much weaker bar and thus their kinematics are more axisymmetric, resulting in no forbidden velocities. We define a metric ξ to quantify these forbidden velocities as the integrated separation between the young and old proper motion rotation curves. We then present predictions for fields observed by *HST* and for potential regions of interest.

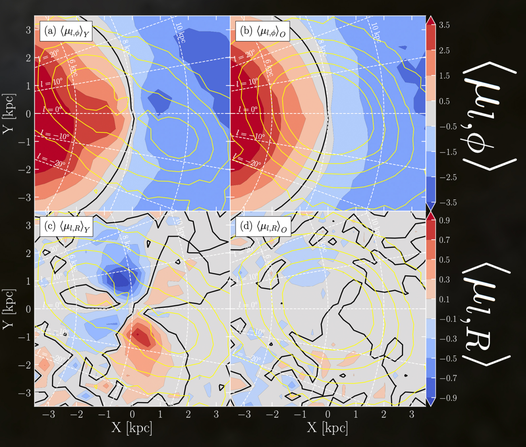
Model

Paper Access link



We demonstrate using the model that forbidden velocities in μ_l are a projection effect of young stars' intrinsic velocities. Due to the bar's inclination angle, high amplitude galactocentric radial velocities are aligned almost perpendicular to the line of sight, which results in large μ_l.

The Vera C. Rubin Observatory/LSST has the potential to produce a one-of-a-kind synoptic data set to test the predictions presented in this study. In particular, a multi-epoch survey of the Galactic bulge region, deep enough to reach the main sequence turn off, would provide the ideal data set to measure both ages and proper motions (Gonzalez et al. 2018, LSST bulge white paper) and apply the methods used here. A key output of LSST data would be a homogeneous, wide-field map of these properties (similar to the map above). This 'definitive map' would allow us to characterize the morphologies of different stellar populations of the bulge and bar in unprecedented detail, answering fundamental questions about the formation of the MW bar.



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