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Stellar proper motions in the Galactic bulge with ACS/WFC on HST

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Abstract. In 2004 the Sagittarius Window Eclipsing Extrasolar Planet Search (SWEEPS) project undertook a very deep ACS/WFC exposure-set of the Sgr-I low-reddening window in the Galactic Bulge, with repeat observations 2.04 years later. The combination of superb first-epoch sampling, wide field of view and high PSF stability of ACS/WFC on Hubble allows proper motions to be extracted for more than 137,000 objects, over 85,000 to accuracy better than 0.3 mas yr^{-1}. We present these proper motions and outline some of the uses to which they have been put, including the separation of a pure-Bulge sample and the inner Galactic rotation curve.

Keywords. stars: kinematics, Galaxy: bulge, Galaxy: disk, Galaxy: kinematics and dynamics

1. Introduction

Proper motions have much to tell us about the dynamics and evolution of the Galactic Bulge. Constraints on the nature and spatial variation of the motion of stellar populations within the Bulge allow testing of dynamical galaxy models to a level not available for external galaxies. Equally importantly, stellar proper motions allow kinematic separation of a cleaner Bulge sample for studies of its age (Kuijken & Rich 2002).

2. Extraction of Relative Proper Motions from HST Photometry

The first epoch observations included 265 exposures in F814W and 254 in F606W, at 339 seconds each and with subpixel dithers that well and redundantly sample pixel phase-space. In 2006, ten 345-second exposures in F814W were taken with a four-way sub-pixel dither. Mutual misalignment and rotation between epochs are of order 5 pixels and $< 8''$ respectively. Up to 265 measurements are available for each star in 2004 using a modified version of the Anderson & King routines; we combine the 2004-epoch measurements to produce a master catalogue from this epoch. Each position-estimate from 2006 is then mapped onto this 2004 master-list, producing up to ten proper motion estimates for each star. This mapping is computed separately for each star using 100–150 suitably selected nearby, well-measured objects. The proper motion error resulting is only 2 mas yr^{-1} at

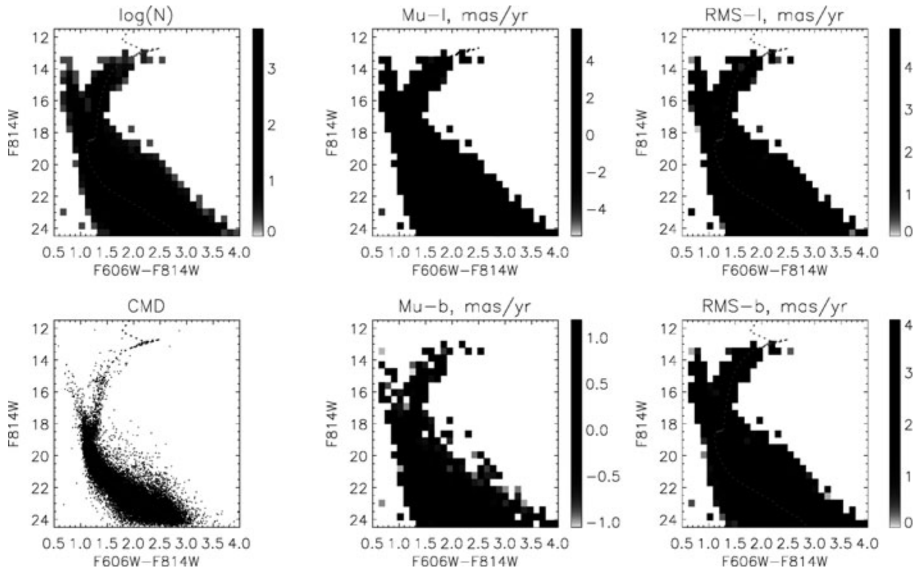

Figure 1. Proper motion Hess diagrams for our field, with mean-Bulge isochrone from SWEEPS photometry (Sahu *et al.* 2006). The Bulge is clearly visible in μ_l, σ_b and σ_l. Solar reflex motion contributes a relatively insignificant trend $|\mu_{l,b}| < 0.2$ mas yr^{-1} (e.g. Vieira *et al.* 2007)

F814W = 24, reaching 0.3 mas yr^{-1} at F814W = 19. The Bulge shows intrinsic dispersion (σ_l, σ_b) for this field of (3.24, 2.85) mas yr^{-1} (Kuijken & Rich 2002), thus we have reached the precision necessary to observe real kinematic trends (Figure 1).

3. Discussion

Full uses of our unique dataset are described elsewhere (Clarkson *et al.* 2007 in preparation). By reference to the Bulge isochrone a photometric distance estimate can be assigned to main-sequence stars interior to the innermost spiral arm, averaging over the Bulge metallicity distribution with 500-1500 stars per distance-bin. This yields kinematic constraints as a function of distance, including the transverse rotation curve of the Milky Way down to 0.2 kpc galactocentric radius. This indicates that the Bulge appears to only exhibit solid body-like rotation for galactocentric radii $\lesssim$0.7 kpc (in qualitative agreement with Rich *et al.* 2007). A second product is the $\{v_l, v_b\}$ velocity ellipse as a function of distance, which will be used in future work to constrain dynamical models of the Bulge. Additionally, selecting stars by μ_l and σ_b produces a clean sample of 21,292 probable Bulge objects, which will allow improved constraints on the Bulge age estimates.

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References

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