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THE GALACTIC BULGE VELOCITY DISPERSION AS MEASURED BY STELLAR PROPER MOTIONS IN PLAUT'S WINDOW

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RESUMEN

Ya hemos comenzado el estudio en la ventana de baja extinción de Plaut, localizada en (l,b)=(0,-8), para conectar bulbo y halo. Para ello, se han escaneado 43 placas que cubren un área de $25' \times 25'$. Estas placas se tomaron a lo largo de 21 años, con cinco telescopios diferentes, y con la idea de formar un catálogo profundo de movimientos propios en el bulbo Galáctico. En la reducción se hace especial énfasis en la corrección de la distorsión óptica y de la refracción diferencial. Problemas adicionales son la poca calidad de las imágenes y la gran densidad de objetos en ellas. Los datos fotométricos se han obtenido parcialmente de la reducción y serán combinados con los datos infrarrojos de 2MASS para separar las estrellas del bulbo de las del disco. Una vez realizada esta segregación, se estudiarán las propiedades cinemáticas del bulbo. De un total original de 60.000 estrellas, la muestra final seleccionada es de 3.000 estrellas. Todas ellas de magnitud $V > 18$ y con movimientos propios de alta precisión. La dispersión en movimiento propio para esta muestra es de 3.12 msa/año y 2.82 msa/año en longitud y latitud galáctica, respectivamente.

ABSTRACT

We have begun an investigation at Plaut's low extinction window, located at (l,b)=(0,-8), i.e., at the interface between the bulge and the halo. We use 43 scanned photographic plates which cover around $25' \times 25'$. These plates were taken through five different telescopes over 21 years of time in order to get a deep and large catalog of relative proper motions of the Galactic bulge. Particular attention was paid to the correction of optical field-angle distortion and to differential atmospheric color refraction. The analysis is further complicated by the relatively poor image quality and high degree of crowding on these plates. The photometric data have been partially reduced and will be used in combination with 2MASS infrared data to photometrically segregate the bulge stars from the disk ones. Thus, relatively clean samples will be provided for the study of the bulge's kinematical properties. From the 60,000 stars measured, a subset of ∼3,000 stars with high precision proper motions and $V > 18$ mag was selected as probable bulge members. This subsample yields a proper motion dispersion of 3.12 mas/yr and 2.82 mas/yr in galactic longitude and latitude, respectively.

Key Words: **ASTROMETRY — GALAXY: BULGE — GALAXY: KINEMATICS AND DYNAMICS**

1. INTRODUCTION

The Milky Way consists of at least three kinematically distinct components: the bulge, the disk and the halo. The regions where a transition is made from one component to another are of paramount importance. For example, while the halo does not appear to exhibit clear correlations of abundances with kinematics (Carney et al. 1990), there is some indication that metal-rich bulge stars have a smaller velocity dispersion (Rich 1990), or equivalently, have greater rotational support (Minniti 1993, 1996). These issues can be settled by correlating abundances with accurate proper-motion and radial velocity dispersions.

Our study addresses the tangential kinematics of the Galactic bulge in Plaut's (Plaut 1970, 1971) low extinction window ($E_{B-V} = 0.25$ mag, van den Bergh & Herbst 1974). This window is centered at (l, b)=(0,-8) and lies at approximately 1 kpc south of the Galactic nucleus. It offers the opportunity to get a more clear view of the interface zone between the dense metal-rich bulge and the metal-poor halo. Furthermore, this region has a smaller reddening and is less crowded than Baade's window.

2. MATERIAL

A rich history of photographic observations exist for Plaut's Window which consist of 43 plates taken through the Hale 200", CTIO 4m, duPont 100", KPNO 84" and YSO 20" telescopes. Approximately, half of them are visual plates and the other half are blue. The first-epoch plates were taken in 1972-73 and the second-epoch in 1992-93, but we also have a few intermediate-epoch plates taken in 1979.

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In addition, we have made CCD photometric observations of the region in the B and V bands through some of those telescopes.

3. ASTROMETRIC REDUCTION

All of the plates were measured on the Yale PDS microdensitometer and reduced with the Yale astrometric reduction programs. Particular attention was paid to the correction of optical field-angle distortion due to the telescopes and to the differential atmospheric color refraction since Plaut's Window is always observed at a high air mass from the northern hemisphere. The analysis is further complicated by the relatively poor image quality and the high degree of crowding on these plates due to the large air mass through which they were taken.

Once all the plates were transformed to a selected master plate and the distortions removed, we computed proper motions by performing a weighted least-square linear fit to position vs. time, taking into account the individual plate solutions. Individual proper motion errors were computed from the scatter of the residuals around the best-fit line, as well as from the formal error of the slope of the linear fit. Therefore, these proper motions are not absolute but relative proper motions.

A photometric calibration was done using 26 photoelectric standards identified in the field (van den Bergh & Herbst 1974). Both V and B were obtained, with a mean error ranging from $\sim$0.1 for $V < 17$ up to $\sim$0.4 mag for $V = 21$. The final catalog of stars obtained goes deep enough ($V_{\rm lim} \sim 21$) to reach below the bulge main-sequence turnoff.

4. RESULTS

A 60,000 stars final catalog was obtained, with a position mean error of $(\epsilon_l, \epsilon_b) = (1.43, 1.46)$ mas, and a proper motion mean error of $(\epsilon_{\mu_l}, \epsilon_{\mu_b}) = (1.81, 1.83)$ mas/yr. From these stars, a sample of probable bulge members with good proper motions was extracted by applying the following conditions: a) (x,y) position in plate far from the edges, b) proper motion errors both less than 1 mas/yr, and c) $V > 18$ mag. A total of 2970 stars fulfilled all three conditions and share the following characteristics: position mean error of $(\epsilon_l, \epsilon_b) = (0.76, 0.80)$ mas, and proper motion mean error $(\epsilon_{\mu_l}, \epsilon_{\mu_b}) = (0.80, 0.79)$ mas/yr.

For this final sample of stars, Figure 1 shows the smoothed histograms of the proper motions, in both galactic longitude and latitude. A shift was applied to them in order to center them around a zero mean proper motion. The true (error-corrected) dispersion (Spaenhauer et al. 1992) in proper motions measured in each component is $(\Sigma_{\mu_l}, \Sigma_{\mu_b}) = (3.123, 2.825) \pm (0.041, 0.037)$ in mas/yr. These results are in good agreement with previous investigations on the same subject (Spaenhauer et al. 1992). Assuming a distance of 8.5 kpc from the Sun to the Galactic center, these numbers correspond to a velocity dispersion of $(\Sigma_{V_l}, \Sigma_{V_b}) = (125.9, 113.9) \pm (1.6, 1.5)$ km/s.

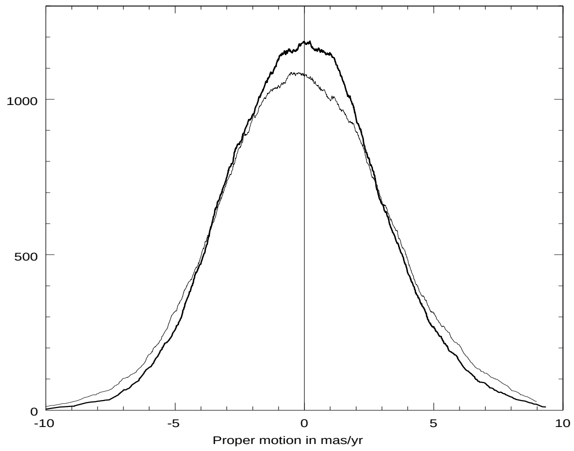

Fig. 1. Smoothed histograms of the proper motions in both galactic longitude and latitude, for the final sample of probable members of the galactic bulge. Thin line is for μ_l and thick line is for μ_b.

To improve the segregation of bulge stars from foreground disk stars, 2MASS infrared photometry is being used to separate the bulge red giant stars from the 60,000 stars in our catalog. Around 20,000 2MASS stars are located in a $30' \times 30'$ centered in (l,b)=(0,-8) and we expect to recover most of them. We will later proceed to use our precise proper motions to recompute a more accurate velocity dispersion.

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