Kinematical Properties of an RR Lyrae Star Overdensity in the Inner Milky Way

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Abstract

The observed orbital properties of the globular cluster ω Centauri can be modeled accurately by simulating the capture of a galaxy of larger mass, the outer layers of which are disrupted gravitationally and accreted to the Milky Way, leaving behind a smaller orbiting core of similar mass to ω Centauri (Tsuchiya, Dinescu, & Korchagin, 2003). The Siding Spring Survey's recent observation of over 9000 RR Lyrae (Torrealba et al., 2014), matched with kinematical data from Southern Proper Motion Program 4 (Girard et al., 2011), provides us with a map of the inner galactic disk which displays one significant stellar overdensity some 8 kpc from the Sun and within the current orbital path of ω Centauri. We use kinematical, spatial and compositional features of stars within this overdensity in comparison with simulated models of the Milky Way to better understand the kinematical properties of the overdensity and the possibility that it is part of the parent satellite of ω Centauri.

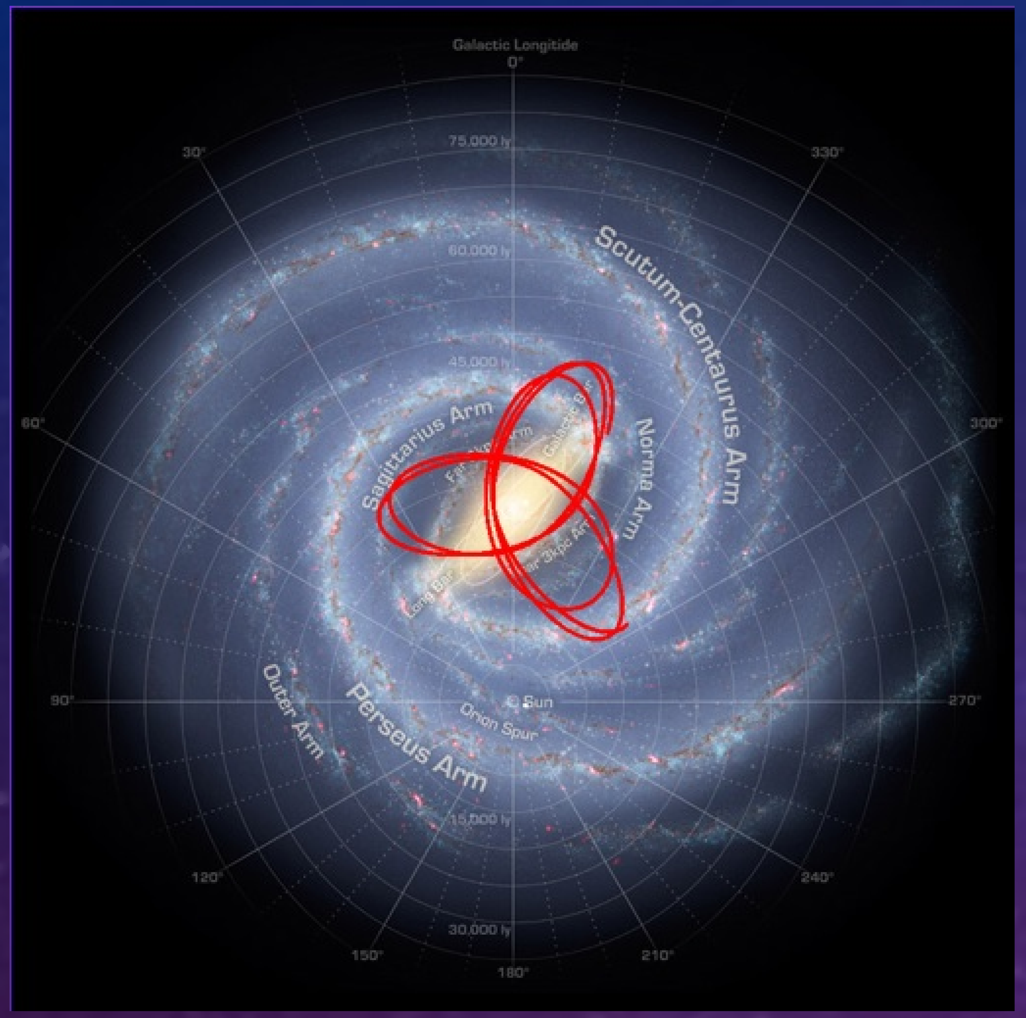

Figure 1 - A map of the galactic plane overlaid with an integration of the past 1 Gyr of ω Centauri's orbit.

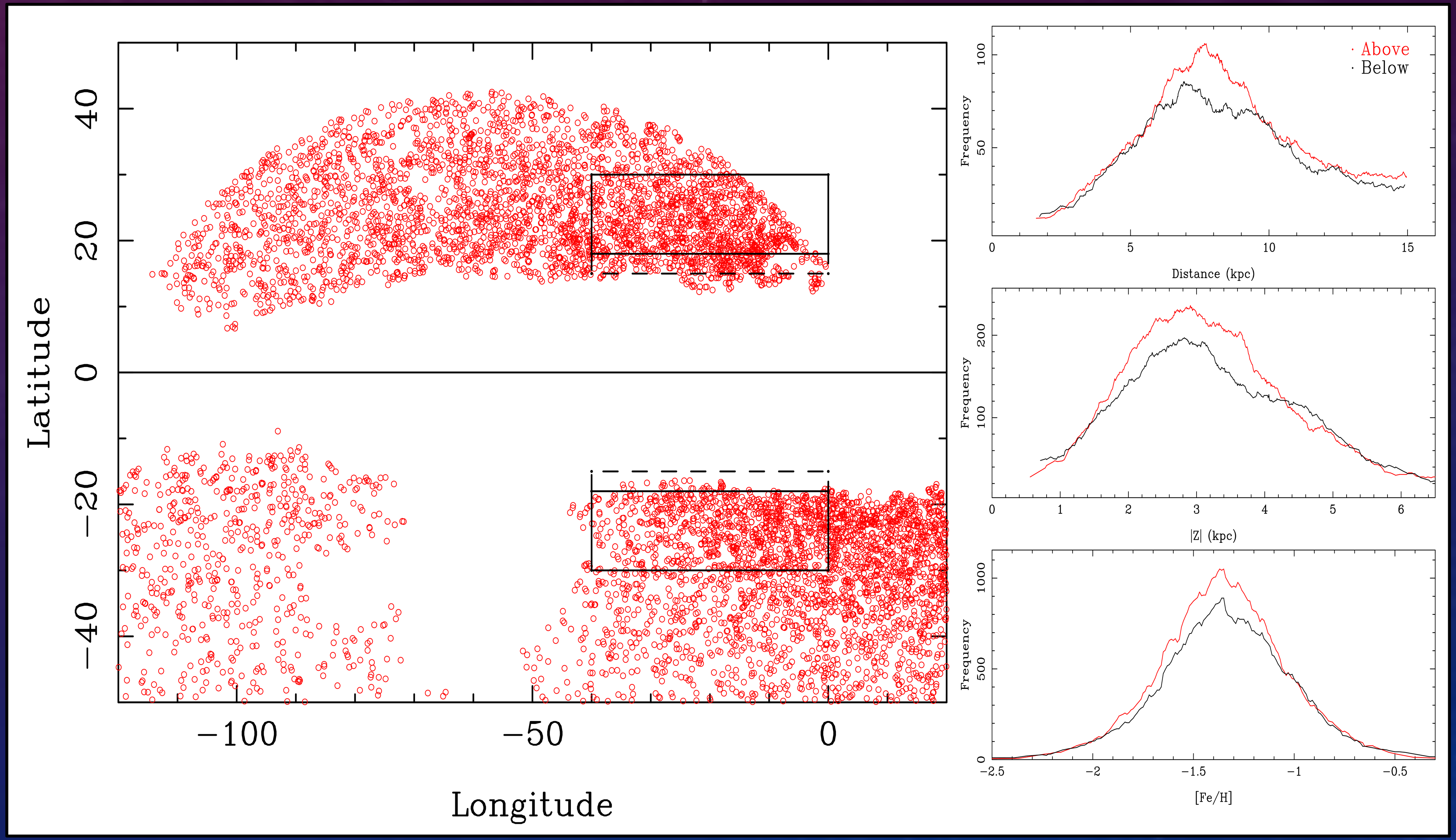

Figure 2. The Catalina South Survey provides us with a map of the inner galaxy that displays one significant RR Lyrae overdensity between -40 < *l* < 0 above the galactic plane from 18 < *b* < 30, which we examine here along with a symmetrical portion of the same square angle from -18 > *b* > -30. The sample is extended to 15 and -15 respectively for a more robust kinematical analysis.

Figure 3. Histograms of distance, distance from the plane and metallicity. The overdensity peaks at a heliocentric distance of approximately 8 kpc and about 3 kpc from the galactic plane. The metallicity distribution indicates that the above-plane sample consists predominately of stars with halo-like properties, and is more metal-poor than the below-plane sample.

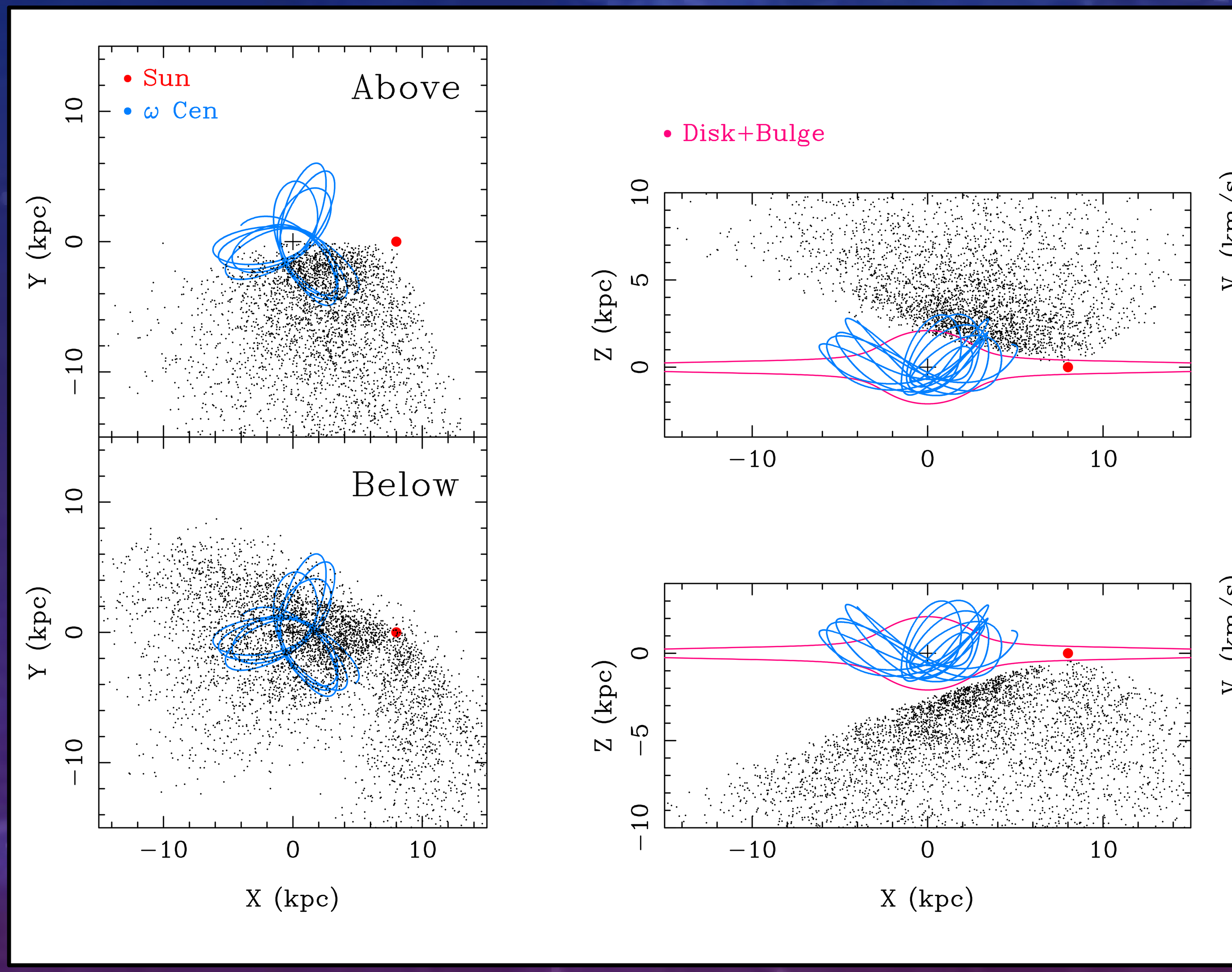

Figure 4. A face-on (left) and edge-on (right) view of the inner regions of the Galaxy. Dots represent the RR Lyrae stars, the orbit of w Cen is shown in blue, and the edge-on profile of the bulge and disk of the Galaxy are shown in pink. The location of the Sun is also shown with a red symbol.

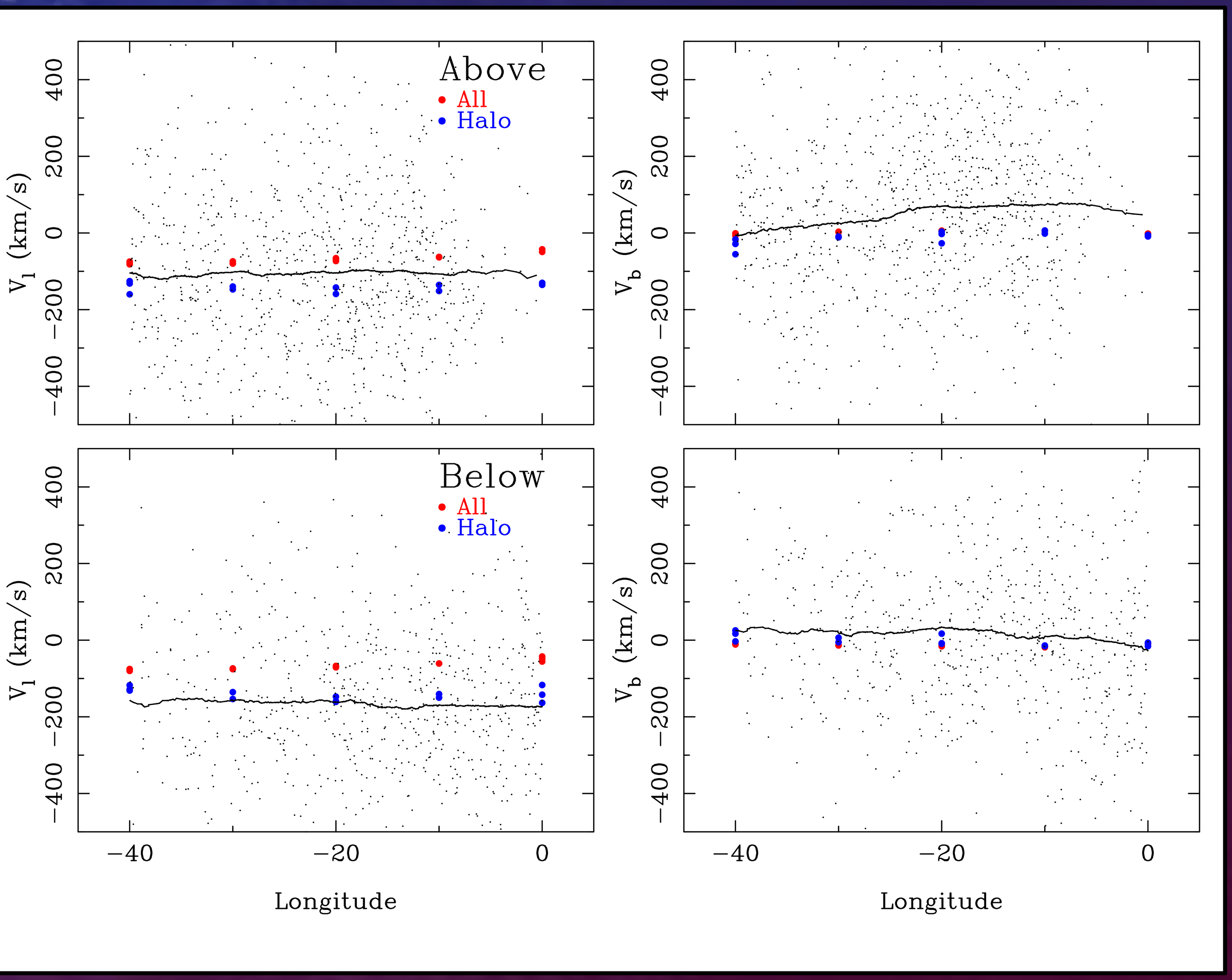

Figure 5. Transverse velocities along Galactic longitude *l* and latitude *b* for the samples above and below the plane. Black dots represent the RR Lyrae stars, and the line shows a moving median for each sample. The colored symbols represent predictions of the Besancon model for the halo population (blue) and the full stellar population, which is dominated by the disk (red).

Method

The Catalina South Survey matched with SPM 4 and mapped in galactic latitude and longitude displays one significant overdensity above the galactic plane. By mapping these stars we identify and analyze a sample of the overdensity and its symmetrical square angle, and trim the sample in those coordinates [Figure 2]. We find that the above-plane sample contains 911 RR Lyrae stars while the below-plane sample contains only 661, despite the above-plane sample missing a portion of its stars beginning at *l* = -15. These samples were also plotted as frequency distributions in heliocentric distance, |Z|, and metallicity [Figure 3]. The samples were then extended by 3 degrees in *b* and the RR Lyrae were analyzed kinematically by plotting their transverse velocities in both *l* and *b* by galactic longitude [Figure 5].

Results

The metallicity plots of the overdensity show that the RR Lyrae in the above-plane sample are more metal-poor [Figure 3], indicating that they have halo-like properties and are unlikely to have formed in the disk. In plotting the transverse velocities of these samples in *l* and *b* we find that observations and predictions agree with Besancon models for the below-plane sample, while they do not for the above-plane sample [Figure 5]. Our research indicates that the RR Lyrae in the above-plane sample are overabundant and have unusual kinematics. This suggests that the stars did not form in the galactic disk or inner halo, and were possibly part of a past galactic merger event.

References

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