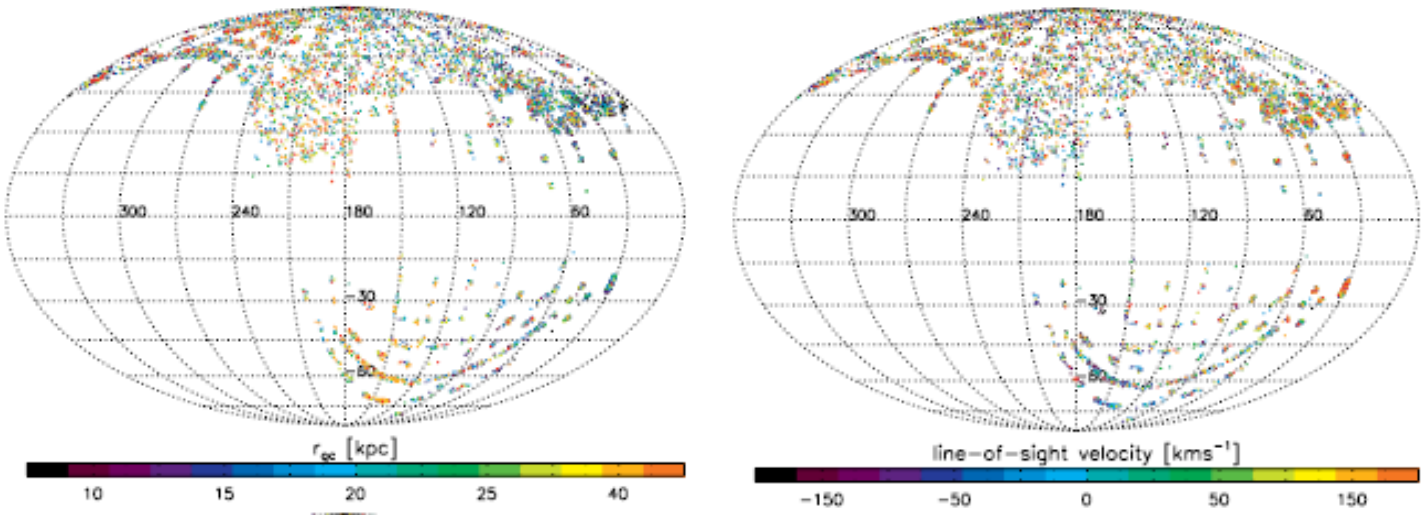
Joint Institute for Nuclear Astrophysics

Quantifying Kinematic Substructure in the Halo of the Milky Way



The distances and radial velocities of stars in the halo system of the Milky Way provide a powerful probe of the degree to which "clumpiness" exists, where it exists, and how it came to be. JINA researchers and their colleagues have analyzed the positions, distances, and radial velocities for over 4000 blue horizontal-branch (BHB) stars in the Milky Way's halo, drawn from SDSS DR8. They searched for position–velocity substructure in these data, a signature of the hierarchical assembly of the stellar halo. Using a cumulative "close pair distribution" as a statistic in the four-dimensional space of sky position, distance, and velocity, we quantify the presence of position–velocity substructure at high statistical significance among the BHB stars: **pairs of BHB stars that are close in position on the sky tend to have more similar distances and radial velocities compared to a random sampling of these overall distributions.**

Analogous mock observations of 11 numerical halo formation simulations, in which the stellar halo is entirely composed of disrupted satellite debris, demonstrated a level of substructure comparable to that seen in the actually observed BHB star sample. This result **quantitatively confirms the hierarchical build-up of the stellar halo t**hrough a signature in phase (position–velocity) space. In detail, the structure present in the BHB stars is somewhat less prominent than that seen in most simulated halos, quite possibly because BHB stars represent an older sub-population. BHB stars located beyond 20 kpc from the Galactic center exhibit stronger substructure than distances less than 20 kpc .

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