The Structure of the Milky Way

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Perspectives on Galactic Structure

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The Milky Way is currently the subject of great observational effort. This includes both ESA's unique Gaia mission, as well as a multitude of ground-based surveys. Several of these are already returning data of unprecedented depth and quality for large numbers of Milky Way stars. These new data are likely to lead to a quantum step in our understanding of Milky Way structure and evolution. Because the new data will allow us to study our Galaxy at much greater resolution than possible in other galaxies, we also expect to greatly improve our understanding of disk galaxy formation in general.

In this talk I gave an overview of the stellar components and the dark matter distribution in our Galaxy, concentrating on its inner regions. The Milky Way is a barred galaxy whose central bulge has a box/peanut shape and consists of multiple stellar populations. With dynamical equilibrium models for the bulge, bar, and inner disk based on recent survey data stellar masses have been determined for the different Galactic components. According to these models, about two thirds of the Milky Way's stellar mass is located inside $R \sim 5.3$ kpc, and the bulge has $\sim 25\%$ of the total stellar mass.

The best estimate of the pattern speed puts corotation at $R \sim 6.1 \pm 0.5$ kpc, only ~ 2 kpc inside the solar orbit. Combining the mass of dark matter determined in the bulge with the Galactic rotation curve near the Sun leads to the inference that the dark matter mass distribution in the Galaxy must have an inner ~ 2 kpc core or shallow cusp. Incoming proper motion data from the VVV survey and from Gaia will tighten these results significantly.

Chemo-dynamical equilibrium models for the bulge and bar show a strongly barred distribution of the metal-rich stars, and a radially varying dynamics of the metal-poorer stars: these correspond to a thick disk-bar outside ~ 1 kpc, but change to an inner centrally concentrated component whose origin is presently not clear. APOGEE data have similarly shown an inside-out gradient in the surface density distributions of disk stars with metallicity. From on-going ground-based surveys and the Gaia data we expect large progress in charting the Galactic disk around the Sun, the Milky Way's spiral arms, and the chemo-kinematics of disk stars, as well as in understanding the dynamics and evolution of the Galactic disk.

Similarly, mapping the multiple substructures in the Galactic stellar halo from these new data, as well as mapping the Galactic gravitational potential and, thus, the gravitational mass distribution of the dark matter halo on large scales, are amongst the primary goals of the Gaia mission and of Galactic research. This work has already begun and significant progress is expected in the coming years. The ability of carrying this work out in depth based on star-by-star data will make the Milky Way a unique case for studying how similar galaxies form and evolve.

References

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