# Dissecting the Milky Way with the SDSS

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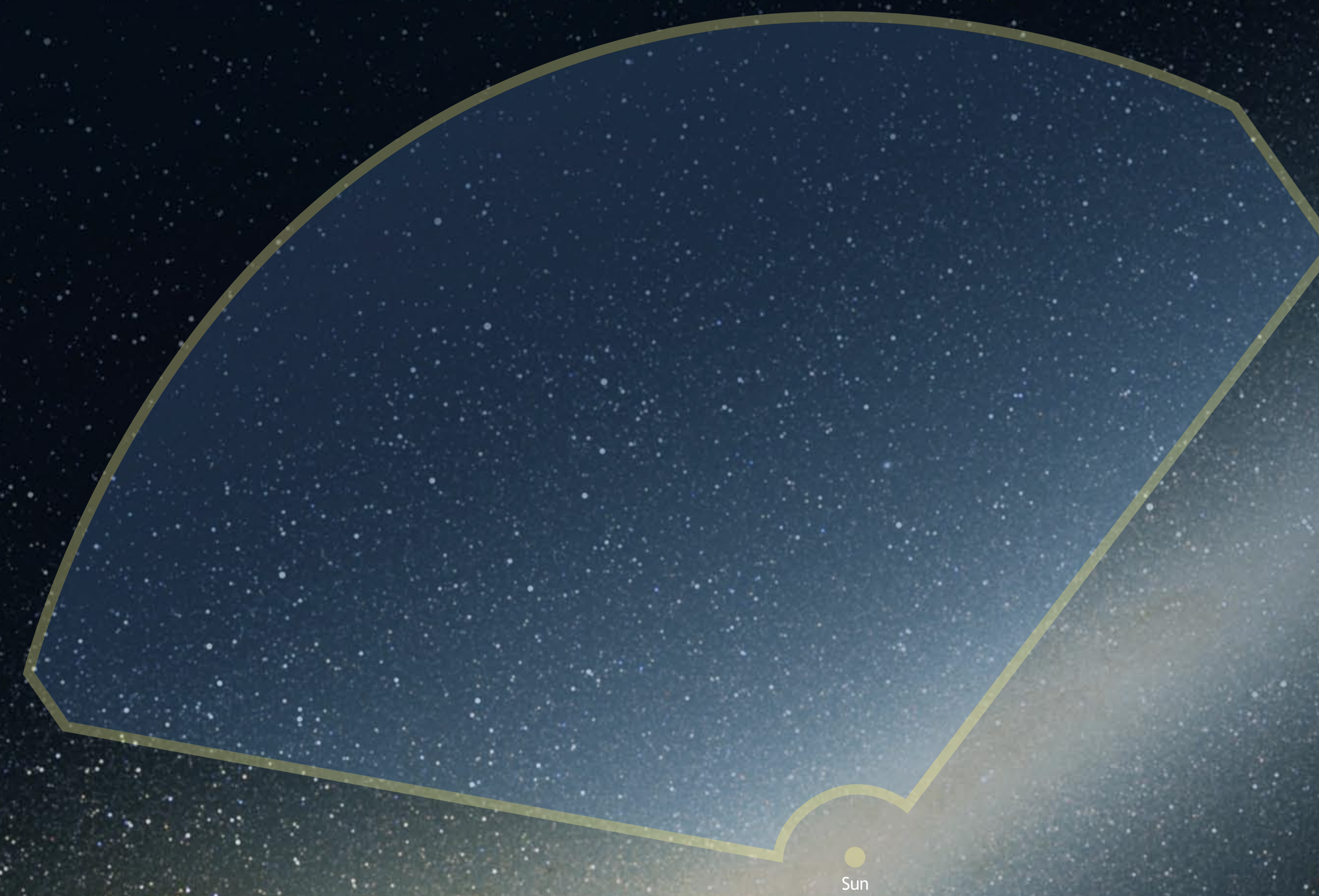
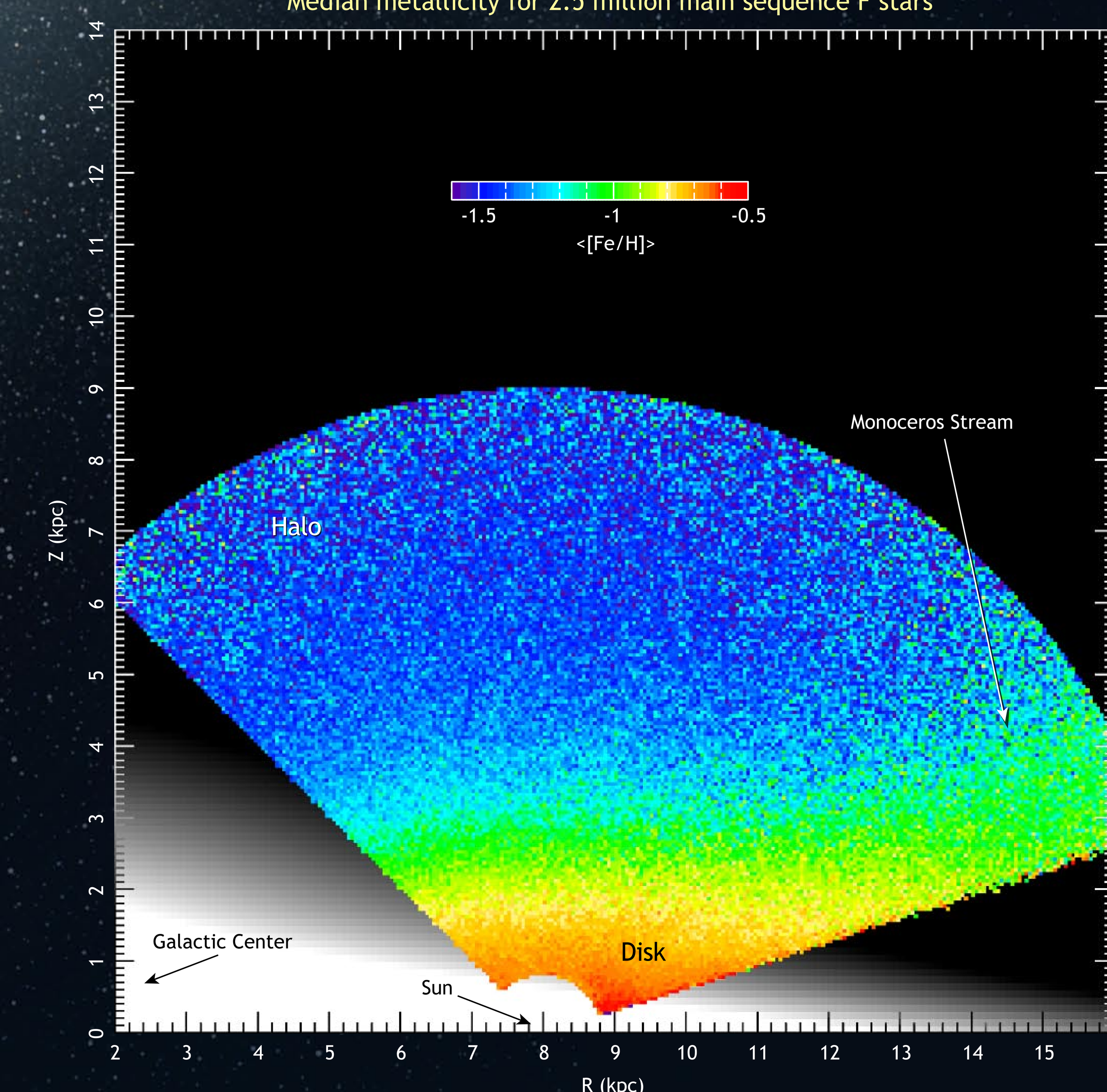
The spatial distribution of the Milky Way stars as a function of their metallicity and kinematics encodes information about the formation and evolution of the Galaxy. Traditionally, samples of stars with such measurements were often biased, included small number of stars, and did not extend very far beyond the Solar Neighborhood. The metallicity map shown here is produced using photometric metallicity and distance estimates based on imaging data from the Sloan Digital Sky Survey (SDSS). The map is based on data for an essentially complete sample of 2.5 million main-sequence F stars within 10 kpc from the Sun, and represents the most complete and detailed map yet of the chemical composition in the Milky Way.

Photometric metallicity estimates are calibrated using SDSS spectroscopic data for about 100,000 stars. In addition to distance and metallicity estimates, proper motion measurements based on SDSS and the Palomar Observatory Sky Surveys are available for practically all stars. The metallicity and kinematic maps reveal, in dramatic fashion, the differing content of metals and different rotational velocity distributions for disk and halo stars in our Galaxy. With these new SDSS maps, astronomers can begin to tackle many unsolved mysteries about the birth and growth of the Milky Way. The paper describing the construction and analysis of these maps is available from http://lanl.arxiv.org/abs/0804.3850




The panel on the right shows the dependence of the median metallicity for about 2.5 million main sequence F stars observed by the SDSS, as a function of the position in the Milky Way galaxy (a cylindrical coordinate system, R and Z, is aligned with the Galactic center; the midplane of the Galactic disk corresponds to Z=0 and is perpendicular to the image plane; the Sun is at R=8 kpc and Z=0 kpc). The median metallicity, color-coded as shown in the inset, is evaluated for about 8,000 pixels (0.1 kpc by 0.1 kpc), with a median of 120 stars per pixel (the full range is 5-1000). The metallicity is estimated using colors obtained by the SDSS imaging survey and the metallicity-color relation is calibrated using SDSS spectroscopic survey.

Median metallicity for 2.5 million main sequence F stars



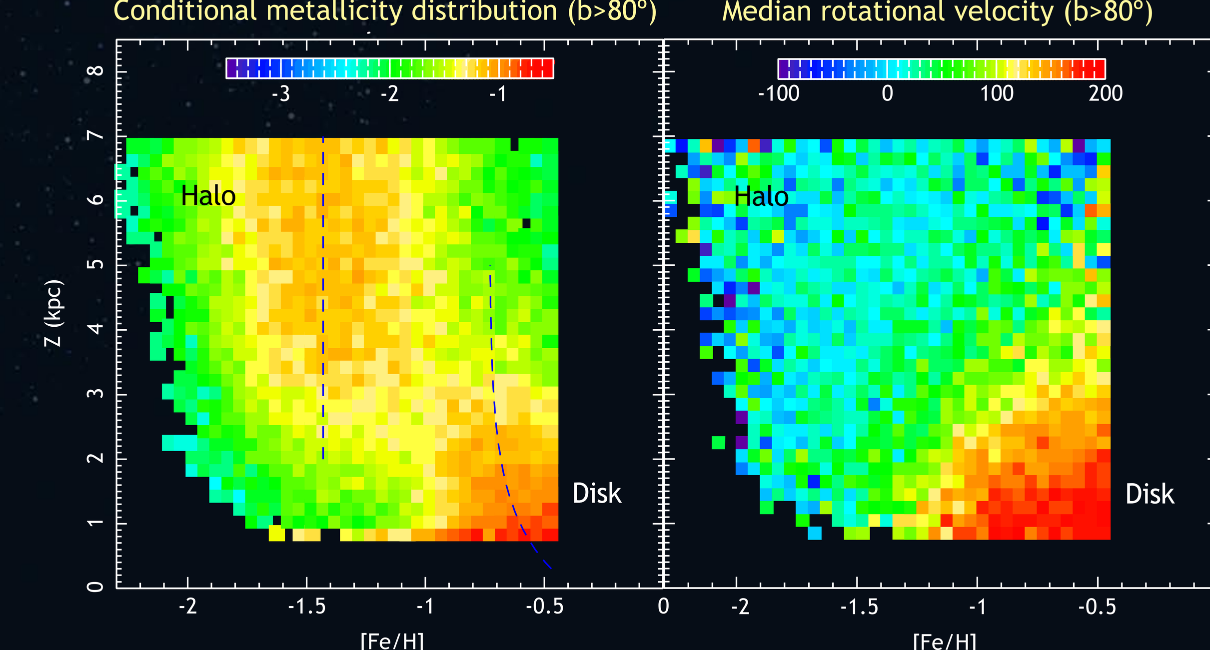

Stars that formed early in the life of the Galaxy are expected to have low metallicity (below about -1), while younger stars have higher metallicity due to the chemical enrichment of gas by older generations of stars. The data clearly delineate the high-metallicity disk region from the low-metallicity halo region. The only deviation from the overall smooth decrease of the median metallicity (with the distance from the Galactic plane) is observed in the region around the Monoceros stream. This stream is a remnant of a galaxy cannibalized by the Milky Way, and includes stars that have metallicities higher than halo stars, but lower than disk stars.

The lower left panel shows the full metallicity distribution, as a function of the distance from the Galactic plane, for about 60,000 stars within 10 degrees from the North Galactic Pole. The distribution is displayed on a logarithmic scale and color-coded as shown in the inset. Two distinct Galaxy components, the halo and the disk, are evident. High-metallicity disk stars dominate close to the plane, while low-metallicity halo stars dominate beyond 3 kpc from the plane. The dashed lines mark the median metallicity of each component. The median metallicity for disk stars shows a gradient, while halo stars have spatially invariant metallicity distribution.

These two components with distinct metallicity distributions also have different kinematics. The lower right panel shows the median rotational velocity component for the same stars as in the lower left panel. The velocity is determined from displacements of stars on the sky over half a century that lapsed between the Palomar Observatory Sky Survey in the 1950s and the SDSS. The high-metallicity disk stars have large rotational velocity (about 200 km/s, see the inset), while the low-metallicity halo stars display behavior consistent with no net rotation. The rotational velocity for disk stars decreases with the distance from the Galactic plane, while it is constant for halo stars, similarly to the behavior of their metallicity distributions.

Conditional metallicity distribution (b>80°)

Median rotational velocity (b>80°)




Background image: 2MASS/J. Carpenter, T. H. Jarrett, & R. Hurt