Dissecting the Milky Way with LSST

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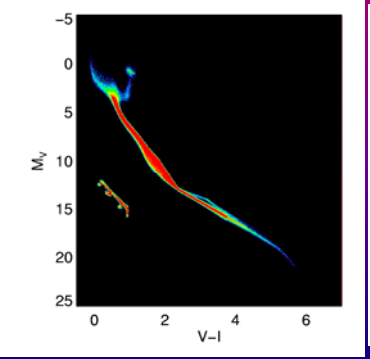
Large Synoptic Survey Telescope

The LSST will produce an accurate multi-color digital map of half the sky down to V~27.5. Accurate colors will allow the estimate of photometric distance, and hence the three-dimensional number density distribution, for over a billion main-sequence stars, to a distance limit of 100 kpc. This final deep map will be based on several hundred observations (to V~24.5) spread over ten years that will enable proper motion measurements accurate to 0.2 mas/yr (corresponding to 10 km/s at 10 kpc) and geometric parallax measurements accurate to 1 mas. We use models and extrapolate a similar study based on SDSS data (V<21.5) to illustrate how LSST will enhance the detailed knowledge of our Galaxy.

What are the fundamental properties of all stars within 200 pc of the Sun?

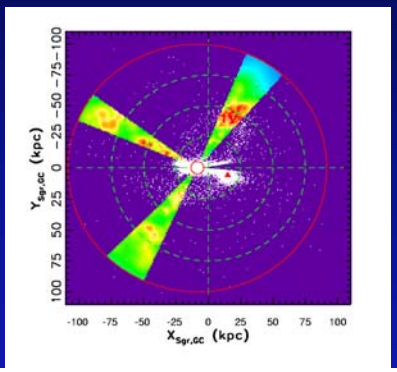
Astrometric tools:

- **Parallax: 2 - 4 mas positional accuracy per observation will yield 10% distances out to 250 - 500 pc by end of survey for stars near the H-burning limit**
- **Sensitivity to wiggles: binary orbits will be measured in systems with orbital periods up to 40 years, allowing clear separation of binary sequence**

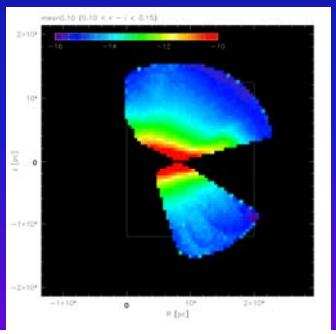


Simulation of the stellar populations detectable by LSST within 200 pc of the Sun. Stars with parallax errors <10% and photometric errors < 0.1 magnitudes are plotted in this image representation of a color-magnitude diagram, where warm colors denote increasingly high densities of stars. The simulation follows the Galactic disk star formation history of Bertelli & Nasi (2001), and incorporates the stellar IMF measured by Reid, Gizis, & Hawley (2002) and the substellar IMF of Burgasser (2004). V and I magnitudes for the 1.1×10^6 objects were calculated using the Girardi et al. (2000) stellar isochrones, the white dwarf models of Richer et al. (2000), and the Baraffe et al. (2003) isochrones for substellar masses. The simulation assumes that all stars are uniformly distributed within the volume.

LSST limit for RR Lyrae: 400 kpc



The structure of the outer Milky Way (Ivezic et al. 2003). The number density multiplied by the cube of the galactocentric radius for 923 SDSS candidate RR Lyrae stars within 10° from the Sgr dwarf tidal stream plane. The solid circles show the sample distance limits (5 kpc and 100 kpc). The dashed circles are centered on (X=0,Y=0), and have radii of 25, 50, and 75 kpc. The triangle marks the position of the Sgr dwarf core.The clumps at (X,Y) of (20,-35) and (-20,25) are definitely associated with the tidal stream, as is discernible from the distribution of 2MASS M giants (Majewski et al. 2003), shown as the white dots. Other clumps, while consistent with being part of the stream, could also be unrelated super-Poissonian fluctuations, such as those suggested by Bullock et al. (2001). LSST will extend such mapping to about 50 times larger volume.



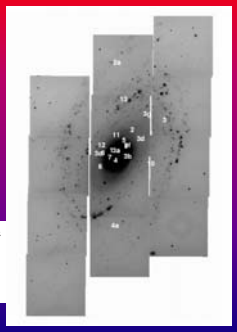
The structure of the inner Milky Way (Juric et al. 2005). The space density of Galactic main sequence stars detected by SDSS, selected by the criterion $0.10 < r' - i' < 0.15$, is displayed logarithmically in this edge-on view of the Milky Way. The center of the galaxy is at R=0, z=0; while the Sun is at $R=8.5 \times 10^3$ pc. The shapes of the thin and thick disks are clearly seen, while the outer edges of the thick disk appear disturbed, perhaps marking the transition to the halo. LSST will produce a similar map out to distances of 100 kpc, a volume currently only available to the much less numerous RR Lyrae stars in SDSS and M giants in 2MASS.

What is the history of galactic cannibalism?

Tools:

- **Novae as tracers of stripped material**

Expect ~2000 intergalactic novae to be detected by LSST out to distance of Virgo; these trace the older stellar populations that have been torn out in interactions



The distribution of classical novae in M81. 19 novae discovered by Neill & Shara (2004) are shown in this image. The majority of the novae are concentrated towards the bulge, indicating that the novae are tracers of older populations. There also appears to be an asymmetry in the distribution along the major axis of the galaxy.

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