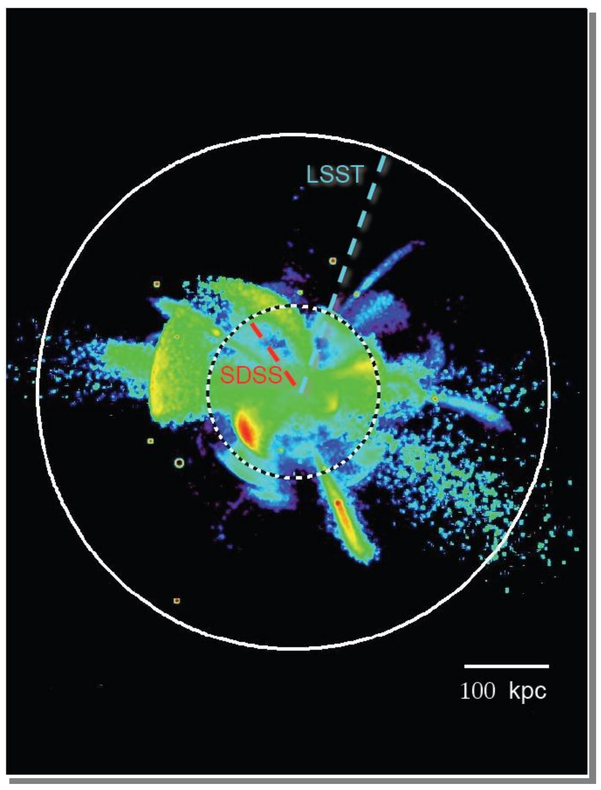
Large Synoptic Survey Telescope

Mapping the Milky Way with LSST

J. Bullock (UC Irvine) and the LSST Milky Way Structure Science Collaboration

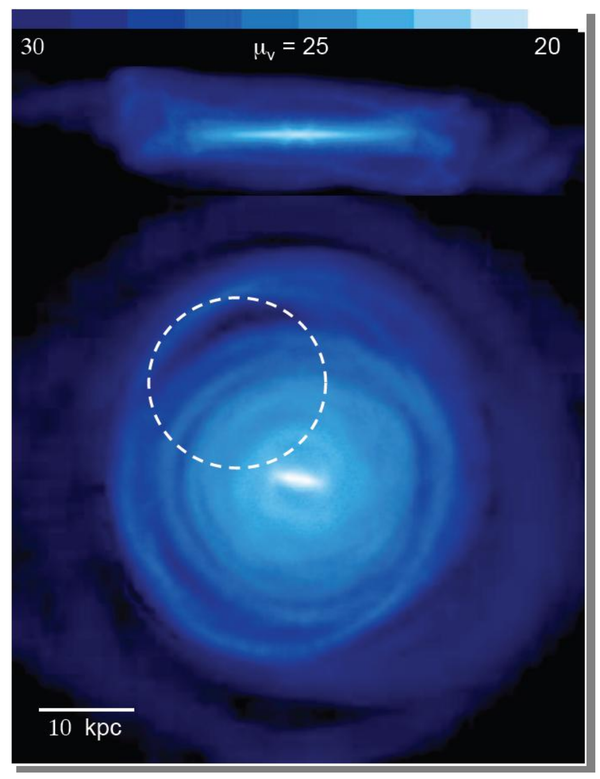
The multicolor, multi-epoch photometric map created by the LSST will provide an unprecedented means to explore the Galaxy's structure, star formation, chemical enrichment, and accretion history on a panoramic scale. Strategic time and space sampling of each field over ten years will allow variability, proper motion and parallax measurements for objects brighter than V=24, and the final map will cover half the sky to V=26.5. This combination of area, depth and time resolution will enable Galactic science from the solar neighborhood to the edge of the Milky Way's halo and well into the Local Group. The data set will provide a powerful laboratory for testing theories of galaxy formation and the small-scale predictions of CDM cosmology.



Structure of the Outer Milky Way:

Left: Star density multiplied by radius cubed from the stellar halo simulations of Bullock & Johnston (2005). LCDM predicts that the Milky Way should have accreted and destroyed hundreds of small dwarf galaxies in the past 10 Gyr. The residue of this process survives as structure in the outer halo. Overdensities of this kind have been revealed by SDSS star count studies (e.g. Bell et al. 2007), including RR Lyrae stars to a distance of 100 kpc (Ivezic et al. 2003).

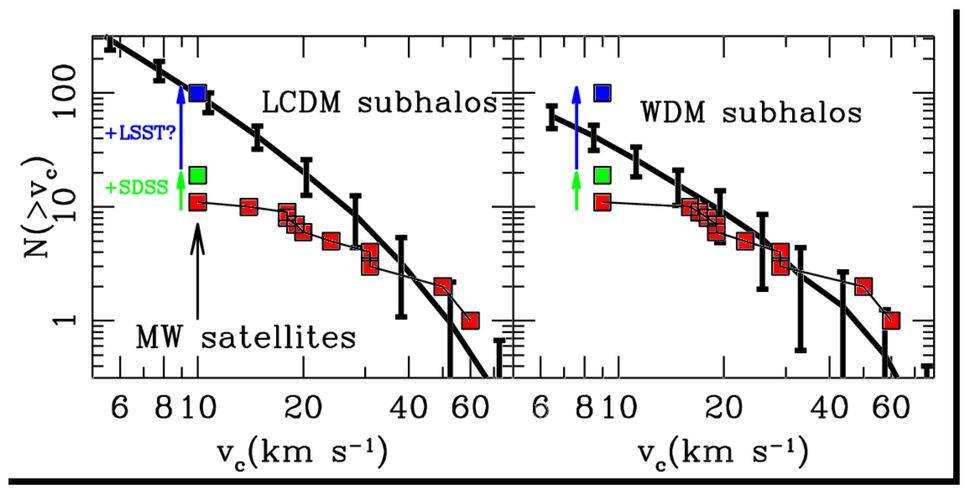
- LSST will detect RR Lyrae to 400 kpc, extending the SDSS mapping area by a factor of 50. This will provide an important test of the small-scale accretion history of the Galaxy and a test of LCDM.
- RR Lyrae maps and related main sequence star counts with kinematics will allow precise measurements of the Milky Way dark halo potential.



Structure of the Inner Milky Way:

Left: Surface brightness maps from a disk galaxy simulation by Kazantzidis et al. (2007). Faint, complex structures arise from its hierarchical merging history. Star count maps offer a unique means to constrain theories by revealing detailed features. The first generation of studies have found similar structures in the Milky Way and M31 (Newberg et al. 2002, Ferguson et al. 2002, Juric et al. 2005).

- LSST will provide photometric parallaxes for over a billion main sequence stars to 100 kpc and map the Galaxy's surroundings to high precision.
- Time series data will provide proper motions at ~10 km/s at 10 kpc (dashed circle) and chemical abundance estimates for main sequence stars. Multi-dimensional maps will produce a phase-space record of the Galaxy's formation history.



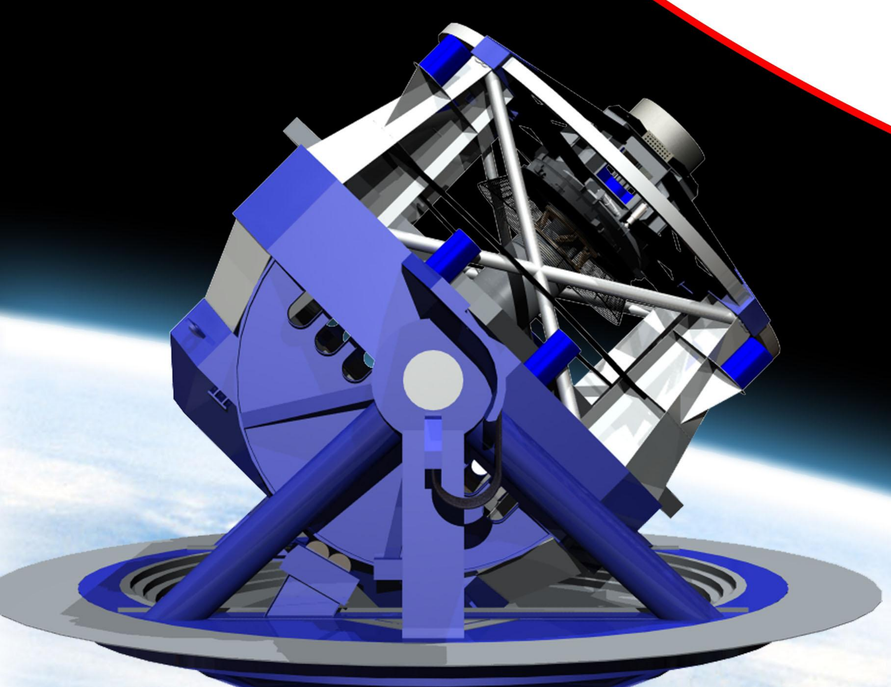
Dwarf Satellites and the Nature of Dark Matter:

Left: Predictions for the dark subhalo velocity function in Milky-Way size halos for LCDM (σ_8=0.83, left panel) and WDM (right panel) from Zentner & Bullock (2003). Red squares show the cumulative dwarf satellite count prior to SDSS. The green square includes 11 new low-surface brightness dwarf spheroidals discovered using star counts in SDSS maps (e.g. Willmann et al. 2005, Belokurov et al. 2007).

- Fainter star count maps over more sky will allow LSST to reveal new dwarfs as stellar overdensities. This possibility is represented by the blue square in the figures.
- A more complete census of the Milky Way satellites will help elucidate the nature of the dwarf satellite problem facing CDM. The current count (green) is close to the WDM prediction and new discoveries may potentially rule out interesting WDM models.

References:

Bell, E. et al. 2007, arXiv:0706.0004
Belokurov, V. et al. 2007, ApJ 654, 891
Bullock, J. S. & Johnston, K. V. 2005, ApJ 635, 931
Ferguson, A. M. N. et al. 2002, AJ 124, 1452
Ivezic, Z. et al. 2003, astro-ph/030905
Juric, M. et al. 2005, astro-ph/0510520
Kazantzidis, S., Bullock, J. S., Zentner, & Kravtsov, A. V., 2007, arXiv:0708.1949
Willmann, B. et al. 2005, ApJ, 626, L85
Zentner, A. R. & Bullock, J. S. 2003, ApJ, 598, 49



LSST is a public-private partnership. Design and development activity is supported by in part the National Science Foundation under Scientific Program Order No. 9 (AST-0551161) and Scientific Program Order No. 1 (AST-0244680) through Cooperative Agreement AST-0132798. Portions of this work are supported by the Department of Energy under contract DE-AC02-76SF00515 with the Stanford Linear Accelerator Center, contract DE-AC02-98CH10886 with Brookhaven National Laboratory, and contract W-7405-ENG-48 with Lawrence Livermore National Laboratory. Additional funding comes from private donations, grants to universities, and in-kind support at Department of Energy laboratories and other LSSTC Institutional Members.

Brookhaven National Laboratory, California Institute of Technology, Columbia University, Google, Inc., Harvard-Smithsonian Center for Astrophysics, Johns Hopkins University, Kavli Institute for Particle Astrophysics and Cosmology - Stanford University, Las Cumbres Observatory Inc., Lawrence Livermore National Laboratory, National Optical Astronomy Observatory, Princeton University, Purdue University, Research Corporation, Stanford Linear Accelerator Center, The Pennsylvania State University, The University of Arizona, University of California at Davis, University of California at Irvine, University of Illinois at Urbana-Champaign, University of Pennsylvania, University of Pittsburgh, University of Washington