Supernova Science and Cosmology with LSST

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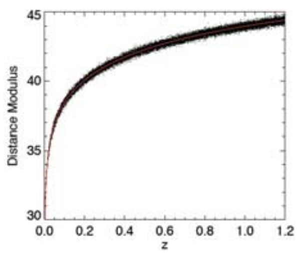
The LSST will open up new opportunities for supernovae and supernova cosmology through the discovery of hundreds of thousands of Type Ia supernova out to and above redshifts of 1. This redshift range will allow for precise investigations of the equation-of-state parameter of dark energy out to a redshift of 1. While the concern for future supernova cosmology experiments is generally with the systematics rather than quantity of supernovae, the unprecedented number of supernovae that will be found by the precisely-calibrated LSST system will provide a means to detect and calibrate many of these important systematic effects. Supernovae of all types will be discovered by LSST and we anticipate that the wealth of data provided will allow many questions of supernova progenitor and late-stage stellar evolution to be addressed by a combination of the supernovae found by the LSST extra-galactic survey and the survey of the billions of stars in our own galaxy. We present here the expected numbers, distribution, and coverage of supernovae based on the nominal LSST cadence program and discuss the opportunities for supernova and cosmological science from the resulting rich supernova data set.

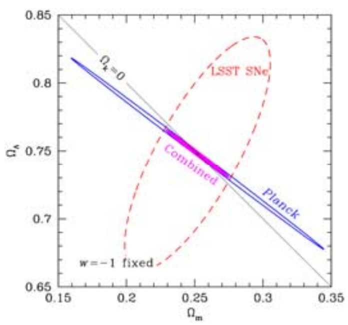
Cosmology

Expansion

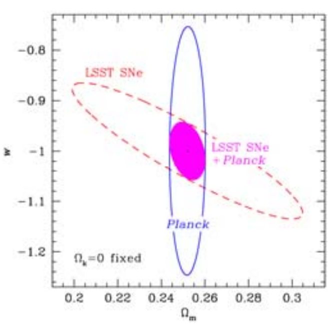


LSST will deliver the ultimate ground-based Hubble diagram with hundreds of thousands of SNe Ia out to a redshift of 1. This will allow precision measurements of the composition of the Universe and the nature of dark energy.

Composition



Dark Energy



Supernova

Properties and Progenitors

Statistical studies of the host properties as a function of SN Ia characteristics will provide clues to the SN Ia progenitor(s). The large sample will permit a study of the evolution of SN Ia properties with redshift that may further reduce systematic errors in the estimate of the dark energy equation of state.

Cosmic Structure

With so many SNe Ia LSST will be able to probe higher-order variations by looking for angular correlations in various redshift. This will allow for the tracing the substructure with largerly different systematics than BAO or weak lensing.

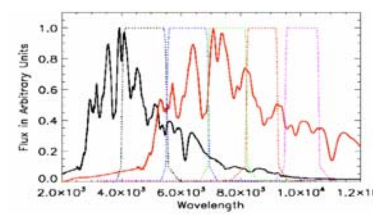
Rates

The discovery of millions of SNe of all types in a systematic fashion will allow for unprecented precision in the determination of supernova rates and a corresponding investigation of star formation and galaxy evolution.

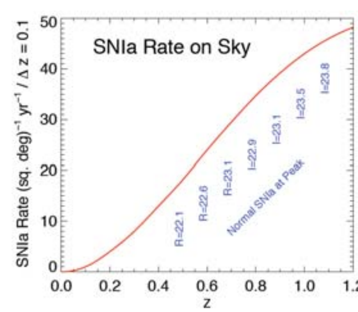
Analysis Techniques

Photometric Typing and Redshifts

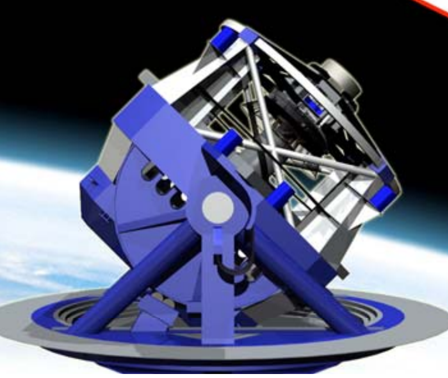
Maximizing the use of one million SNe Ia will require the use of photometric typing and redshifts. These present several challenges, but with well-chosen spectroscopic sub-samples with additional spectroscopic resources or from precursor missions such as Pan-STARRS and SkyMapper we believe photometric redshifts will be determined to 0.01 with a non-SNe Ia contamination rate of < 1% and a photo z residual bias of < 0.0014. The LSST SN Science Team is focusing on this challenge as a key issue to explore in the next two years.



Above: The filter set of LSST plotted together with SNe Ia spectra at optical maximum, at redshift zero (black solid line) and at redshift of 0.8 (red solid line). The band passes are sketched in dotted lines for g (black), r (blue), i (green), z (red), and Y (purple).



Type Ia Supernovae Are Plentiful: There are 200 SNe Ia per square degree per year out to z=1.



The effort to build the Large Synoptic Survey Telescope is overseen by the LSST Corporation, a non-profit 501(c)3 corporation formed in 2003, with headquarters in Tucson, AZ. The LSST research and development effort is funded in part by the National Science Foundation under Scientific Program Order No. 9 (AST-0551161) through Cooperative Agreement AST-0132798. Additional funding comes from private donations, in-kind support at Department of Energy laboratories and other LSSTC Institutional Members.

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