

Preface

Major advances in our understanding of the Universe over the history of astronomy have often arisen from dramatic improvements in our ability to observe the sky to greater depth, in previously unexplored wavebands, with higher precision, or with improved spatial, spectral, or temporal resolution. Aided by rapid progress in information technology, current sky surveys are again changing the way we view and study the Universe, and the next-generation instruments, and the surveys that will be made with them, will maintain this revolutionary progress. Substantial progress in the important scientific problems of the next decade (determining the nature of dark energy and dark matter, studying the evolution of galaxies and the structure of our own Milky Way, opening up the time domain to discover faint variable objects, and mapping both the inner and outer Solar System) all require wide-field repeated deep imaging of the sky in optical bands.

The wide-fast-deep science requirement leads to a single wide-field telescope and camera which can repeatedly survey the sky with deep short exposures. The Large Synoptic Survey Telescope (LSST), a dedicated telescope with an effective aperture of 6.7 meters and a field of view of 9.6 deg^2 , will make major contributions to all these scientific areas and more. It will carry out a survey of $20,000 \text{ deg}^2$ of the sky in six broad photometric bands, imaging each region of sky roughly 2000 times (1000 pairs of back-to-back 15-sec exposures) over a ten-year survey lifetime.

The LSST project will deliver fully calibrated survey data to the United States scientific community and the public with no proprietary period. Near real-time alerts for transients will also be provided worldwide. A goal is worldwide participation in all data products. The survey will enable comprehensive exploration of the Solar System beyond the Kuiper Belt, new understanding of the structure of our Galaxy and that of the Local Group, and vast opportunities in cosmology and galaxy evolution using data for billions of distant galaxies. Since many of these science programs will involve the use of the world's largest non-proprietary database, a key goal is maximizing the usability of the data. Experience with previous surveys is that often their most exciting scientific results were unanticipated at the time that the survey was designed; we fully expect this to be the case for the LSST as well.

The purpose of this Science Book is to examine and document in detail science goals, opportunities, and capabilities that will be provided by the LSST. The book addresses key questions that will be confronted by the LSST survey, and it poses new questions to be addressed by future study. It contains previously available material (including a number of White Papers submitted to the ASTRO2010 Decadal Survey) as well as new results from a year-long campaign of study and evaluation. This book does not attempt to be complete; there are many other scientific projects one can imagine doing with LSST that are not discussed here. Rather, this book is intended as a first step in a collaboration with the world scientific community to identify and prepare for the scientific opportunities that LSST will enable. It will also provide guidance to the optimization and

implementation of the LSST system and to the management and processing of the data produced by the LSST survey.

The ten LSST Science Collaborations, together with others in the world astronomy and physics community, have authored this Science Book; the full list of over 200 contributors may be found in [Appendix D](#). These collaborations perform their work as semi-autonomous organizations in conjunction with the LSST Project, and provide access to the LSST and its support infrastructure for large numbers of scientists. These scientists are laying the groundwork necessary to carry out LSST science projects, defining the required data products, and developing optimal algorithms and calibration strategies for photometry, astrometry, photometric redshifts, and image analysis. Membership in the science collaborations is open to staff at the member institutions, and two US community-wide open call for applications for membership have already been issued. There will be regular future opportunities to join the science collaborations.

This Science Book is a living document. Our understanding of the scientific opportunities that LSST will enable will surely grow, and the authors anticipate future updates of the material in this book as LSST approaches first light.

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