Precision Distance Measurement with the Space Interferometry Mission

Stephen C. Unwin
Jet Propulsion Laboratory, California Institute of Technology,
4800 Oak Grove Drive, Pasadena, CA 91109
e-mail: unwin@huey.jpl.nasa.gov; WWW: http://sim.jpl.nasa.gov/sim/

May 25, 1998

Abstract

The Space Interferometry Mission (SIM) will be NASA's first space-based long-baseline optical interferometer. SIM will produce a wealth of new astronomical data and serve as a technology pathfinder for future astrophysics missions. The SIM architecture uses a 10-m Michelson interferometer in Earth-trailing solar orbit to provide 4 microarcsecond (μas) precision absolute position measurements of stars down to 20 magnitude. The corresponding parallax accuracy allows distance measurements to 10% accuracy at 25 kpc. SIM will achieve a proper motion accuracy of about 2 $\mu\mathrm{as\,yr}^{-1}$ during its 5-year lifetime, equivalent to 10 $\mathrm{m\,s}^{-1}$ at 1 kpc. This sensitivity will allow SIM to perform an astrometric (reflex motion) search for low-mass planets around a large sample of nearby stars. Combining distances and proper motions measured using SIM with ground-based radial velocity data provides a powerful tool for stellar dynamics. Using samples of stars in the Galactic disk and the halo as tracers, SIM will address a variety of questions relating to the formation and dynamics of the Galaxy.

In addition to precision astrometry, SIM will produce images with a resolution of 10 milliarcsec, equivalent to a diffraction-limited optical aperture of 10 meters. It will also demonstrate interferometric nulling with suppression of the on-axis starlight to a level of 10^{-4}.

SIM will allow us to measure distances to many stellar constituents of the Galaxy with unparalleled accuracy. Many of these, such as Cepheids, RR Lyrae stars, open clusters, globular clusters, novae and planetary nebulae, play a crucial role in the development of the cosmic distance scale. Precision distance will allow a better understanding of subtle effects on luminosity calibration due to metallicity, reddening, etc.