Wide-Field InfraRed Survey Telescope (WFIRST)

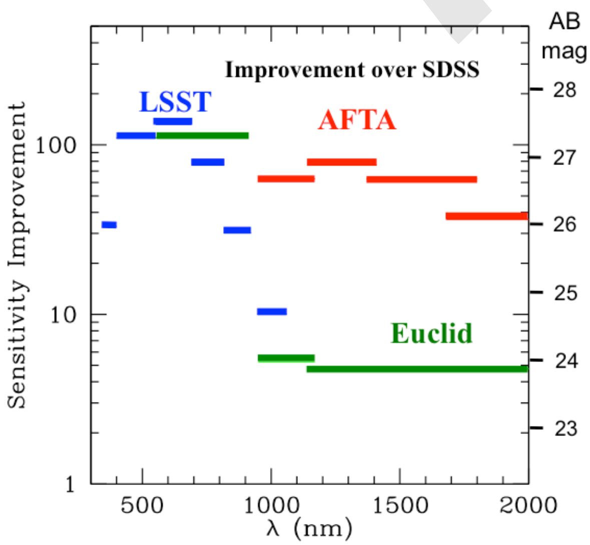
The Wide-Field Infrared Survey Telescope (WFIRST) is the top-ranked large space mission from the Astro2010 Decadal Survey. It is a NASA observatory designed to settle essential questions in the areas of dark energy, exoplanets, and infrared astrophysics. Strategic key science programs plus guest observer and guest investigator programs are featured, as described here.

A Science Definition Team and a Study Office at the Goddard Space Flight Center and Jet Propulsion Laboratory are studying the mission. Past studies have included versions with telescope primary mirror sizes of 1.1 m, and 1.3 m. The current study uses an existing telescope with a 2.4 m primary mirror recently transferred to NASA. The 2.4 m version, called “Astrophysics Focused Telescope Assets” (AFTA) is significantly more capable, enabling gains in science of 50-100%, over the smaller versions. The 2.4 m version also enables the addition of a coronagraph for direct imaging of exoplanets.

Dark Energy

The discovery that the Universe’s expansion is accelerating was described by the journal Science as one of the most important scientific problems of our time and was the topic of the Nobel Prize physics awards of 2011. The implication that three quarters of the mass-energy in the Universe is due to an unknown entity, called “dark energy,” may revolutionize cosmology and physics when this phenomenon is fully understood through observations by WFIRST-AFTA.

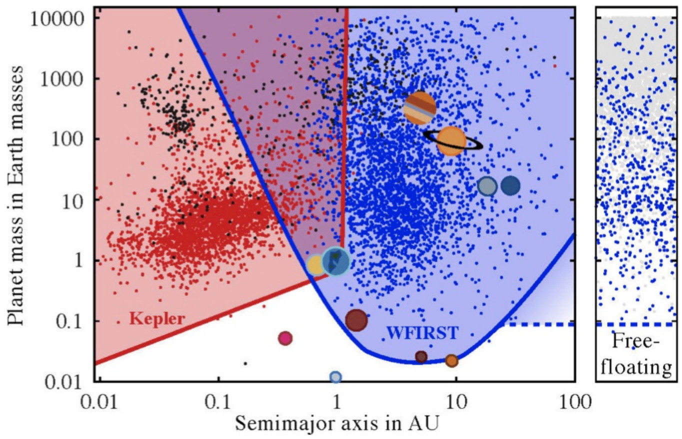
WFIRST-AFTA will perform precision measurements to probe the dark energy equation of state, test the validity of General Relativity, and make an order of magnitude step forward in dark energy studies. These measurements will be conducted using several different techniques. Baryon Acoustic Oscillations and Redshift Space Distortions: Quantifying the density and distribution of baryonic matter in the universe, as well as cataloging both the expansion history and growth of cosmic structure requires a spectroscopic survey to measure accurate redshifts and positions of large numbers of galaxies. Type Ia Supernovae: This technique uses SN Ia’s as “standard candles” to measure absolute distances. Patches of the sky are monitored to discover supernovae and measure their light curves and spectra. Weak Gravitational Lensing. This technique exploits the fact that images of very distant galaxies are distorted by the bending of light as it passes more nearby mass concentrations. These distortions are measured to infer the evolution of matter and the laws of gravity on large spatial scales.



Sensitivity comparison of WFIRST, LSST and Euclid showing WFIRST near-IR sensitivity that is several magnitudes deeper than Euclid and comparable to LSST and Euclid visible sensitivities.

Exoplanets

The discovery of well over 1000 confirmed (and thousands of candidate) planets orbiting other stars, in solar systems quite different from our own planetary system, is inspiring observers and theoreticians to understand how they were formed, how they evolve, and ultimately whether there are any Earth-like planets on which we might someday search for signs of life. Discovering the statistics of exoplanets via microlensing is crucial for understanding the prevalence and formation of Earth-like planets. Imaging of planetary disks and planets via coronagraphy will give direct observations of individual solar systems that are near neighbors to our Sun.



WFIRST microlensing measurements and Kepler transit measurements cover complementary parameter regions for planetary systems. Only WFIRST will detect free-floating exoplanets.

Exoplanet Detection by Microlensing

Gravitational microlensing is based on Albert Einstein's general theory of relativity. More than 20 planets have been discovered from the ground using this technique. The WFIRST-AFTA microlensing survey has the potential to detect thousands of planets, including smaller-mass planets since the spike will be more likely observed from a space-based platform. This will lead to a statistical census of exoplanets with masses greater than a tenth of the Earth at distances 0.5 AU and beyond. The WFIRST-AFTA microlensing survey will complement the exoplanet statistics from Kepler, and will provide invaluable information about planet formation, evolution, and prevalence in the galaxy.

Exoplanet Direct Imaging by Coronagraphy

A coronagraph instrument is part of the payload for the 2.4 m WFIRST-AFTA mission concept. The larger mirror provides a finer angular resolution, enabling meaningful coronography. The goal of WFIRST-AFTA is to directly observe planetary disks and giant planets at distances of 5 AU (Astronomical Units) and beyond from their parent star. The observation will include the spectroscopy of light from the exoplanet to determine molecules in the atmosphere of the giant planet. The mission will also be a test bed for advancing coronagraph technology towards future Earth-characterizing missions.

Large-Area Near-Infrared Surveys

WFIRST-AFTA will conduct large-area infrared imaging and spectroscopic surveys over multiple epochs to enable scientific investigations that touch upon virtually every class of astronomical object, environment and distance.

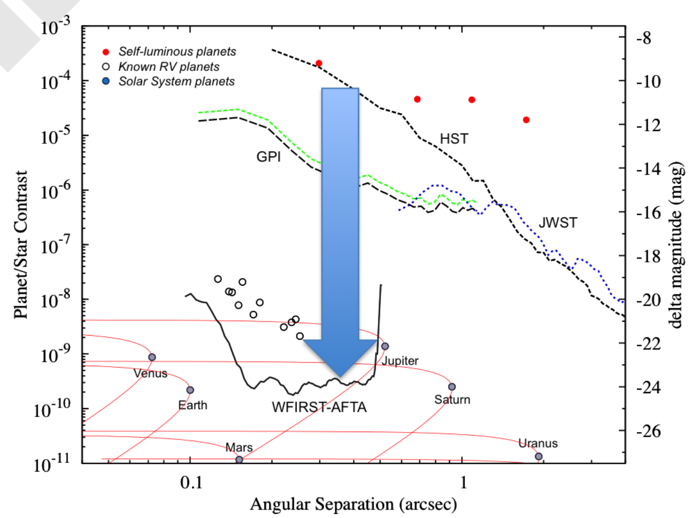
WFIRST-AFTA will answer fundamental questions about the efficiency and mechanisms of formation of low-mass stars, brown dwarfs, and planets in the Milky Way. These most common constituents of the Universe will be identified by their unique infrared colors, by their proper motion acquired through multi-epoch WFIRST-AFTA surveys and comparison with earlier surveys, and by their spectral signatures.

Predecessor infrared space missions such as NASA's Spitzer Space Telescope and Wide-field Infrared Survey Explorer (WISE) have discovered thousands of stars in nearby star formation regions that exhibit infrared emission in excess of what is expected from their photospheres, indicating the presence of surrounding structures of gas and dust. WFIRST-AFTA imaging will determine the sizes and morphology of these structures that may evolve into planetary systems.

Sensitive near-infrared imaging and spectroscopy over large areas by WFIRST-AFTA will probe the star formation history of the Universe and the evolution of active galactic nuclei, and will trace the large-scale structure and clustering properties of galaxies at $z>1$. Deep, wide-field imaging with WFIRST-AFTA will also determine whether the fluctuations in the infrared background surface brightness that have been observed by Spitzer arise from faint galaxies at $z\sim2$ or if they are produced by first-light galaxies containing Population III stars near the epoch of reionization.

Guest Observer and Guest Investigator Programs

WFIRST-AFTA will offer Guest Observer and Guest Investigator programs that support both community-based observing programs as well as archival studies to address a broad range of astrophysical research questions. While the baseline mission emphasizes the exoplanet and dark energy measurements, the additional surveys carried out via the Guest Observer program can exploit WFIRST-AFTA's unique capabilities to substantially broaden the science return of the mission.



The contrast of the WFIRST exoplanet coronagraph is orders of magnitude better than current and planned instruments.

For more information, visit: http://wfirst.gsfc.nasa.gov/ or contact Study Scientist Neil Gehrels (neil.gehrels at nasa.gov)

National Aeronautics and Space Administration

Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, MD 20771

www.nasa.gov