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TITLE

Eclipse: Technology and Mission Concept for a Coronagraphic Imaging Survey of Nearby Planetary Systems

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ABSTRACT

Eclipse is a proposed NASA Discovery-class mission to perform a sensitive imaging survey of nearby planetary systems, including a complete survey for jovian-sized planets orbiting 5 AU from all stars of spectral types A-K to distances of 15 pc.

Eclipse is a coronagraphic space telescope concept designed for high-contrast visible wavelength imaging and spectrophotometry. Its optical design incorporates essential elements: a telescope with an unobscured aperture of 1.8 meters, optical surfaces optimized for smoothness at the critical spatial frequencies, a coronagraphic camera for suppression of diffracted light, and precision active optical correction for suppression of light scattered due to residual mirror surface irregularities. For reference, Eclipse is predicted to reduce diffracted and scattered starlight between 0.25 and 1.5 arcseconds from the star by at least three orders of magnitude compared to any HST instrument.

The Eclipse mission offers precursor science explorations and critical technology validation in support of coronagraphic concepts for NASA's Terrestrial Planet Finder (TPF). A baseline three-year science mission would provide a survey of the nearby stars accessible to TPF before the end of this decade, promising fundamental new insights into the nature

ABSTRACT (continued)

and evolution of possibly diverse planetary systems associated with our Sun's nearest neighbors.

Predictions of the contrast performance of the Eclipse coronagraphic telescope are based on optical propagation models and the known physical characteristics of commercially available optical components. It is important to demonstrate the key technologies that enable the Eclipse concept in a flight-simulating laboratory environment. A high contrast imaging testbed has been developed at JPL to validate the critical technologies for an actively corrected coronagraphic space telescope. This testbed includes light sources, relay optics, a precision deformable mirror, wavefront sensors, apodized occulting and Lyot masks, detectors, and baffles into a vibration-isolated vacuum environment. With the exception of a large telescope, the testbed provides all the essential elements needed for a system-level demonstration of instrument contrast levels of 10^{-9} as near as four airy radii ($4\lambda/D$) from a bright star. The testbed is used to evaluate the coronagraphic camera design, including pupil shapes and apodizations, smoothness and uniformity of optical surfaces, precision wavefront phase sensing and control, stray light control, and alignment tolerances. In the process, it also validates the optical models and propagation codes required to predict the performance of space telescope architectures for direct imaging of extrasolar planets, in support of future coronagraphic planet finding mission concepts.