Super Lyot ExoEarth Coronagraph (SLEEC)

John Trauger, PI (Jet Propulsion Laboratory, California Institute of Technology)

This is a SAT/TDEM (Strategic Astrophysics Technology / Technology Development for Exoplanet Missions) proposal to provide enabling technologies for the HabEx (Habitable Exoplanet Imaging Mission) and LUVOIR (Large UV/Optical/IR Surveyor) strategic mission concepts.

The HabEx and LUVOIR objectives include direct imaging and spectroscopic characterization of Earth-like exoplanets in the habitable zones of nearby stars. These objectives pose substantial technological challenges well beyond currently demonstrated capabilities. For instance, the ongoing HabEx and LUVOIR concept studies have already shown that a robust ExoEarth science program requires instrumentation surpassing WFIRST/CGI's (Wide Field Infrared Survey Telescope / Coronagraph Instrument) pioneering benchmarks. Better contrast, significantly higher core throughput, improved tolerance to telescope pointing jitter and thermal drifts, minimal manufacturing and operational complexity, and larger high-contrast fields of view are among the critical factors. We rise to the challenge by offering innovations in design approach utilizing wavefront amplitude and phase manipulation in all available planes, leading to "super Lyot" coronagraphs. We leverage a body of record-holding accomplishments and extensive experience in contrast performance to ensure success. We propose to extend our previous ASMCS (Astrophysics Strategic Mission Concept Studies), SAT/TDEM, and WFIRST coronagraph studies in the areas of optimal design, mask fabrication, and laboratory demonstrations.

We adopt an end-to-end systems approach for the proposed work. This incorporates our best understanding of space telescope performance opportunities and limitations, an optimal coronagraph design with masks and stops at strategic locations in the instrument optical path, and precision wavefront control with state-of-the art deformable mirrors (DMs).

Previous work has established that all necessary components of the proposed technology have achieved at least Technology Readiness Level (TRL) 4. In particular, achievement of WFIRST milestones thus far have demonstrated successful modeling, manufacture, and performance validation of the fundamental Lyot mask, shaped pupil, and wavefront control technologies to TRL 5. Thus, relevant system breadboards have been built and operated to demonstrate basic functionality and critical test environments, and associated performance predictions have been defined relative to final operating environment, placing our entry firmly at TRL 4. Advancement to TRL 5 requires system-level demonstration of the performance objectives in a simulated operational environment. We adopt performance metrics that are consistent with HabEx and LUVOIR's scientific goals, which are roughly an order of magnitude beyond the requirements and expectations for WFIRST/CGI contrast and wavefront error tolerances.

Advancing the Lyot-based coronagraph—the leader in validated coronagraphic performance—to a TRL 5 option for ExoEarth imaging and spectroscopy is important for formulating credible HabEx and LUVOIR project concepts. Now is the time to commence this work, as the mission studies are underway in preparation for the 2020 Astrophysics Decadal Survey. This proposing team is uniquely qualified for the task, as evidenced by our track record in high-contrast coronagraph performance demonstrations.