IRAD FY16 SCIENCE PROJECTS

ATLAST and the Search for Earth 2.0: Are We Alone?

(Domagal-Goldman, Stapelfeldt, Roberge, Mandell, *et alia*)

In FY16 we will continue to improve our current simulations especially to improve the fidelity of the optical system requirements. This will include noise from starlight (after starlight suppression), dust in the target system, and detector performance. This will be done for at least our baseline reference mission design and one starlight suppression technique. We will also expand our analysis to new science cases in the areas of exoplanets and stellar astrophysics. We will begin simulations of the time-dependent noise in transit spectra, based on a similar simulator for JWST. This will allow us to explore the potential for very high-resolution transit spectral analysis as a means of detecting specific lines that would otherwise be unavailable due to coronagraphic constraints. We will also continue to improve our estimates for the overall planet yield from ATLAST observations; that is, understanding the yield of rocky versus gaseous planets, and the overall number of non-Earth planets that will be discovered over the mission lifetime.

Additionally, we will lead professional outreach activities for those scientific communities relevant to ATLAST. These activities will include co-organizing workshops with other exoplanet-related NASA organizations such as the NASA Astrobiology Institute and the NASA Exoplanetary Systems Science (NExSS) Network. We will leverage public science engagement opportunities, such as the autumn celebration of the 20th anniversary of first exoplanet detection at National Air and Space Museum. And, of course, we will continue to collaborate with stellar astrophysics and galaxy science colleagues in 660 to increase the focus on non-exoplanet astrophysics science with ATLAST and to engage planetary sciences colleagues (690 and beyond) on Solar System science.

Finally, we will work with colleagues at JPL (M. Werner) and STScI (J. Green) to assess the feasibility of mid-IR (~ 4 μm) planet transit spectroscopy with a room temperature telescope to search for diagnostic molecular lines that may be observable no other way.

<u>On the Shoulders of a Giant: Piggy-backing Science Applications of a Large Aperture Space Telescope</u>

(Jeremy Schnittman)

I would like to study the wide range of astrophysics applications that will be achievable with the exquisite performance of a large-aperture space telescope. Specifically, the high-precision astrometry, high sensitivity (limiting magnitude), broad wavelength coverage, and high-contrast imaging available with a space telescope like ATLAST. ATLAST will have all the benefits currently enjoyed by HST over ground-based telescopes: a highly concentrated (diffraction-limited) PSF, allowing the study of faint stars and crowded fields; highly stable pointing platform; and thermal and structural stability; NUV and mid-IR coverage.

While the driving science requirements for ATLAST will come from direct imaging and spectroscopy of exoplanets, there are many other excellent astrophysics applications that may come along "for free." Over the next year, I plan to analyze a broad range of these applications, and how their scientific return scales with various observatory parameters like wavelength coverage, field-of-view, and aperture. I will try to focus specifically on sources somewhat outside of the traditional space telescope applications of exoplanets, cosmology, and stellar populations. Additionally, the relative value of ATLAST will be compared to the anticipated state-of-the-art facilities 20 years hence, such as 30m ground-based AO telescopes, WFIRST/AFTA, and JWST.

Some examples of "outside of the box" applications include:
Galactic microlensing: break degeneracies of light curve to measure the distribution of black holes, neutron stars, brown dwarfs, and free-floating planets in the Milky Way.

Galactic center: measure 3D orbits of stars around Sgr A* to map out gravitational potential, star cluster morphology (NIR capabilities crucial).

Full 3D orbit solutions for binary stars, compact objects, giving precise masses. (many exoplanet applications here too!)

Resolving binary AGN systems in galaxies at z~1

Proper motion, parallax to hyper-velocity stars allows us to trace them backwards towards origin.

I anticipate spending 20% of my time on this effort and will thus charge at the 0.2 FTE/yr rate for FY16. The deliverables will include a talk for the ATLAST seminar on my findings, as well as the more intangible result of broadening support for ATLAST throughout the diverse astronomy and astrophysics community.

Lastly, in addition to the astrometry study described above, I will continue my efforts on the exoplanet atmosphere modeling supported by our Science Task Group.