Terms of Reference for SAG on the impact of Exo-Zodiacal Dust on Exoplanet Direct Imaging Surveys

Motivation

The first SAG of the ExoPAG, entitled “Debris Disks & Dust”, was completed ten years ago and highlighted the fact that dust similar to that of the Zodiacal Cloud in the Solar System, so-called exozodis, could have a significant impact on missions that plan to directly image exoplanets and characterize Earth-like planetary atmospheres. Exozodi disks, as targets of study in their own right, can elucidate the architecture and chemistry of terrestrial planetary systems. In the intervening time from SAG 1, rapid advancements in instrumentation, theoretical understanding of debris disks and interplanetary dust, observational capabilities, and data reduction techniques have occurred that impact the detection of disks via thermal emission at mid-infrared wavelengths or via high contrast direct imaging in the visible and near-IR.

The recent publication of the results from the HOSTS survey, which used nulling interferometric observations at 10 µm, demonstrated that exozodi systems exist around nearby stars to varying degrees and that the typical exozodi level is within a few orders of magnitude of the Solar System’s zodiacal dust, paving the way for current direct imaging exoplanet concepts. It is important then to identify the key questions that remain unanswered so that the astronomical community can make the most of the planned launch of a visible light coronagraph on the Nancy Grace Roman Space Telescope, the construction of the next generation of ground-based instruments and telescopes, and any future direct imaging or mid-infrared interferometric missions (or both) as envisioned by the Astro2020 report and the ESA Voyage 2050 plan.

Goals

This SAG will bring together an interdisciplinary team of scientists who study dust in various forms throughout the Solar System and galaxy in order to review the current gaps in knowledge on exozodis and identify those areas of debris disk science that should be prioritized in the coming years. The goals that could be addressed by this SAG include:

1. Review the current state of knowledge for warm zodiacal dust in the Solar System, particularly its dust composition and origin, which may be useful for understanding exozodi systems that potentially host planets.
2. Review the current state of knowledge on the average exozodi level around potential targets of future exo-Earth imaging missions and create a prioritized target list for studies of exozodis.
3. Explore the limits of empirical and probabilistic models of thermal and scattered light emission from disks and prioritize the techniques and observations which will yield the largest improvement in their performance. Additionally, explore what components of a planetary system are most important for determining exozodi levels, ie. planetary architecture, the presence of outer debris disks, or the presence of inner hot dust.

4. Identify methods for extended source detection and image post-processing, that may be relevant for detecting exozodi disks with future missions or in archival data. Provide findings on what works best to retire risks to direct imaging exoplanet surveys, such as whether exozodi disks add more than photon noise in background limited observations.
5. Evaluate the merit of both theoretical and observational studies of debris disks and exozodiacal dust in support of future exo-Earth imaging missions. Prioritize which studies can be carried out based on anticipated data from those missions and which ones are needed sooner.
6. Identify near-term and long-term ground-based opportunities to fill in exozodi knowledge gaps relevant to future exoplanet and exozodi studies.

Methods

The primary mode of SAG operations will be based on regular teleconferences with SAG members, invited guests, or interested parties. A workshop or symposium will be planned with an existing meeting to facilitate additional input from the community. We will also communicate via an email list and other online tools as needed. We will adopt a code of conduct and replicate best practices from recent SAGs.

Deliverables

The SAG will report its progress to the ExoPAG on a quarterly basis, present at public ExoPAG meetings, and will deliver a white paper to the Agency when its work is completed. The SAG will also submit any findings that warrant publication to a relevant open-access journal.