**General astrophysics** shall be considered when designing L-class missions on exoplanets.

This includes topics directly connected to exoplanets (e.g. objectives 9, 10, and 11 in Greene et al. 2013, NASA ExoPAG SAG#5 team report):

- **planet formation**: protoplanetary disks and forming jovian planets in young, gas-rich disks.
- **planetary systems as a whole**: young debris disks forming telluric planets, and collisionally evolving debris disks.
- **Debris dust in the habitable zone of stars, aka exozodiacal dust**, is clue for the presence of asteroids and comets, that can deliver volatiles.
- **Exozodiacal dust** is a potential source of background noise and confusion for planet detection.
EXOZODIACAL DUST

- Ongoing near- and mid-IR interferometric surveys (CHARA/FLUOR, VLTI/PIONIER, soon LBTI)
- 29% of nearby stars have K-band excess (CHARA/FLUOR, Absil et al. 2013)
- 4-13% of stars with N-band excess emission (KIN, Millan-Gabet et al. 2011)

Jean-Charles Augereau, April 4th, 2013
Fig. 7. Same as Fig. 5 after separating the target stars based on both their spectral type and the presence of outer dust reservoirs.

Fig. 8. Measured K-band disc/star flux ratio as a function of the age of the target stars. The error bars on the ages are generally huge and have been omitted for the sake of clarity. Triangles (resp. squares) are used for A-type (resp. solar-type) stars. Blue (resp. black) symbols are used for stars with (resp. without) significant K-band excess.

Stars without outer reservoirs in our sample, so that this result is based on small number statistics. Another interesting trend found in Fig. 7 is the difference in K-band excess occurrence rate for solar-type stars as a function of the presence of outer dust reservoirs. A p-value of 0.04 is found when comparing the K-band excess occurrence rate for the two samples, which confirms the significance of this trend.

Correlations with other stellar parameters than just spectral type and the presence of outer dust reservoirs are worth investigating. Stellar age in particular could give an indication on the time dependence of the K-band excesses. Fig. 8 shows the absence of correlation between stellar age and K-band excess in our sample, although there is a trend for A-type stars to have larger K-band excesses at older ages. A similar trend does not seem to appear in the case of solar-type stars, for which both the youngest (ksi Boo, 280 Myr) and the oldest (tau Cet, 10 Gyr) targets show a significant K-band excess. To check whether the excesses could be associated to a particular period in the stellar evolution, we plot in Fig. 9 the measured K-band excess as a function of the evolution of the star on the main sequence, represented by the fractional age relative to the main sequence lifetime. Here again, no significant correlation is found. Finally, another interesting stellar parameter to investigate is metallicity, which is known to be correlated to the presence of high-mass extrasolar planets, but not to the presence of low-mass planets (e.g., Santos et al. 2001). Furthermore, metallicity could be slightly correlated to the presence of cold dust (Maldonado et al. 2012). We collected metallicities in the literature for most of our stars, using the catalogs of Soubiran et al. (2010) and Gray et al. (2003, 2006). The result is shown in Fig. 10 and suggests the absence of correlation.

6. Discussion

In this section, we discuss the implications of the statistical trends found above on the nature and origin of the detected K-band excesses. Because A-type and solar-type stars show significantly different behaviour in terms of correlation between cold dust and K-band excess, they will be discussed separately.

Absence of time dependence (Absil et al. 2013). => Any target, independent of its age, may be affected by the presence of hot/warm dust.

Detected exozodis are usually much hotter than our zodi => Be very cautious when using the zodiacal spectrum as a reference for designing space missions: it might not be representative.
Several scenarios are explored to explain their origin:

- steady-state inward scattering of material by chains of planets
- LHB-like events (dynamical instability)
- planet migration driven by planetesimals scattering

In short:

- likely linked with the presence of planets
- many interesting science questions to be addressed by observing exozodis, in tight connexion with exoplanetary science
Overall impact of exozodiacal dust disks on planet detection (e.g.: Defrere et al. 2010, Absil et al. 2010, Roberge et al. 2012):

- Increased observing time because it creates a background noise => reduced the sample of targets to be observed during the mission lifetime

- If exozodis are bright, the fraction of systems with exo-Earths has to be higher to get a chance to detect one, and characterize it

- Exozodis might be sculpted by planets => dust blobs might be brighter than the planet to detect and could mimic the presence of a planet