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Unraveling the mystery of exozodiacal dust

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Abstract. Exozodiacal dust clouds are thought to be the extrasolar analogs of the Solar System's zodiacal dust. Studying these systems provides insights in the architecture of the innermost regions of planetary systems, including the habitable zone. Furthermore, the mere presence of the dust may result in major obstacles for direct imaging of earth-like planets. Our EXOZODI project aims to detect and study exozodiacal dust and to explain its origin. We are carrying out the first large, near-infrared interferometric survey in the northern (*CHARA*/FLUOR) and southern (*VLTI*/PIONIER) hemisphere. Preliminary results suggest a detection rate of up to 30% around A to K type stars and interesting trends with spectral type and age. We focus here on presenting the observational work carried out by our team.

Keywords. infrared: stars, circumstellar matter, surveys, techniques: interferometric, techniques: high angular resolution

1. How to detect an exozodi?

The thermal emission from hot exozodiacal dust (typically several hundred Kelvin up to the sublimation temperature) results in a near-infrared excess above the stellar flux (typically 1% for known systems). This accuracy is not reachable by simple photometry. It is necessary to spatially disentangle the dust and stellar emission. As the emission extends up to only a few hundred milli-arcseconds for nearby stars, this is only reachable by interferometry. At short baselines (~ 10 to $40\,\mathrm{m}$), considering fully extended (incoherent) dust emission around a nearly unresolved star, the emission results in a visibility drop compared to purely stellar visibilities that is equal to twice the disk/star flux ratio (Di Folco et al. 2007). Latest high precision near-infrared interferometers (*CHARA*/FLUOR, *VLTI*/PIONIER) allow us to detect this visibility drop.

2. An all-sky, near-IR survey for exozodiacal dust

We are carrying out the first large, near-infrared interferometric survey for exozodiacal dust. We are using the *CHARA*/FLUOR instrument in K band in the northern hemisphere and our *VLTI* visitor instrument PIONIER in H band in the southern hemisphere. A total of $\sim$ 200 stars will finally be surveyed. Observing strategy and target selection are designed for combining the data to a large, statistical, and unbiased sample. A first sample of targets observed with CHARA consisting of 42 stars ($K < 4$) has just been accepted for publication (Absil et al. 2013). The PIONIER sample (89 stars with $H < 5$) has been observed and the data are under analysis (Ertel et al., in prep.). Detection statistics for the CHARA sample are shown in Figure 1. Differences are most probably due to differences in sensitivity and lower excess in H band.

Our magnitude limited sample allows for statistical investigation of correlations of the

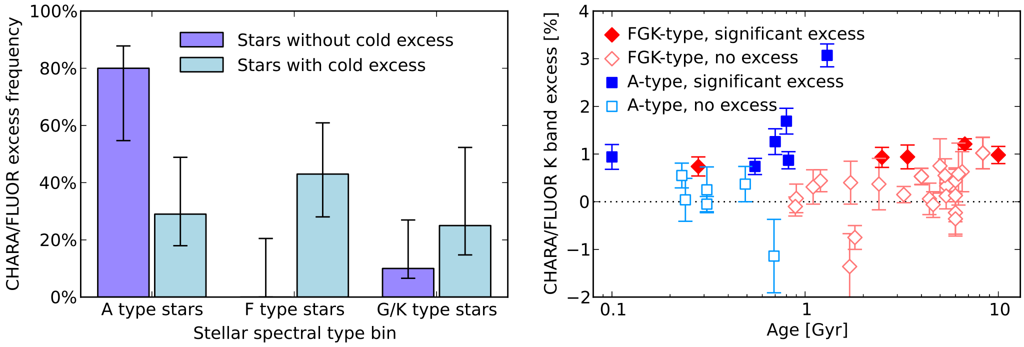

Figure 1. *Left: CHARA*/FLUOR *K* band detection rate of exozodiacal dust with respect to the spectral type of the host star and the presence or not of a cold, Edgeworth-Kuiper belt like debris disk. *Right: K* band excess as a function of stellar age.

detection rate and excess levels with other parameters such as the stellar age, spectral type, or presence of cold dust that could serve as a reservoir replenishing the dust.

The most intriguing results so far from the *CHARA*/FLUOR part of the survey (preliminary results from *VLTI*/PIONIER are largely consitent) are the fact that not only stars with an outer reservoir harbor exozodiacal dust and that there is no significant correlation of the excess levels with the age of the star (Absil et al. 2013, Figure 1). This would be expected in analogy to the well known trend in normal debris disks if the dust was produced in a steady state collisional process of larger bodies over the whole age of the system.

3. Future observational perspectives

The results from our survey as well as the state-of-the-art instruments and observing strategies used allow for important and promising observational studies. Using *VLTI*/PIONIER and in the near future *VLTI*/GRAVITY and *VLTI*/MATISSE, the topics our team is currently working on include in particular multi-wavelength observations constraining temperatures of known exozodis, the search for time variability of known exozodis on time scales of years, detailed studies of the hot dust in prominent debris disks, and investigation of the connection between warm mid-IR and hot near-IR excess.

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