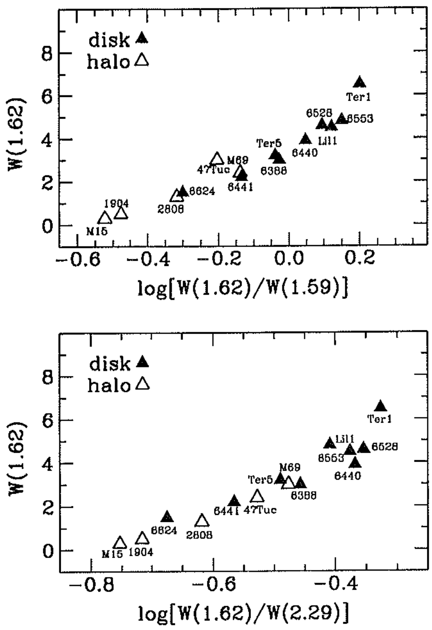

Figure 2: *Spectroscopic 1.62 vs 1.62/1.59 and 1.62 vs 1.62/2.29 colour-magnitude diagrams.*

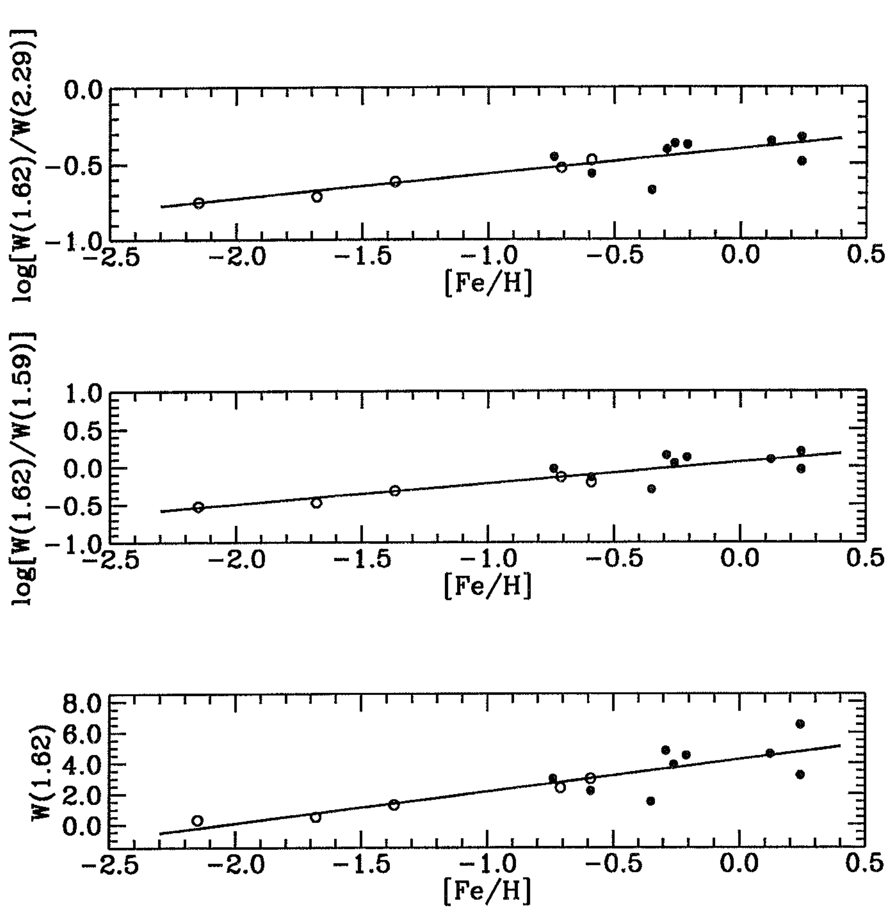

Figure 3: *Correlation between the 1.62, 1.62/1.59 and 1.62/2.29 indices with the metallicities reported by Zinn (1985). Open circles are the halo clusters and filled ones are the disk+bulge clusters.*

metallicities while NGC 6553 ([Fe/H] = −0.28) seems to be as cold as clusters with [Fe/H]>0 (NGC 6528, Lil 1). Unless this is due to large anomalies in the C/Fe and Si/Fe abundances, this probably demonstrates that our IR indices provide a more precise measurement of [Fe/H] in high metallicity systems. The same conclusion can be drawn from the plots of spectroscopic indices versus [Fe/H] in Figure 3 which show a scatter at large metallicities which is considerably in excess of the measurement accuracy.

We are now studying the possible effects of C/Fe and Si/Fe anomalies using synthetic spectra based on model stellar atmospheres before producing a precise metallicity scale on diagrams like those in Figures 2 and 3.

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Probing Dust Around Main-Sequence Stars with TIMMI

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The search for extra-solar planetary systems is a fascinating challenge. Direct imaging of such planets is hopeless, at least nowadays, so that efforts have been focused on looking for possible effects induced by a planet on its host star, such as faint modulation of the apparent flux (Paresce 1992 and references therein) or modulation of the apparent period in case of pulsars (Wolszczan and Frail 1992); but these searches are difficult. Since the discovery by IRAS in 1984, that many main-sequence stars are surrounded by dust (Aumann et al. 1984, review by Backman and Paresce 1993 and references therein), it has been recognized that gravitational perturbations of dust orbits by a planet could result in large modifications of the dust structure, such as voids of matter in the region inside the planet orbit or asymmetries (for example, Roque et al., in press). That is why many telescopes have been pointed towards main-sequence stars with IR excess, in an attempt to image the dust responsible for the excess.

Up to now, only the dust around the β-Pictoris star has been unquestionably imaged, thanks to visible observations (Smith and Terrile 1984). The dust was shown to be in a disk-like structure. But even with sophisticated techniques, using coronographic adaptive optics or antiblooming CCDs, the region inside a radius of 2.5″ (40 AU at the distance of

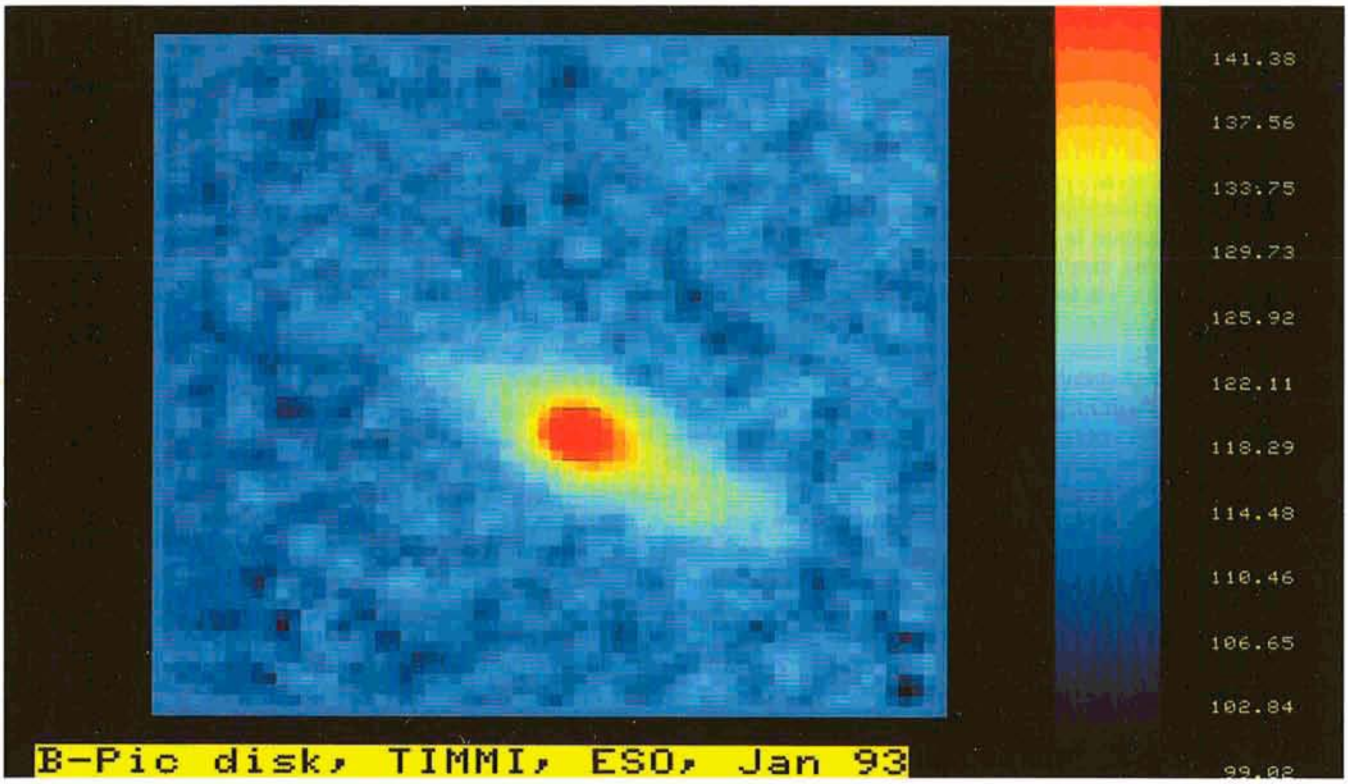

Figure 1: *β-Pictoris dust disk as observed at 12μm with TIMMI (see also Lagage and Pantin, in press). The pixel field of view in use was 0.3″, corresponding to 5 AU at the distance of β-Pic (16.5 pc) and the total field is about 20″×20″. East is at the top, north on the left; the colour scale is logarithmic. The star contribution (of the same order as the disk contribution) has been removed; but the image shown here has not yet been deconvolved from the point spread function (full width half maximum of 0.9″).*

β-Pic, 16.5 pc), where traces of planets are expected to be present, has been inaccessible so far (Lecavelier des Etangs et al. 1993, Golimowski et al. 1993). The problem with visible observations is too high a contrast between the central star and the dust disk emission, which originates from scattering of the star radiation.

In the Mid-Infrared domain (MIR) the situation is quite different. Indeed, the radiation at these wavelengths originates from thermal radiation of grains, which reprocess a small fraction of the visible radiation into the mid-infrared domain, where the photospheric emission of the star is much fainter than in the visible. For example, at 10μm, the dust contribution and the star contribution in the β-Pic system are of the same order, so that it is possible to remove the star contribution and to obtain the disk structure down to the diffraction limit of the telescope (0.7″ for a 3-m-class telescope). By using appropriate deconvolution techniques, we can even expect to go beyond the diffraction limit.

To achieve the diffraction limit in the MIR, we had to await the recent developments of monolithic detector arrays (although the scanning technique allows, in principle, for high angular resolution with monodetectors, such observations are difficult and consume a lot of telescope time). ESO has recently acquired a 10μm camera, TIMMI, equipped with a detector array manufactured at the LETI/LIR, CEN Grenoble. This camera was built under an ESO contract, by the Service d'Astrophysique (SAp) at Saclay, which had already developed two other ground-based 10μm instruments: C10μ (Lagage et al. 1993a), in collaboration with the Observatoire de Lyon, and CAMIRAS (Lagage et al. 1993b); both in use in the northern hemisphere. The TIMMI camera has now started its scientific life, as shown below. Technical details on TIMMI can be found in the papers by Lagage et al. 1993c, and Käufl et al. 1994.

We observed β-Pic with TIMMI at the 3.6-m telescope during 5 half nights at the beginning of January 1993. Two nights were useless, because of too variable a seeing. Only about one hour was lost for technical reasons. (After moving the f/36 rotator to align the disk with one of the axes of the array, the guiding had lost the north! This software problem is now fixed.) The final image obtained through the 10.3 – 13μm filter and the smallest pixel field of view (0.3″), is shown in Figure 1; the on-source integration time is 75 min, spread over 3 nights, corresponding to a total observing time of about 200 min (the increase in time originates from the observing technique; no loss is due to the acquisition system, even with a flow of data as high as one 14 bit pixel every μs!). The observing technique used to remove the huge photon background generated by the telescope and the atmosphere (10^6 times brighter than the faintest signal detected in the β-Pic disk) is the standard chopping (moving of the secondary mirror at a frequency of a few Hz) and nodding (moving the telescope every minute) techniques. The only little trick is that the mirror chopping frequency is half the effective sky chopping frequency (AABBAABB . . . instead of ABABABAB . . .). The nearby (a few degrees) α-Car star was used both as photometric reference and as point spread function reference; the full width half maximum was measured to be of 0.9″, close to the diffraction limit.

The image of Figure 1 confirms without ambiguity the previous claims that the β-Pic disk is extended at 10μm (Telesco et al. 1988, Backmann et al. 1992); the extension is observed up to more than 4″ from the star. Then, these observations definitely dismiss the models with large grains (> 10 μm), which, at 4″ from the the star, would have a blackbody-like temperature of 70 K, too low to be observed at 10μm. Another interesting feature is the morphology of the disk, which appears asymmetric. The asymmetry seems too wide in size to be due to the emission of a cold companion, but could be accounted for by the presence of a planet on a slightly excentric orbit, able to generate arc-like structures in the dust disk (Roque et al., in press). The other possible dust trace generated by a planet, a void of matter, is not apparent on Figure 1. But the brightness of the disk seen on Figure 1 is (schematically) the result of 2 parameters: the dust density number and the dust temperature. Modelling the dust temperature, we found a temperature induced brightness gradient steeper than observed, so that a deficiency of matter towards the star is needed, even if the brightness is still increasing (Lagage and Pantin, submitted).

Note that thanks to the Richardson-Lucy deconvolution algorithm, we were able to resolve the disk structure at the level of one pixel. That means that a better sampling of the diffraction pattern would make sense. An improvement in this direction could be easily achieved by upgrading TIMMI with the new 128×192 Si:Ga detector array under manufacturing at the LETI/LIR (Lucas et al., in press) and whose pixel size will be of $75 \times 75 \mu m^2$, instead of $100 \times 100 \mu m^2$ for the actual detectors. Note also that the reference for the point spread function has to be taken not too far away from the object, because the aberrations (decentring coma . . .) of the 3.6-m telescope in the f/36 configuration, of the order of 1″, depends on the telescope position (Gilliotte, private communication).

Another promising candidate to image in the MIR is 51 Oph. Indeed, the 10 μm emission from this object is large (10 Jy) and almost entirely due to thermal radiation of dust (Coté and Waters 1987). Furthermore, from similarities between the gaseous optical and ultraviolet lines detected around β-Pic and 51 Oph, it was concluded that the 51 Oph dust was probably in a disk-line structure seen edge-on, like the β-Pic structure (Lagrange-Henri et al. 1990, Grady et al. 1993), which makes the detection easier. But the object has the disadvantage of being far away from us (70 pc). Nevertheless, given the size of the β-Pic disk observed, it was worthwhile trying to image the 51 Oph dust. The observations were conducted in June 1993. After data analysis, we were able to image a dust envelope . . . but that of α-Sco, the reference star! This observation is encouraging for the programmes aiming at studying the dust around late-type stars (Mékarnia, private communication); but this is another subject. Fortunately, we always observe two reference stars; the second reference star was point-like. Oph 51 also appears point-like; nevertheless, the negative result led to interesting constraints on dust disk models (Pantin and Lagage, in preparation).

We have now observed all the few main-sequence stars of the southern hemisphere with a large 10 μm excess. (The last data, obtained in December 1993, are not yet fully reduced). We are now observing stars with a much fainter excess, but which are nearby, so that we can still expect a detection. However, for two reasons the best window for detecting new disks is not the 10 μm window, but the 20 μm window, even though it has a poorer atmospheric transmission than the 10 μm window: first, most of the star disk candidates exhibit a sizeable excess only beyond 10 μm (Aumann and Probst, 1991); second, the 20 μm radiation is emitted by grains twice cooler than the grains detected at 10 μm; these grains are at least 4 times more distant from the star, which is more than enough to compensate for the loss in diffraction-limited angular resolution. The 17 μm channel of TIMMI, with a sensitivity more than an order of magnitude worse than expected for a good 20 μm camera, is of no help for the kind of programmes discussed here. The weather conditions at La Silla may not be good enough to justify an ESO investment in a 20 μm camera. On the contrary, Paranal is a promising site for 20 μm observations, so that a 20 μm channel is an indispensable complement to the 10 μm channel of the Mid-Infrared instrument under study for the VLT. We can anticipate a large use of this window for all the programmes dealing with dust around stars, whatever their evolutionary stage: young, main-sequence or late-type.

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NTT Observations of Obscured Globular Clusters

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The bulge of our Galaxy contains a number of globular clusters hardly observable due to the high obscuration close to the direction of the Galactic centre. At the Galactic plane, the extinction may amount to more than $A_V = 30$ magnitudes. A few clusters and fields located in regions of low extinction (or "windows"), such as the Baade Window, have been known for some time and can be easily observed. More recently, however, a number of very ob-