Astronomical Polarimetry: Current Status and Future Directions
ASP Conference Series, Vol. 343, 2005
Adamson, Aspin, Davis, and Fujiyoshi

Near-IR Imaging Polarimetry of Dust-Debris Disk Candidates

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Abstract. We have carried out JHK polarimetric observations of ten stars around which dust-debris disks may be present, by using the polarimeter module IRPOL2 with the near-IR camera UIST on UKIRT. Our sample targeted systems for which UKIRT-resolvable disks were predicted by model fits to their spectral energy distribution. Since only the light from the disks should be polarized, the bright central stars are suppressed in polarized light images. Our observations have detected the presence of extended polarized emission around at least four of our ten targets, confirming the potential of imaging polarimetry for substantially raising the overall number of systems with directly imaged debris disks.

1. Observations and Data Reduction

We selected a sample of ten stars with dust-debris disks from the surveys of Sylvester et al. (1996) and Mannings & Barlow (1998), from which modelling of their excess spectral energy distributions predicted angular sizes that should be resolvable at near-IR wavelengths using UIST on UKIRT. The data presented in this work were acquired on April 29th 2003, using the dual-beam polarimeter module IRPOL2 in conjunction with the near-IR camera UIST on UKIRT. In order to minimize errors in polarization, each measurement was repeated at 3 different array (jitter) positions. All data were identically reduced using the STARLINK data-reduction pipeline ORAC-DR[1], which also uses the dual-beam imaging polarimetry package POLPACK[2] to produce resultant I, Q and U Stokes images.

2. Results

Centro-symmetric polarization patterns around TW Hya (Figure 1, left panel) and HD 169142 (not shown) were detected. This confirms the face-on nature of their respective circumstellar disks (Apai et al. 2004; Kuhn, Potter & Parise 2001). The detection of polarized emission around TW Hya between 0.5 and 1.4 arc seconds from the star is in agreement with previous values for the extension

[1]http://www.jach.hawaii.edu/UKIRT/software/oracdr

[2]http://www.starlink.ac.uk/dsb/polpack/polpack.html

of TW Hya's disk, from HST near-IR coronagraphic imaging (Weinberger et al. 2002), confirming the reliability of our method.
Aligned-vector polarization patterns around two Herbig Ae/Be were found: the binary system HD 150193 (Figure 1, right panel) and HD 142666 (not shown). The polarization patterns show vectors aligned at PAs of 59 and 64 degrees respectively, measured from North to East. Parallel orientation of vectors is usually attributed to scattering in a very optically thick disk/envelope. This hypothesis would also be consistent with the large IR excesses observed for these objects (respectively $L_{IR}/L_{star} = 0.37$ and 0.34; Sylvester & Mannings (2000); Sylvester et al. (1996).

It is intended to construct detailed scattering models for these systems, using the code described by Gledhill & Takami (2001) in order to investigate disk/envelope geometries, the distribution of dust and the composition and size distributions of the dust grains.

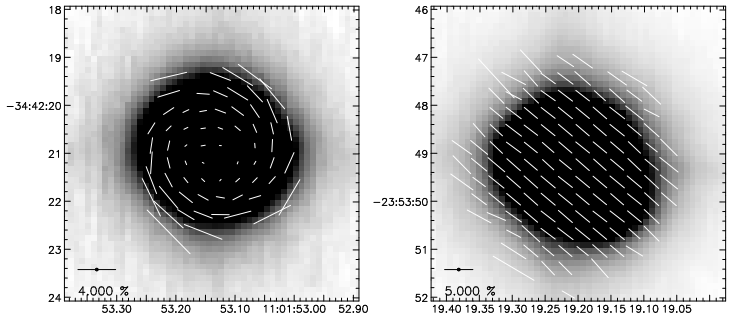

Figure 1. J-Band imaging polarimetry of TW Hya (left) and HD150193 (right). Polarization vector maps are superimposed upon total intensity grey-scale images. Polarization measurements have been binned in 3×3 square bins and a 2σ cut was applied to avoid spurious values.

References

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