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

Near Infrared Polarimetry of IRAS 19306+1407

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Abstract. Polarimetry can be used to observe the dusty outer shells of Post-AGB stars. We can discriminate between the unpolarized light from the central star and the reflected polarized flux. The polarisation vectors and polarized flux can give valuable information on the morphology of the object and the dust grain size distribution. Here we present J and K waveband polarimetry information and modeling of *IRAS* 19306+1407. We have detected scattered light and high degrees of linear polarisation. In polarized flux we have detected a 'dumbbell' structure, possibly indicating a detached dusty circumstellar envelope (CSE). We have constructed a light scattering model that includes polarisation to investigate the CSE structure in detail.

1. Observations and Results

We present total and polarized intensity images and vector maps for *IRAS* 19306+1407, in the J and K bands (Figure 1). The observations were made using the 3.8m UKIRT, with the UIST 1 to 5 micron imager, in conjunction with the IRPOL2 polarisation module. The conditions were photometric and the magnitudes at J and K bands are 11.32 ± 0.04 & 10.31 ± 0.11 respectively. The polarisation vectors are centrosymmetric, indicating isotropic illumination. The maximum degrees of polarisation are found in the outer regions of the nebulosity and reach $\sim$17% and $\sim$16% at J and K bands respectively. In the central region, the lower polarisation is partially due to dilution by the unpolarized emission from the star. The polarized emission shows scattered light from the central source and a dumbbell-shaped appearance with two scattering peaks.

2. Modelling *IRAS* 19306+1407 and Results

We use an axisymmetric detached shell model to investigate the chemical composition, geometry, grain size distribution and polarization properties of *IRAS* 19306+1407, which are constrained by our observations. The model images are smoothed to mimic the effect of the atmosphere. We have adopted amorphous carbon dust grains (Hodge et al. 2004; Hrivnak et al. 2000) and used the optical constants obtained from Preibish et al. (1993). The spectral type for this object is unknown, so we assumed a type of F2, for the central source. This, along with our measured J-K colour and using a standard interstellar redding law, gives an estimated extinction of A_v=3.9. The power law for the dust grain size distribution, and minimum and maximum grain sizes are constrained by the observed percentage polarization (Table 1). The equation, $\rho\,(r,\theta) = \rho_0 \left(\frac{r}{r_0}\right)^{-\beta} (1 + \varepsilon \sin^{\gamma}\theta)$ (Gledhill & Yates 2003), describes the density distribution for a detached shell with inner radius, r_0, polar angle, θ, equator-

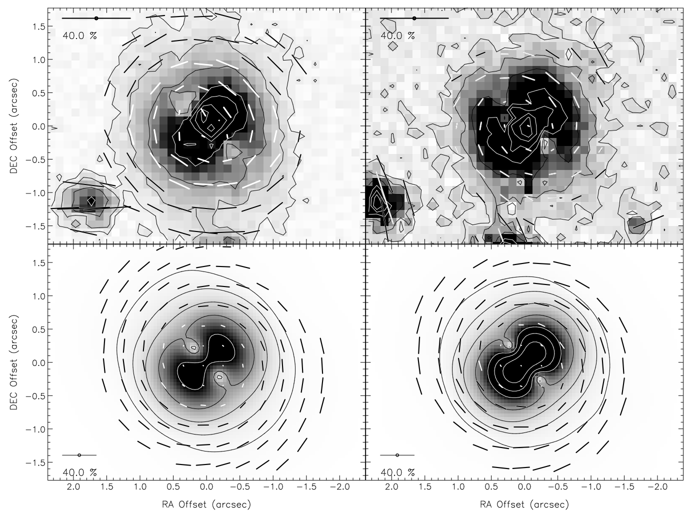

Figure 1. The observed, top, and model, bottom, polarized flux and polarization vectors of *IRAS* 19306+1407. J and K bands are shown left and right, respectively. The two highly polarized stars on the edges of the images are spurious.

to-pole density contrast, $1 + \varepsilon$ and a dust density fall off index, β. The model results are presented in Figure 1. The percentage polarization, ∼17% and ∼16% at 1.2 and 2.2 microns respectively, at equivalent radial distances from the central source. The modeled normalized azimuthal profile fits well to the J band observations, while the K band is a 'looser' fit. We have shown that this object can be modeled effectively using amorphous carbon dust, ranging from 0.15 to 2.0 microns, using parameters described in Table 1 (Lowe & Gledhill 2004, in prep).

Table 1. Model Parameters for *IRAS* 19306+1407

	J	K
Extinction cross section	3.7×10^{-9}cm^2	2.0×10^{-9}cm^2
Scattering cross section	2.9×10^{-9}cm^2	1.5×10^{-9}cm^2
Forward scattering ratio (g)	0.54	0.50
Density radial falloff (β)	-2	
Equator to pole density contrast ($\varepsilon + 1$)	7	
γ	5	
Grain size distribution exponent	-4	

References

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