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12.5 MICRONS IMAGING POLARIMETRY OF η CARINÆ

T.J.T. Moore, C.H. Smith, and D.K. Aitken
Department of Physics, University College,
Australian Defence Force Academy, Canberra 2600, Australia

RESUMEN

Presentamos una imagen polarimétrica de η Carinæ en 12.5 μm limitada por difracción (con resolución de $\sim 0.75''$). Encontramos polarización debida a emisión por granos alineados, en toda el área de la capa de polvo que forma el Homunculus. Los vectores del campo eléctrico muestran una distribución simple que sugiere la presencia de un campo magnético ordenado sobre la superficie de la capa.

ABSTRACT

We present a diffraction-limited ($\sim 0.75''$ resolution) polarimetric image of η Carinæ at 12.5 μm. Polarization levels of a few percent, due to emission from aligned grains, were found across the whole of the dust shell forming the Homunculus. The observed electric field vectors are arranged in a simple, large-scale pattern which suggests the presence of an ordered magnetic field lying in the surface of the shell.

Key words: **CIRCUMSTELLAR MATTER — INFRARED: STARS — ISM: MAGNETIC FIELDS — POLARIZATION — STARS: INDIVIDUAL: (η CAR)**

1. OBSERVATIONS

Observations of η Carinæ were made at the Anglo-Australian Telescope in July 1993, using the new mid-infrared imaging polarimeter NIMPOL built by members of the infrared group in the Department of Physics, University College, at the Australian Defence Force Academy.

The detecting element of NIMPOL is a 128×128 element Si:Ga Focal Plane Array by Amber Engineering, USA. The polarimeter provides diffration-limited images on the AAT and has a field of view of about $32''$ of sky with $0.25''$ pixels. Rotation of the polarization plane was effected with a warm CdS half-wave plate and a cold fixed wire grid was used as an analyser. The image presented here was obtained using a $\Delta\lambda \simeq 1$ μm, $\lambda =$ 12.5 μm filter.

2. RESULTS AND DISCUSSION

The 12.5 μm surface brightness (Figure 1) shows complex inner structure dominated by two small but slightly resolved sources (one of which is coincident with the visible star η Carinæ) plus an extended feature resembling an incomplete loop. Counterparts to these objects have been observed at thermal near-infrared wavelengths (see Rigaut & Gehring 1995). The bright central contours correspond closely to the shape of the radio continuum emission map presented by Duncan et al. 1995. Surrounding this central region is the dust shell of the Homunculus, very similar in size and shape to that seen in scattered light at visible and near-infrared wavelengths, which has the appearance of two intersecting, almost spherical, hollow shells as suggested by Hillier & Allen (1992) and Meaburn, Walsh, & Wolstencroft (1993). The surface-brightness distribution in Fig. 1 is also very similar to the enhanced-resolution results of Hackwell, Gehrz, & Grasdalen (1986).

Degrees of polarization of a few percent were found across the whole source (Figure 2) and the orientation of the electric field vectors of the polarized emission component form a coherent, large-scale pattern across the η Carinæ dust shell. The observed emission is thermal radiation from dust and the polarization is due to emission from aligned grains.

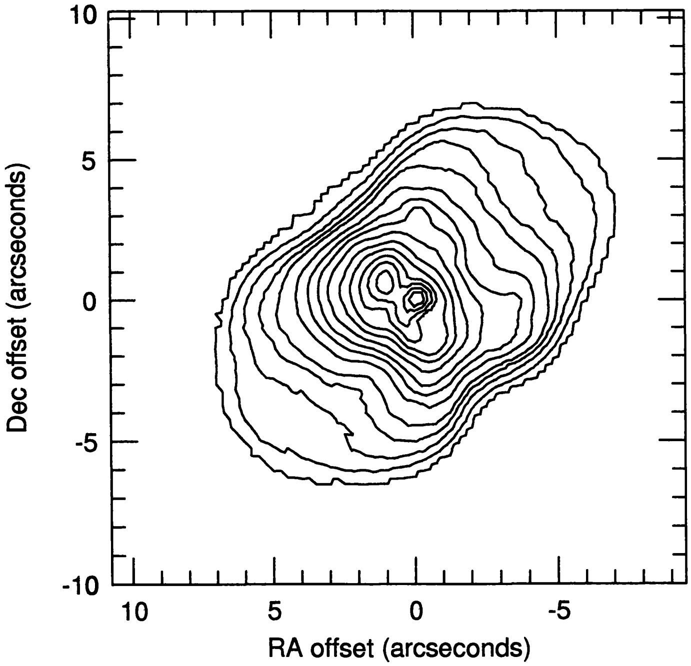

Fig. 1. 12.5 μm surface brightness in η Carinæ. Contours are at 2,3,5,7,8,12,15,20,25,33,42,50,67,83,95 per cent of the peak. The pixel scale is 0.25″ and the spatial resolution is $\sim$ 0.75″

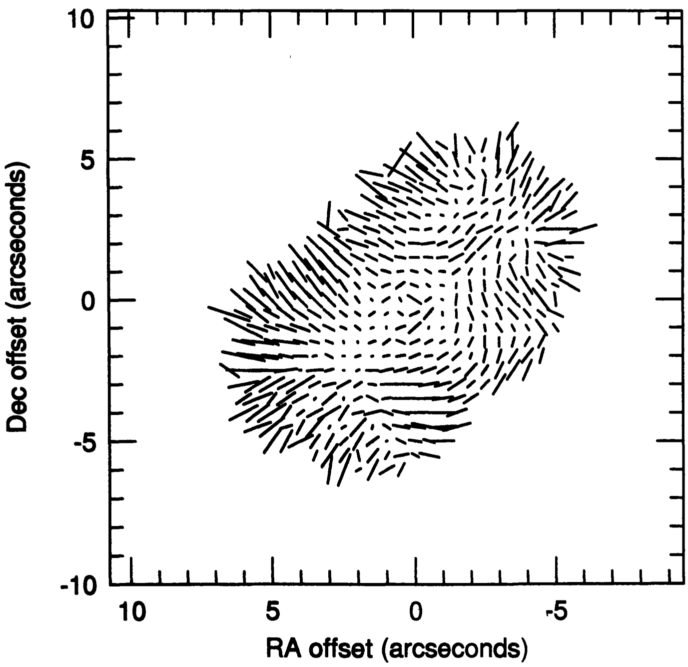

Fig. 2. 12.5 μm polarization. The position angle of the vectors shows the orientation of the electric field vector and the degree of polarization is proportional to their length.

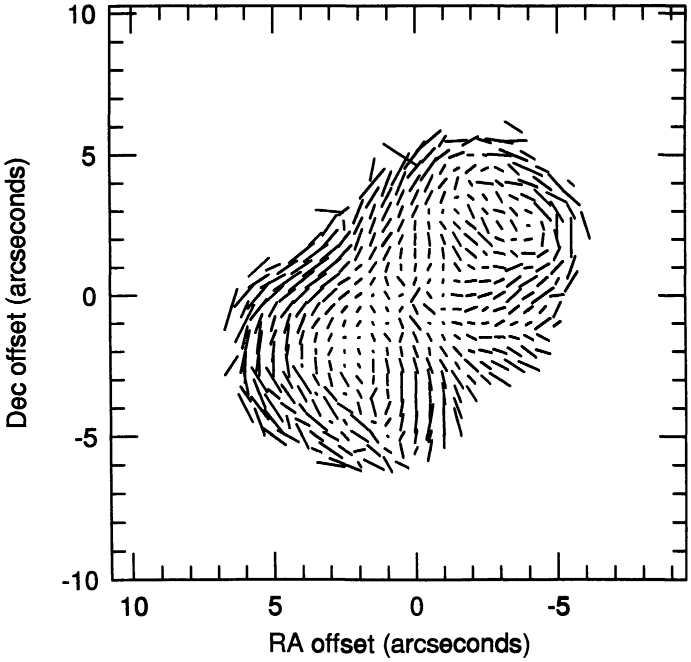

Fig. 3. Here the polarization vectors from Fig. 2 have been rotated through 90° to illustrate the direction of the magnetic field which may be determining the grain orientation.

The alignment of the grains is probably due to streaming of the dust relative to the gas in the shell in response to radiation pressure from the luminous central source. However, the expanding material will sweep up and compress any ambient magnetic field and the resultant field will lie within the surface of the shells. Such a field will determine the orientation of the grain spin and may assist the alignment process. In that case, the projected magnetic field direction, perpendicular to the E-vectors (Figure 3), represents the field amplified and disturbed by the outflowing material.

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