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Near-IR Polarimetry of the Obscured Nucleus in the Circinus Galaxy

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Abstract. We present J and K band imaging polarimetry and optical and K band spectropolarimetry of the Circinus galaxy. The imaging polarimetry shows a bipolar scattering cone in the J band and a more compact structure in the K band. The spectropolarimetry shows broad polarised hydrogen alpha in the optical, however broad lines are not detected in the K band. Analysis of the observations show that galactic and stellar processes dominate in the optical total and polarised flux whilst the nucleus dominates in the near-IR polarised flux. Modelling of the observations show that the small fraction of nuclear polarisation in the optical is due to electron scattering whilst the K band polarisation is dominated by dichroism.

1. Introduction

The Circinus galaxy is a nearby massive spiral that lies close to the plane of the Galaxy and is, optically, difficult to detect (Freeman et al, 1977). The galactic disc is inclined by 65 degrees, with a dust lane to the SE of the nucleus making the Hubble type difficult to determine. The nucleus displays both Seyfert and starburst activity and at a distance of only 4 Mpc is the closest Seyfert/starburst galaxy and therefore an excellent object to test the unified theory of AGN. It is highly polarised in the optical and a broad hydrogen alpha line has been detected in polarised flux (Oliva et al, 1998).

2. Observations and Data Reduction

The observations were taken in 1997 at the Anglo-Australian Telescope. The Royal Greenwich Observatory spectrograph and the University of Hertfordshire waveplate modulator were used for the optical observations. The IRISPOL imaging spectrometer and the University of Hertfordshire polarimeter were used for the near-IR observations (IRISPOL). The spectral slits were positioned on the nucleus at a position angle of 150 degrees.

3. Results and Discussion

The J band polarisation is 2% across the galaxy with a small nuclear enhancement. In polarised flux, prominent bipolar scattering cones are observed with the NW cone coincident with the [OIII] ionisation cone (Marconi et al, 1994). The K band polarisation is 0.5% across the galaxy, but higher (3%) at the nucleus where a compact structure dominates in polarised flux.

Polarised broad hydrogen alpha is detected with a width and flux consistent with that found by Oliva et al (1998). Strongly polarised optical stellar lines show that the galactic polarisation contribution is very high. Based on our measured broad hydrogen alpha flux, and a non-stellar R band continuum to broad hydrogen alpha line flux correlation that we've found for Seyfert 1s, we determine that just 0.1% of the measured R band polarisation is from the nucleus. In the K band, broad brackett gamma is not detected, putting an upper limit of 7.7 mags on the scattered visual extinction, assuming electron scattering and the Case B approximation.

We've modelled the spectropolarimetric results with the cone scattering model of Young et al (1995) with electron scatterers visually extincted by 5 mags and distributed in a 45 degree opening half-angle cone, consistent with the J band bipolar scattering cones, inclined at 50 degrees, giving an intrinsic polarisation of 26%. To fit to the near-IR an additional polarisation source of dichroism was required with a visual extinction to the near-IR emission region of 35 mags through the dusty torus.

The starlight fraction in the optical is greater than 99% whilst the radio and IR luminosities are lower than any other observed Seyfert 2 galaxy with polarised broad lines. The high optical polarisation of the galaxy is produced mostly through galactic processes and it is only in the near-IR that the nucleus is clearly detected. As this is the closest Seyfert 2 galaxy this suggests considerable difficulty in detecting polarised broad lines in other low powered obscured AGN.

References

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