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Beaming in Radio-Quiet AGN

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Abstract. We have obtained new optical spectropolarimetric data for the radio-quiet Seyfert NGC 1068, taken through apertures on the nucleus and at two positions within the ionization/scattering cone. The equivalent width of scattered broad-Hβ at these positions, is consistent with the presence of intrinsically beamed continuum radiation.

1. Introduction

The presence of intrinsically anisotropic continuum radiation in radio-loud active galaxies is now well established, being invoked as an explanation for the continuum dominated BL Lac and OVV objects and the observed one-sided core-jet morphologies (Blandford & Königl 1979). Anisotropy, from selective obscuration of an intrinsically isotropic source, has also been invoked to explain many observations of radio-quiet active galaxies, e.g. the presence of scattered broad lines in Seyfert 2 galaxies, which has led to the unified model for active galaxies (Antonucci & Miller 1985).

Recent observations and modelling, however, suggest that even radio-quiet objects may exhibit intrinsically anisotropic radiation. The evidence is strongest for NGC 1068, where the radiation field required to produce the observed ionization level, if isotropic, implies a luminosity greater than the bolometric luminosity (Miller, Goodrich & Mathews 1991). Also, to completely explain the infrared spectral energy distribution requires the presence of an extra dust component in the torus funnel that sees a radiation strength 5-6 times greater than seen by the torus (Efstathiou, Hough & Young 1995).

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Spatially resolved spectropolarimetry can provide a test for the presence of intrinsically beamed radiation. Variations of the equivalent width of a scattered broad line in polarized flux, at different points within the ionization/scattering cone, will show that the continuum radiation is not isotropic, assuming that the broad line photons are themselves isotropically distributed. The nature of the scatterers is not important since we are comparing broad line and continuum strengths at the same wavelength, in the same aperture.

2. Observations & Measured Hβ Equivalent Widths

The observations were carried out at the Anglo-Australian Telescope on the nights of 1995 September 24, 25 and 26, using the RGO spectrograph with the University of Hertfordshire built waveplate modulator and the 600V grating centred on Hβ. Adverse weather conditions on the first two nights limited the number of points observed within the cone. Observations were made at three positions, on nucleus, 5″ out at PA 33° (the cone centreline) and 5.5″ out at PA 6°. The data were reduced in the normal manner for optical spectropolarimetry using standard STARLINK packages.

To measure the Hβ equivalent widths Gaussians were fitted to the broad line in polarized flux. Hβ was observed, rather than the stronger Hα, because it is easier to deconvolve from any narrow line components. The equivalent widths are listed in Table 1. Though any variation in equivalent width with position is marginal, the data suggests that the continuum is beamed along the centre line of the cone, hence the reduced equivalent width measured here. The nuclear position shows a high equivalent width which can be explained by partial filling of the illuminated conical region with scatterers. Observations suggest that the ionized/scattering medium is concentrated at a PA of 0° close to the nucleus (Packham et al. 1996). This is consistent with most of the scattering material being towards the edge of the cone, where it would see the higher equivalent width.

Table 1. Hβ Equivalent Widths

Position	Equivalent Width (Angstroms)
nucleus	82 ± 9
5″ at PA=33°	48 ± 8
5.5″ at PA=6°	73 ± 12

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