

*The First Stromlo Symposium: The Physics of Active Galaxies*  
*ASP Conference Series, Vol. 54, 1994*  
*G. V. Bicknell, M. A. Dopita, and P. J. Quinn (eds.)*

## SPATIALLY RESOLVED SPECTROPOLARIMETRY OF NGC 1068

M. D. INGLIS, S. YOUNG, AND J. H. HOUGH  
*Division of Physical Sciences, University of Hertfordshire, Hatfield, Herts*  
*AL10 9AB*

D. J. AXON  
*Space Telescope Science Institute, 3700 San Martin Drive Baltimore, MD*  
*21218, USA*

J. A. BAILEY  
*Anglo-Australian Observatory, PO Box 296, Epping, NSW 2121 Australia*

M. J. WARD  
*University of Oxford, Astrophysics and Nuclear Physics Laboratory, Keble*  
*Road, Oxford OX1 3RH*

### INTRODUCTION

A turning point in the study of AGN was the discovery of broad hydrogen lines seen in polarized light in the nucleus of NGC 1068 (Antonucci and Miller 1985). A model was developed whereby the scatterers responsible for continuum and broad line polarization are located above and below the optically and geometrically thick torus which obscures our direct view of the Seyfert 1 nucleus, and hence the object appears as a Seyfert 2 galaxy. A cone shaped region of high ionization gas aligned with the radio axis and emanating from the nucleus is seen clearly in an interference filter image (Pogge 1988a). It is now widely accepted that the gas is photoionized by nuclear radiation which only illuminates the conical zone.

### OBSERVATIONS

The data were taken with the spectropolarimeter on the 3.9 m Anglo-Australian Telescope on the 24, 25 and 26 October 1990. The spectropolarimeter uses a waveplate modulator built by the University of Hertfordshire, in conjunction with the RGO spectrograph and a Thomson CCD. Using the 25 cm camera and 270R grating a spectral resolution of 8.4 Å was obtained. A two aperture dekker, each of width 1.3 arc-seconds and length 2.7 arc-seconds was used, with a separation of 23 arc-seconds. The raw spectra were reduced to the form of wavelength and flux calibrated spectra using a Cu-Ar arc and the photometric star VMA2 respectively. The polarimetric reduction, using the two normalized linear Stokes parameters, Q and U, was performed using the STARLINK TSP (Time Series Polarimetry) package developed by J. Bailey.

## RESULTS AND DISCUSSION

The aperture positions (arranged at intervals of 2.5 arcseconds in an equally spaced grid) lie within, and on either side of, the U. V. ionizing cone and are at approximately the same PA as the radio axis.

The value for the Balmer decrement  $H\alpha/H\beta$  of 1.16 mag. for the nucleus is similar to that measured by other workers ( $A_v = 1.7$  mag., Ward et al 1987,  $A_v = 1.6$  mag., Koski 1978). The  $A_v$ 's are seen to rise with increasing distance from the nucleus. Although an increase in dust obscuration might occur a more likely explanation is that the  $H\beta$  photons are being lost through dust scattering.

The Broad Line redshifts do not appear to be related in a simple way to the ionization cone.

The [OIII] line profiles provide information on the relative motions and extinction within the NLR. The observed blueward symmetry in the [OIII] line is similar to that seen in several other Seyfert galaxies, and has generally been interpreted as evidence for radial cloud motion coupled with differential extinction within the NLR. The redward asymmetry observed in the spectra south east of the ionizing cone is rarely seen in Seyfert galaxies (DeRobertis and Shaw 1990).

At the nucleus position there is a decrease in PA over the [OIII] line from the blue to red. At several other positions however the PA rises from the blue wing to a maximum in the core, before falling to a minimum value in the red. At the nucleus the degree of polarization rises across the line from the blue to the red as expected if the polarization is produced by dichroism in the NLR. The changes in polarization elsewhere are complex.

## CONCLUSIONS

From spatially resolved spectropolarimetry we can attribute many of the observed results to dust in the NLR. This dust is responsible for scattering and extinction along our line of sight and gives rise to the steep Balmer decrement and some of the polarization and PA changes observed in the [OIII] lines. Further work to be presented in a future paper will describe the observed intrinsic flux and polarized flux along with modelling of the continuum polarization at each of the aperture positions.

## REFERENCES

- Antonucci, R. R. J., and Miller, J. S. 1985, *ApJ*, **297**, 621  
 DeRobertis, M. M., and Shaw, R. A. 1990, *ApJ*, **301**, 727  
 Koski, A. T., 1978, *ApJ*, **223**, 75  
 Pogge, R. W., 1988a, *ApJ*, **328**, 519  
 Ward, M. J., Geballe, T., Smith, H., Wade, R., and Williams, P., 1987, *ApJ*, **316**, 138