ACTIVITY IN THE NUCLEI OF NORMAL Sbc GALAXIES - A MULTIWAVELENGTH STUDY

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1. INTRODUCTION

This study of the activity in the nuclei of normal galaxies began as an investigation into the spread in the observed properties of normal galaxies used as standard candles in measurements of departures from the Hubble flow (Hart & Davies 1982). Extensive studies of the integrated properties of normal galaxies show the influence on these properties of quiescent star formation and embedded starburst-type activity (Staveley-Smith & Davies, 1987,1988). Normal galaxies have a significant level of nuclear activity, although it is not strongly correlated with their integrated properties. This investigation of nuclear activity is based on a sample of the 100 brightest nearby Sbc galaxies, a sample unbiassed in its selection of activity.

2. RADIO EMISSION

λ20 cm VLA observations at an angular resolution of 12"-15" set detection limits of 1 mJy on 88 Sbc galaxies (Hummel et al. 1985). 40 percent had an excess of emission greater than 5 mJy in their nuclear regions. This sample of 34 galaxies was then observed with 1" resolution using the VLA and the brightest 23 were subsequently also observed at λ6 cm. All but one of the components detected had a steep spectrum, indicating that synchrotron emission is operating at these wavelengths. Two types of structure were identified. The first was extended structure reaching to a diameter of 1 kpc and most likely represents enhanced starburst activity in the vicinity of the nucleus. The second was more compact and closely located at the centre of the galaxy, possibly ejection from a condensed central object.

Typical internal pressures in these components are 5×10^{10}dyne cm^{-2}. Magnetic fields are $\sim7\times10^{-5}$ gauss, on the assumption of equipartition.

D. E. Osterbrock and J. S. Miller (eds.), Active Galactic Nuclei, 520–521.

Typical component energies are 3×10^{52} erg, with a spread of 10^2 either way. The remarkable fact is that these component energies are not very different from those of Seyfert galaxies - perhaps being on average a factor of 3 smaller than the Seyferts. The level of radio emission in normal galaxies and in Seyfert galaxies is scarcely distinguishable.

3. THE NEAR INFRARED

Davies & Wolstencroft have made JHKL' photometry in 5", 8", 12" and 20" apertures of the central regions of the majority of the programme galaxies. They find excess IR emission of 60 per cent of the sample observed. The excess is defined relative to the normal colours of galaxy bulges. The reddening increases towards the central regions of a typical galaxy; in some cases the maximum reddening may occur at a distance of $\sim$1 kpc from the centre. The excess reddening corresponds to emission from dust at a temperature of 500-1000K.

A modest correlation is found between the IR flux in a 12" aperture and the central 12"-15" λ20 cm radio emission (Hummel et al. 1985). The correlation was most strongly seen in those sources which were most heavily reddened in the near IR. Most unreddened objects were weak radio emitters.

4. OPTICAL LONG-SLIT SPECTROSCOPY AND CCD MULTICOLOUR IMAGING.

Long-slit spectroscopy observations have been made on the sample with the INT 2.5-m telescope. Liner and starburst activity was identified in some 40 percent of the galaxies. A number of these active objects also had excess nuclear radio emission. This data base also provides rotation curves for the inner part of each galaxy. There is a wide range of steepness in the rotation curves; these will be compared with light distributions derived from the CCD images and any correlation with nuclear activity. The colour distribution within the inner region will be related to the near IR and radio emission to help identify the processes at work in these "normal" galactic nuclei.

5. CONCLUSION

Our observations at radio, optical and near IR wavelengths show that nuclear activity is relatively common in normal galaxies. The relationship of this nuclear activity to more wide-spread star forming activity in Sbc galaxies (Hummel et al. 1988) has still to be established.

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