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THE SEYFERT - STARBURST CONNECTION

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RESUMEN

La mayoría de las galaxias Seyfert siguen la misma correlación radio-IR lejano que las galaxias normales y con brote de formación estelar. Esto es interpretado como indicación de que la luminosidad bolométrica de las Seyferts está dominada por formación estelar, aunque no se entiende la relación entre núcleos activos y formación estelar. Una posibilidad es que las galaxias clasificadas ópticamente como de brote tengan un núcleo activo obscurecido, pero demostramos que ese no es en general el caso.

ABSTRACT

Most Seyfert galaxies roughly follow the same radio-far-infrared correlation as starburst and normal galaxies. We interpret this, together with other evidence, to indicate that the bolometric luminosity of most Seyfert galaxies is dominated not by the active nucleus but by starburst activity. However, the relationship between the active nucleus and the starburst activity remains unclear. A potential corollary is that galaxies classified optically as starburst galaxies may have hidden active galactic nucleus obscured by optically thick dust. However, we show that this is not generally the case.

Key words: **GALAXIES: ACTIVE — GALAXIES: SEYFERT — GALAXIES: STARBURST — RADIO CONTINUUM: GALAXIES**

1. INTRODUCTION

Many Seyfert galaxies show a significant amount of star formation, particularly in their nuclear regions. As long ago as 1984, Telesco et al. (1984) showed that half the bolometric luminosity of NGC 1068 is produced by star formation activity, and more recently Mouri & Taniguchi (1992) have argued that much of the FIR emission in Seyferts is produced by star formation activity. This raises the question of whether star formation may be a dominant energy source in Seyfert galaxies. Since the bolometric luminosity of most such galaxies is dominated by the far-infrared (FIR) luminosity, we may use the radio-FIR correlation to examine this hypothesis. Normal spiral and starburst galaxies show a tight correlation between their radio and FIR luminosity (e.g., Wunderlich et al. 1987). This correlation, which extends over five orders of magnitude, is true for both flux density and luminosity, and cannot be accounted for by selection effects, or a simple richness effect. While a detailed mechanism to explain this correlation has yet to be established, it is almost certainly the result of star formation, which generates both the synchrotron radio emission and the thermal FIR emission. This is supported by the fact that all objects that are dominated by star formation (H II galaxies, normal spirals, starburst galaxies) do follow the correlation.

On the other hand, Sopp & Alexander (1991) showed that radio-loud quasars and radio galaxies clearly do not follow the radio-far-infrared correlation. Thus whether or not a galaxy follows this correlation, it may be used as an indicator of the dominant energy source of the galaxy. For example, Roy & Norris (1996) cross-correlated the PMN 6-cm survey with the *IRAS* point-source catalogue and found a number of objects deviating from the radio-FIR correlation. Most Seyfert and starburst galaxies generally followed the correlation, whilst those departing from it included BL Lac objects and radio galaxies.

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2. ARE SEYFERTS DOMINATED BY STARBURST ACTIVITY?

Norris et al. (1988) and Roy et al. (1996) showed that Seyfert galaxies, unlike radio quasars, do roughly follow the radio-FIR correlation, but with a looser fit than normal spirals and starbursts. This suggests that the bolometric luminosity of Seyfert galaxies may be dominated by star formation. This is supported by off-nuclear optical and infrared observations of Seyferts, which show the same line ratios and luminosities as starburst galaxies (Bransford et al. 1996). Thus, although the nuclear optical spectra of Seyfert galaxies are clearly dominated by an active galactic nucleus (AGN), both the integrated radio emission and the far-infrared emission are dominated not by the AGN but by circum-nuclear star formation.

3. DO STARBURST GALAXIES CONTAIN BURIED AGN?

We have observed 210 Seyfert galaxies and 81 starburst galaxies with the 275-km Parkes - Tidbinbilla Interferometer (PTI) at 2.3 GHz (Norris et al. 1988). This has resulted in a high-resolution survey with uniform sensitivity (> 2 mJy) and resolution (0.1 arcsec, corresponding to $20 - 200$ pc over the redshift range of the sample). Thus the PTI is sensitive to structures with brightness temperatures greater than 10^5 K, and so can detect radio emission from compact nuclear objects associated with the AGN, but is blind to extended star-formation activity.

In Seyferts we typically detect about 41 % of the objects observed (e.g., Roy et al. 1994) but in starburst galaxies (Norris & Roy 1996) we detect only 5%. This result shows a significant difference between the two samples, and shows clearly that, although a few starburst galaxies may contain a buried AGN, the majority do not. There is a tendency for these buried AGN to occur in high luminosity objects, such as those classified as ultra-luminous infrared galaxies. Lonsdale et al. (1993) carried out a similar survey on 15 ultra-luminous starburst galaxies and detected eight of them. The difference between this result and that of Norris & Roy may be attributed partly to the fact that the Lonsdale sample were all high-luminosity objects, although the Norris & Roy result demonstrates that even at these high luminosities, some ultra-luminous galaxies are still powered by starburst activity.

4. CONCLUSION

Most Seyfert galaxies obey the same radio-FIR correlation as that which is followed by starburst galaxies, and which is generally taken to be an indicator of star formation activity. We interpret this to mean that both the far-infrared and the radio luminosity, and hence the total bolometric luminosity of most Seyfert galaxies are dominated not by the central AGN, but by starburst activity.

This link between Seyferts and starbursts is not, however, reciprocal, in the sense that starbursts do not often contain hidden AGN cores. Some fraction of ultra-luminous galaxies with starburst spectra do indeed contain hidden AGN, but even at these luminosities there remains some fraction of galaxies which are powered predominantly by starburst activity.

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