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Two Types of Seyfert 2 Galaxies ?

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Abstract. We collect 51 Seyfert 2 galaxies with circumnuclear/nuclear star-forming activities from the recent available literature. After studying their Infrared and Radio properties, we find that those Seyfert 2s with hidden Broad-Line Regions (BLRs) have similar properties as Seyfert 1 galaxies, while for the "real" Seyfert 2s without hidden BLRs, they are similar to the starburst galaxies.

1. Introduction

The connection between AGNs and starburst is one of the most important and active investigations in studying active galaxies. More and more observational evidences show that circumnuclear/nuclear starbursts are common in Seyfert galaxies(Heckman et al., 1997; Gonzalez Delgado et al., 1998). After searching the available literature through ADS and NED for Seyfert galaxies with circumnuclear/nuclear star formation activities as completely as possible, we got a sample of 16 Seyfert 1 and 51 Seyfert 2 galaxies with clear evidence of starburst. Though there exists an observational bias and it is difficult to detect the starburst in Seyfert 1s, our results confirm that star formation activities are more common in Seyfert 2 than in Seyfert 1 (Dultzin-Hacyan et al., 1999). Here we present preliminary results on studying these 51 Seyfert 2 galaxies.

2. Two Types of Seyfert 2 Galaxies ?

Hutchings & Neff (1991) and Neff & Hutchings(1992) have suggested that there are two distinct types of Seyfert 2s, those with hidden Seyfert 1 nuclei (the first type) and those without (the second type). Seyfert 2 galaxies with nuclear starburst should have the steeper IR spectrum and belong to the second type. We plot these 51 Seyfert 2s as shown in Fig 1. As predicted, most of them are located in the second type region. After checking in Veron & Veron (2000), those located in the first type region (with hidden Seyfert 1 nuclei), we find that most of them have broad polarized Balmer lines detected, except IC 4995, MK 607, NGC 5347 and NGC 7672. For NGC 5347, Gonzalez Delgado & Perez (1996) have observed very-high-excitation lines, such as [Ne V], He II, [Fe VII] and [Fe X], which are photoionized by a hard AGN-like continuum. According to Miller & Goodrich (1990), NGC 7672 might have hidden BLRs, but at a flux level below the detection threshold. For the other two sources, IC 4995 and MK 607, there are no spectropolarimetric observations yet. Thus, our results confirm that there might exist two distinct Seyfert 2s: one is the pure Seyfert 2 and the other is the hidden Seyfert 1.

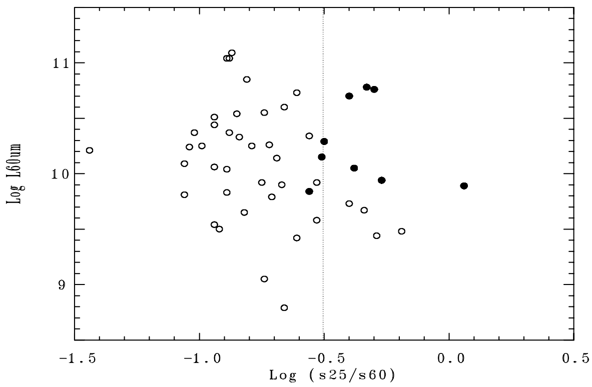

Fig. 1. Distribution of 51 Seyfert 2 galaxies with nuclear starburst in the IR diagram. Open circle represents Seyfert 2 galaxy without hidden Seyfert 1 nucleus, and filled circle for Seyfert 2 with hidden Seyfert 1 nucleus.

3. Radio and FIR Properties

It is well known that there exists a tight relation between radio and far infrared (FIR) emission for normal, starburst and Seyfert galaxies (the later with more scatter). We define q to be the ratio of FIR to 1.49 GHz emission as in Helou (1985). For AGNs, q is less than 2.0, and for starburst, it will be around 2.21 (Condon et al. 1991). And according to de Grijp et al. (1985), the spectral index between 25 um and 60 um, $\alpha(25{,}60)$, is a powerful parameter for finding new AGNs, with AGN-like colour, $-1.5 < \alpha(25{,}60) < 0.0$. Thus, we plot 51 Seyfert 2s in the diagram q vs. $\alpha(25{,}60)$ (see Figure 2). Most of them are located in

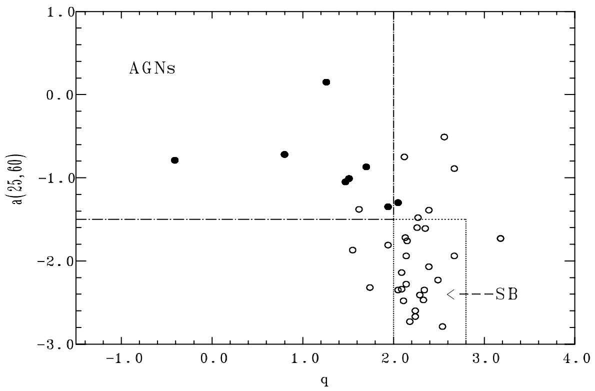

Fig. 2. Distribution of 51 Seyfert 2 galaxies with nuclear starburst in the diagram of ratio of FIR to radio (q) vs. the IR spectral index. The symbol has the same meaning as in Fig. 1.

the starburst region (lower right). For NGC 4639 (q = 3.18) is classified as Seyfert 1 in Veron & Veron (2000), the IRAS 25 um flux is given as lower limit, so α(25,60) is just a lower limit. And it has the largest FIR excess, which may be due to the mismatch of different beam sizes in IRAS and the NRAO/VLA Sky Survey (NVSS) observations. There are eight galaxies locating on the upper-left AGN region, but six of them are Seyfert 2 with hidden Seyfert 1 nuclei. The other two are NGC 3393 and NGC 4507. For NGC 3393, Cooke et al. (1997) detected broad emission lines, so it might contain a Seyfert 1 in the center. As for NGC 4507, Veron et al. (1981) classified it as a weak Seyfert 1, and recent ASCA observation indicated there is a Fe Kα line at 6.4 kev (Comastri et al. 1998). IC 3639 also has a hidden Seyfert 1 nucleus, and locates nearby. It indicates again that the pure Seyfert 2s (without hidden Seyfert 1 nuclei) have the similar properties as starburst galaxies.

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