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Seyferts at milli-arcsec scales

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Abstract. We have observed a sample of Seyfert galaxies using Global Very Long Baseline Interferometry at 5 GHz. Our goal is to investigate the systematics of their nuclear radio morphology on milli-arcsecond scales. We have chosen our objects so as to be able to test the predictions of the Unified Schemes for Seyfert galaxies. We present preliminary results of the VLBI observations.

Key words : Seyfert galaxies, active galactic nuclei, VLB Interferometry

1. Seyfert galaxies and unified schemes

Seyfert (Sy) galaxies are nearby Active Galactic Nuclei (AGNs) which occur mostly in spiral hosts and are "radio-quiet" objects. We define a Sy galaxy as a radio-quiet object (i.e. the ratio of 5 GHz to B-Band flux density < 10), whose host galaxy is a spiral and has nuclear $[OIII]_{FWHM}$ > 300 kms^{-1}. There are two kinds of Sy galaxies, types 1 and 2, distinguished by the widths of their spectrophotometrically observable emission lines; the implied kinematic Doppler widths are > 1000 kms^{-1} and < 1000 kms^{-1} for the two types, respectively.

The Unifited Scheme (US) for Sy galaxies hypothesizes that Sys of Type 1 and 2 comprise a single population. Broad Emission Lines (i.e. lines with implied Doppler widths > 1000 kms^{-1}) have been detected in a few Sy 2s in polarized light. This argues for Broad Emission Lines being present in these Sy 2s but being hidden from view by obscuring material that lies between their Broad Line Region (BLR) and the observer. Current theoretical models of AGNs purport that the obscuring material is both optically and physically thick, and surrounds the central engine and BLR in the form of a torus. According to the US, the torus is present in all Sys; in other words, Sy 1 and Sy 2 galaxies differ only in orientation of the axisymmetric active nucleus with respect to the observer.

2. Why study Seyfert galaxies at radio wavelengths on milli-arcsec scales ?

Sy galaxies have low radio emission, but they do show radio emitting jet-like structures on small scales which appear to be the low-power analogues of jets seen in radio powerful AGNs (Nagar et al. 1999 and refs therein). The US predicts that the total radio emission should be similar in the two classes of Sys (since the radio emission is unattenuated by the obscuring torus), and their radio structures should differ only by projection effects. However, this issue is controversial; e.g. Roy et al. (1994) report that compact radio emission is detected in more Sy 2s than Sy 1s. This result is inconsistent with the predictions of the simple US. The inconsistency remains even if mild relativistic beaming is invoked, because in this case, the face-on AGNs, viz., Sy 1s, would be more likely to show compact structures. *Our goal is to test predictions of the US by investigating the nuclear radio morphology of Seyferts using a MATCHED sample of Sy 1 and Sy 2 galaxies.*

3. Observations

Our sample selection criteria were as follows : (i) the object should be a *bona fide* Sy galaxy (cf. our definition), (ii) it must be in a host galaxy that is a confirmed spiral, (iii) it must be detected with ~ 1 arcsecond resolution at 4-6 cm, and have nuclear flux density at λ_{4-6cm} > 8mJy on these scales (i.e. as observed by VLA-A or -B array; this criterion was required to make our experiment feasible), and (iv) it must have observed ratio of minor and major isophotal diameter axes > 0.5; we thereby exclude edge-on host galaxies. Note that, as per our definition of Sy types, we find that both Sy 1s and 2s are observed in edge-on, face-on and intermediate hosts (isophotal diameter ratios gleaned from de Vaucouleurs et al. 1991 & Lipovetsky et al. 1988). Further, the axis of the radio jet and that of the host galaxy are not known to be related.

From all Seyferts with available nuclear radio flux density (at ~ 1 arcsecond resolution) in the literature (i.e. all VLA-A, & -B array observations of Sys) we chose 10 Sy 1s and Sy 2s each that met the above criteria, such that, the two sub-samples had similar distirbutions of heliocentric redshift, luminosity of the host galaxy (i.e. minus the AGN) in the optical B-filter, $[OIII]_{5007}$ luminosity, and galaxy bulge luminosity. Thereby we ensured that the sub-samples of Sy 1s and Sy 2s are MATCHED, as far as possible, with respect to their intrinsic AGN power and host galaxy properties using *orientation-independent* parameters.

4. Preliminary results

We observed 15 objects from our sample in Feb 1998 at 5 GHz, using 14 stations of the trans-global VLBI network (including VLA, VLBA and EVN stations) giving a resolution of ~ 2 milli-arcseconds. The data reductions are in progress. We have completed the process of fringe fitting for all the sources and have detected fringes. As the phase - VLA was one of the stations, we have simultaneous VLA data also for all the objects. Our perliminary results indicate that the ratio of the compact (milli-arcsec scale or few parsec scale) radio emission to the extended (kpc-scale) emission is not significantly different for the two Sy sub-classes, consistent with the prediction of the simple US, i.e. with no relativistic beaming invoked.

References

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