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Multiwavelength Properties of Narrow-line Seyfert 1's: Studying One Extreme of the AGN Primary Eigenvector

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Abstract. Narrow Line Seyfert 1 galaxies (NLS1s) are an important subclass of radio quiet AGN having extreme optical and X-ray spectroscopic properties. Their relationship to other types of Seyferts remains unclear. NLS1s exhibit many characteristics of Seyfert 1 AGN, but their optical spectra show narrow permitted lines, and some high ionization species. This may result from us viewing them close to 'pole-on' orientation with respect to an inner torus geometry. We present comparisons of the radio and X-ray properties of NLS1s with those of the $12\mu m$ and CfA Seyfert samples.

1. Introduction

"Narrow-Line Seyfert 1s" (NLS1s) were first identified as a distinct subclass of Seyferts by Osterbrock & Pogge (1985). They have intriguing optical properties: while their permitted lines are narrow like Seyfert 2s (on the order of 1000km s^{-1}), they show other characteristics which are normally associated with Seyfert 1s. They have [O III]λ5007Å/Hβ flux ratios of < 3, indicating the presence of a High-Density Region (HDR). They also exhibit blends of Fe II emission multiplets and high ionisation lines such as [Fe VII]λ6807Å and [Fe X]λ6375Å.

The X-ray properties of NLS1's are also unusual; their X-ray spectra are typically steep, and exhibit soft X-ray excesses. They may show large-amplitude, rapid soft X-ray variability; IRAS 13224-3809 varies by a factor $\sim$ 60 in the ROSAT HRI band with a doubling time of $\sim$ 900s (Boller et al. 1997). The cores of bright emission lines such as Lyα also appear to vary.

2. Observations

To date, the only systematic radio imaging of NLS1's has been the work of Ulvestad et al. (1995). We extend Ulvestad et al.'s work in three important respects: (a) we have a systematically-selected sample for comparison with normal Seyferts, (b) we use multi-frequency scaled-array observations to construct accurate spectral maps, and (c) MERLIN 6cm observations have been obtained or approved for 10 of our 15 sources. The combination of MERLIN and VLA data will give high sensitivity to both compact and extended structures.

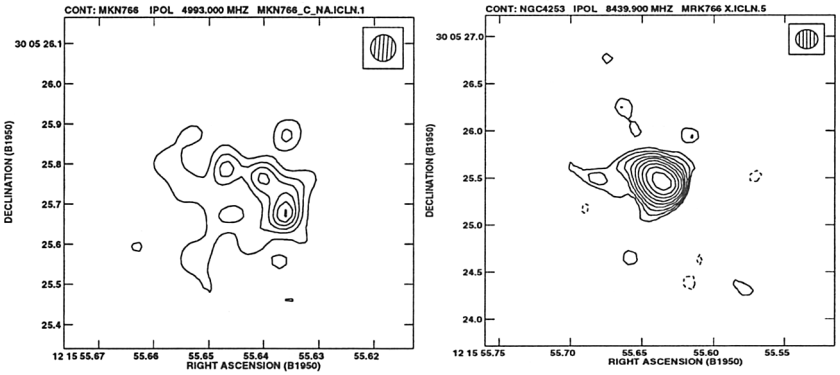

Figure 1. Left: 5GHz MERLIN image of Mkn 766 (Andy Thean, Priv. Com). Right: 8GHz VLA A array map of Mkn 766, from archive data

3. Radio Structures

If NLS1's are generally "pole-on", then we might expect them to have radio structures which are somewhat "blazar-like", containing a significant fraction of their flux in a compact, flat-spectrum core, and having foreshortened, distorted radio jets. Initial MERLIN imaging of the NLS1 Mkn 766 supports this; the jet is one-sided and curved through $\sim 90°$ within 200mas. Radio-loud quasars exhibit an inverse correlation between Hβ line width and radio core dominance (Wills & Browne 1986). The situation for radio-quiet objects is less clear, but the narrow permitted line width in NLS1's may be similarly linked with beaming.

There are currently no published studies of radio variability in NLS1's, despite their known strong variability in other wave bands. We are currently reducing multi-epoch VLA data on one target, IRAS F13349+2438, which we believe to have undergone strong variation (factor ~ 10 in 5 years).

Data on about 25 objects have been retrieved from the VLA archive. Snapshot images of another 20 will be obtained in B array at 6cm under our recent successful observing proposal. Two NLS1s (Mrk 766 and I Zw 1) have been previously studied by MERLIN. Images of a further 8 NLS1s have been obtained under our successful observing proposal.

References

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