Radio Spectra of Intermediate Luminosity Broad-Line Radio Galaxies

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In Brief

Are there any fundamental differences in the physics of **radio-loud (RL)** and **radio-quite (RQ)** AGN? Are both classes capable of forming jets? Is there any fundamental difference in the **central engines** that power those two species? Are both the environmental and intrinsic factors playing a role? These questions are only some of the unresolved matters involved in the study of physics of AGN. A large potential in gaining some insight is stored in the detailed comparison of RL and RQ AGN of similar luminosity.

Introduction

There exist evidences supporting the idea that the nature of the radio emission in RL and RQ is of similar origin. For instance, Gallimore et al. (2006) argue that the radio emission has an AGN origin. Barvainis et al. (2005) support similar radio emission mechanisms. However, **divergence in their X-ray spectra suggests differences in the accretion flow**. Seyfert 1s show a **strong Fe Kα** line and an **excess of emission at high energies** (e.g. Nandra & Pounds 1994). These features are weak or absent in **Broad-Line Radio Galaxies** (e.g. Wozniak et al. 1998, Sambruna et al. 1999, Ballantyne et al. 2004, and Lewis et al. 2005), the radio-loud counterpart to Seyfert 1s. This may be caused by **increased ionization** of the accretion disk, **beaming** X-ray emission, or **dilution** of the reprocessed emission by a jet. The study of BLRGs mostly focuses on a few nearby high luminosity objects. It is **necessary that more intermediate luminosity BLRGs** are studied in order to accomplish a fruitful comparison between Seyferts and BLRGs.

Ultimate Goals

To determine the **Spectral Energy Distribution** from radio to X-rays. The SEDs can provide vital information about the **relative importance** of various emission mechanisms. In particular, BLRGs are observed at **intermediate viewing angles**, and the relative contributions of the **jet** and **disk** at **X-ray wavelengths is debated**.

With contemporaneous radio and X-ray observations one can investigate the **relative contribution** of the jet and disk, and whether it **changes with luminosity**. To test **multi-wavelength correlations**.

Studies of powerful radio galaxies show strong correlations between $L_{[OIII]}$ and L_{5GHz} and L_X (e.g. Tadhunter et al. 1998, Sambruna et al. 1999). However, it has been suggested (Best et al. 2005) that these correlations might not hold at low radio luminosities.

Observations

The **XMM-Newton** satellite provides measurements at X-ray, UV and optical bands. The **Wyoming Infrared Observatory** will provide the IR data whereas the radio band is covered by the **100-m Effelsberg telescope**. Given the low flux densities of the targets, it is an admittedly challenging task only feasible with the 100-m telescope.

The observations are done with the 2.6, 4.85, 8.35, 10.45, 14.60 and 32.00-GHz receivers. The measurements are done in “cross-scan” mode that allows the immediate **detection of confusion** cases and the correction of **pointing offset** errors. The use of multi-beam receivers provides a **supreme atmospheric effect subtraction** and hence reaching low flux density limits (a few mJy). The duty cycle per spectrum is roughly 30-40 minutes. Each measurement is corrected for telescope gain variations and atmospheric opacity effects. For calibration, the standard calibrators are used such as 3C286, 3C48, NGC7027 and 3C161.

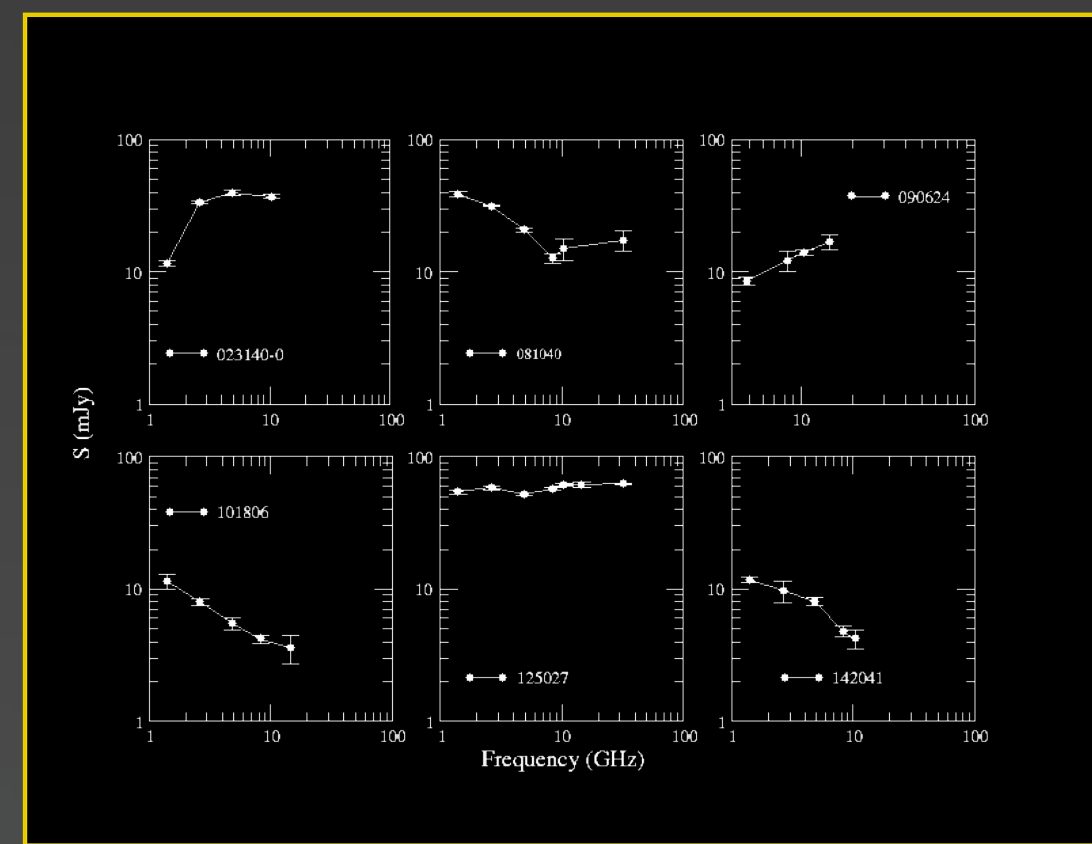
Sample

Source (SDSS J)	z	$S_{1.4}$ (mJy)
090624.60+005756.0	0.070	5.6
101806.68+000559.7	0.049	14.3
125027.42+001345.5	0.047	63.0
142041.03+015930.8	0.078	11.9
150754.38+010816.7	0.061	5.4
155855.79+024833.9	0.047	5.2
003937.83-001943.3	0.055	10.9
23140.97-011003.6	0.054	11.7
081040.29+481233.2	0.078	37.8
170007.17+375022.2	0.063	5.2
233604.04+000447.1	0.077	18.8

The target sample consists of 11 intermediate-luminosity BLRGs candidates at z<0.1. Their 2-10 keV luminosities lie between 10^{42} - 10^{43} erg/s. They were selected among 429 RL AGN with z<0.1 on the basis of having broad Hα lines after careful subtraction of the starlight from the host galaxy (Hao et al., 2005). They are summarized in the table above.

Results and Conclusions

In the figure below are shown some of the observed spectra. It is immediately obvious that the task of measuring their spectra is extremely challenging provided how low their radio flux density is.



As it is seen, the sources possess a **large variety of spectra shapes**. For example, 081040 has a fairly common radio spectrum. Bellow 10 GHz it is dominated by a steep spectrum component (-0.42) whereas at higher frequencies seems to be dominated by possibly a core component of flat spectrum. 125027 is also a typical case of a flat spectrum source. The spectral index is around 0.05 and the source is likely to be core dominated. Contrary to the previous cases, the spectrum of 090624 appears to be less typical. Its rising trend is characterized by a spectral index of 0.62 suggesting a self absorbed system. Therefore, we are tracing its optically thick part. Alternatively, such phenomenology could be attributed to a flat spectrum source (core-dominated) that undergoes a flaring event.

From all the above it is clear that the BLRGs show a variety of radio spectra rather than a uniform shape. All these results in conjunction with the X-ray, UV, optical and IR data are in preparation for publication (Sambruna et al. 2007).

Literature

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