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What Types of Jets Does Nature Make? A New Population of Blazars

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Abstract. We have recently discovered a population of strong-lined blazars with jet synchrotron emission peaks in the UV/X-ray regime. So far, only radio quasars with lower synchrotron energy cut-offs (and so X-rays dominated by inverse Compton emission) were known. Here we present the first VLA maps and preliminary results from XMM spectroscopy of these new class of blazars and discuss their relation to the high-energy peaked BL Lacertae objects.

Key words. quasars – BL Lacertae objects – synchrotron emission – jets

1. Introduction

Blazars come in two flavors: BL Lacertae objects (BL Lacs), defined to have no or only very weak emission lines, and flat-spectrum radio quasars (FSRQ), defined to have strong narrow and broad emission lines. The two blazar subclasses differ also in their jet properties. BL Lacs have jets with synchrotron emission peaks within a wide range of frequencies, from IR/optical to UV/soft-X-ray energies, whereas only quasars with low spectral energy cut-offs were known so far. Two recent surveys have drastically changed this picture. About 10% of the FSRQ discovered in the Deep X-ray Radio Blazar Survey (DXRBS; Perlman et al. 1998, Landt et al. 2001) and $\sim$ 30% of the ones identified in the RASS-Green Bank Survey (RGB; Laurent-Muehleisen et al. 1998) have broad-band emission properties typical of high-energy peaked BL Lacs (Padovani et al. 2003). Our research aims at assessing if these quasars have indeed synchrotron emission maxima in the UV/X-ray regime. A positive result would indicate, similarly to the pure existence of radio-quiet quasars, that jet and accretion disk properties are not very closely linked. Moreover, it would undermine the theory that cooling by an external radiation field, such as the one produced by, e.g., the accretion disk, controls the frequency position of the synchrotron emission peak (Ghisellini et al. 1998).

2. Observations

We have obtained deep radio and X-ray observations for 19 high-energy peaked quasar candidates. We have observed 14 of these with the VLA in A+C array at 1.4 GHz, 4 sources with BeppoSAX (Padovani et al. 2002), 4

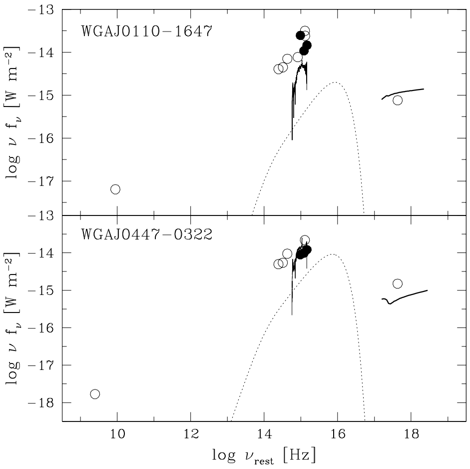

Fig. 1. Spectral energy distributions for two quasars observed with XMM-Newton. Filled circles and thick solid line indicate simultaneous observations with the OM and EMOS detectors. A simulated accretion disk spectrum is shown as dotted line.

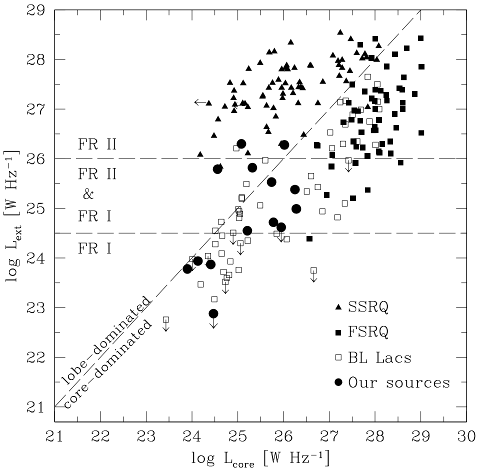

Fig. 2. Extended versus core luminosities at 1.4 GHz for the 14 sources observed with the VLA (filled circles) compared to samples of steep-spectrum radio quasars (SSRQ), FSRQ and BL Lacs.

sources with XMM-Newton, and 6 sources are scheduled for observations with Chandra in the present cycle.

3. Preliminary Results

Two of the high-energy peaked quasar candidates observed with XMM-Newton show a flat X-ray emission spectrum ($\alpha_{\rm x} \sim 1$) indicative of inverse Compton rather than synchrotron radiation. Fig. 1 shows their spectral energy distributions. The synchrotron emission in both these sources peaks at frequencies $\sim 10^{15} - 10^{15.5}$ Hz, about an order of magnitude higher than in previously known FSRQ. However, these values are considerably lower than the ones found for extreme high-energy peaked BL Lacs of $\sim 10^{17}$ Hz.

We have found a population of either FR IIs with extremely low luminosities or of quasars harbored by FR Is. Our VLA observations of 14 high-energy peaked quasar candidates (Fig. 2) show that they extend the range of intrinsic radio powers of strong-lined blazars to the low values typical of BL Lacs. Four of the observed sources are lobe-dominated and a classification of their extended radio morphology is possible. Out of these three sources show an FR II-like morphology, whereas we tentatively classify one source as an FR I.

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