Exploring the bulk of the BL Lac object population: parsec scale radio properties and gamma ray emission

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SUMMARY: ***BL Lac objects have been found to be the largest population of emitters in gamma-ray band. However, since they are relatively weak radio sources, their parsec scale structure and most of their radio properties are poorly known. To increase our knowledge of the BL Lac object popuplation, we selected a sample of BL Lacs from the BZ Cat at low redshift (z < 0.2), with no constrain on the radio flux density and gamma-ray activity. We present here the results of a first VLBA observation at 8 and 15 GHz and shortly discuss their properties.***

Conclusions. In our sample we find a dual BL Lac population: Doppler Dominated objects (DD) where the presence of relativistic jets is evident from radio images and Lobe Dominated (LD) BL Lacs, where radio images do not show any evidence of the presence of relativistic jets with high Doppler factor. Most of bright BL Lacs are DD sources (23 in our sample) in agreement with unified models, while LD BL Lacs (11) are low power radio sources with jets slightly misaligned or not highly relativistic. They could be BL Lacs in a non active-phase. **Among sources detected by the Fermi satellite (2LAC) in our sample, 12 are DD and only 2 are LD objects, confirming the strong correlation between radio and high-energy properties.**

In all sources the comparison between the correlated VLBA flux density and the NVSS flux density suggests the presence of a sub-kpc scale structure.

8 sources have not been detected by VLBA and not classified because of the low NVSS flux density

Results: as shown in Figure 1, our sample of BL Lacs investigates properties of the bulk population of these objects, missing in previous VLBI surveys as **MOJAVE-1** or **VIPS** because of selection effects (high flux density limit).

♦27/42 (64%) of BL Lacs in our sample have been detected with VLBA at 8 GHz and 25/42 (60%) at 15 GHz. Most of detected sources (63%) show a one-sided structure, for the others only a point-like emission is visible

♦**For all BL Lacs we estimated the Core Dominance CD defined as the ratio between the observed core radio power and the expected core radio power from the correlation between the total and nuclear radio power derived by Giovannini et al. 1994. The CD distribution is shown in Fig. 2, where for comparison we added also the 2 BL Lacs and radio galaxies from the Bologna Complete Sample (BCS, Liuzzo et al. 2009).**

♦ **Source Compactness (SC):** We estimated the SC defined as the ratio between the correlated VLBA flux density at 8 GHz and the NVSS flux density, for all BL Lacs of our sample, see Fig. 3.

♦ **Gamma ray properties:** BL Lacs detected in the gamma-ray band, show a **high CD and SC**.

The VLBA flux density at 8 GHz is well correlated with the Gamma-ray flux density (Fig. 4) with the exception of J1419+5423, observed during a known radio flare

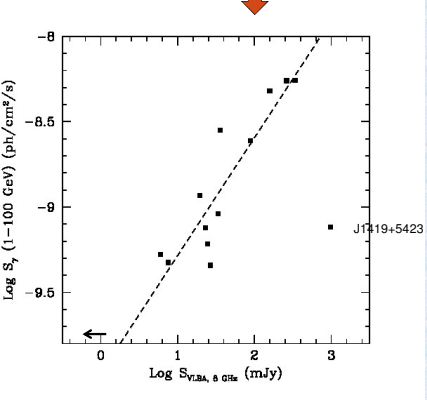

Fig. 4: Log of Gammay-ray flux (2LAC) versus Log of the correlated VLBA flux density at 8 GHz

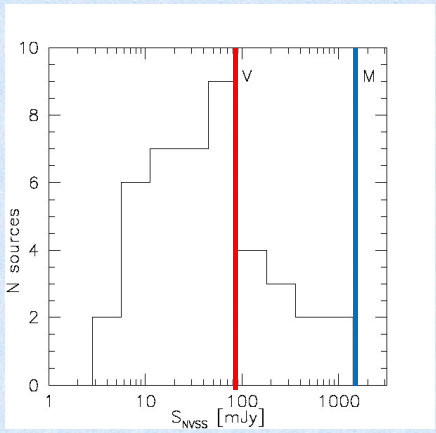

Fig. 1 – Distribution of the NVSS 1.4 GHz flux density for BL Lacs of our sample. Flux density limits for BL Lacs in the MOJAVE-1 and VIPS sample are shown, assuming a spectral index = 0

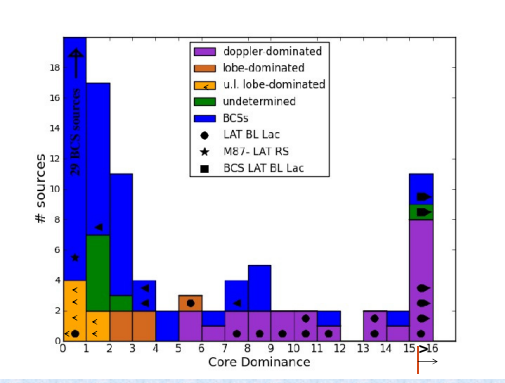

Fig. 2 – Core Dominance (CD) distribution for BL Lacs of our sample and radio galaxies from the BCS

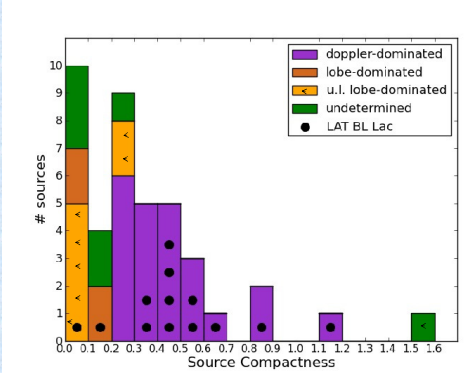

Fig. 3 – Source Compactness (SC) for BL Lacs in our sample