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Nuclear structures in γ–ray loud blazars

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Abstract. We present the status of our study on the nuclear radio morphology and properties of a sample of 15 γ–ray loud blazars detected by EGRET. The sample, including BL–Lacs and quasars, was imaged at parsec–scale resolution with the EVN and VLBA at 1.6 GHz and 5 GHz. VLA observations at 8.4 GHz and 22 GHz were also undertaken, in order to study the alignment between the parsec and kiloparsec scale radio emission. Beyond the core dominated sources, which is the typical morphology of strongly beamed objects, our images show a variety of structures. New images and a preliminary considerations will be given here.

1. Radio and γ–ray emission in AGNs

One of the most significant results of EGRET, on board of the Compton Gamma Ray Observatory, was the discovery of γ–ray emission from AGNs. 66 AGNs were detected at energies above $\sim$ 100 MeV (e.g. Hartmann et al. 1999). They all belong to the class of “blazars” and they are all radio loud. Superluminal motion along their parsec–scale jet is a common feature, suggesting that the γ– ray loud population is strongly affected by beaming. It is now thought that the γ–ray emission originates in the closest proximity of the central engine, both in the accretion disk region and within the inner relativistic jet (e.g Marscher 1995).

The discovery of γ–ray emission from AGNs, while adding new critical information on the nature of the central engine and on the properties of the inner jet, poses new puzzling questions. In particular, the relation between the radio and γ–ray emission is not fully established yet, and the reason why only a fraction of superluminal radio sources is also γ–ray loud is still unknown.

The possibility that the γ–ray loud population of radio sources is more strongly beamed has been investigated through the study of superluminal motion and through the distribution ΔPA, the angle between the parsec and kiloparsec scale jet (misalignment). On the basis of multi-epoch observations of large samples, both Kellermann et al. (1999) and Jorstad et al. (2001) concluded that γ–ray loud AGNs have on average higher superluminal motion than the γ–ray quiet population. Moreover, among the γ–ray loud population, quasars have much higher speeds than BL–Lacs.

The amount of bending in radio jets and the misalignment between the parsec and kiloparsec scale is also a beaming indicator. Hong et al. (1998) studied the distribution of ΔPA on a sample of EGRET sources, and found that it differs for quasars and BL–Lacs. In particular, $\Delta PA_{QSO} \leq 30°$, while $60° \leq \Delta PA_{BL} \leq 150°$.

Here we will show some new and challenging results on a subsample of EGRET sources, observed at parsec and kiloparsec scale resolution.

2. Observations and images

Using the EGRET catalog (Hartman et al. 1999) we selected 15 γ–ray loud sources with little radio information both on the parsec and kiloparsec scale. This sample includes 13 quasars in the redshift range from 0.85 to 2.084, and 2 BL–Lacs at z $\sim$ 0.2.

The sources (Hong et al. in preparation) were observed with the VLBI and with the Very Large Array. In particular, EVN observations were performed at 5 GHz with an array including Effelsberg, Shanghai, Jodrell Bank, Medicina, Noto, Onsala, Hartebeesthoek, Simeiz, Urumqi, WSRT, Torun; VLBA observations were carried out at 1.6 GHz; VLA observations at 8.4 GHz (A and C array) and at 22 GHz (A array). The resolution ranges from $\sim 3'$ to $0.2'$ for the VLA observations, and from $\sim$ 10 to 1 mas for the VLBI observations. The quality of the images is very good, and the rms is about 0.8 and 0.1 mJy/beam respectively for the VLBI and VLA.

The images obtained show a variety of morphologies. In Figures 1 to 4 we show the most interesting sources. Only 7 out of the 15 imaged sources are dominated by a strong component on the parsec scale, as it would be expected in the presence of strong beaming effects (Fig. 1). The morphology of the remaining 8 sources is similar to radio galaxies and quasars affected by moderate beaming. In particular, we found five sources with a long and well defined radio jet containing a high percentage of the total VLBI flux density (Fig. 2), one source containing a lot of extended flux density on the parsec scale (Fig. 3) and one double source, one symmetric source (Fig. 4).

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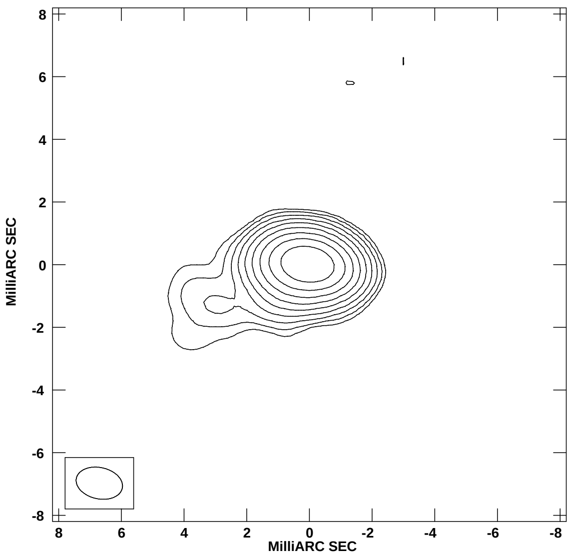

Fig. 1. EVN image of 0446+112. The peak flux density is 0.49 Jy/b. Logarithmic contours are given, the lowest being 0.8 mJy/b.

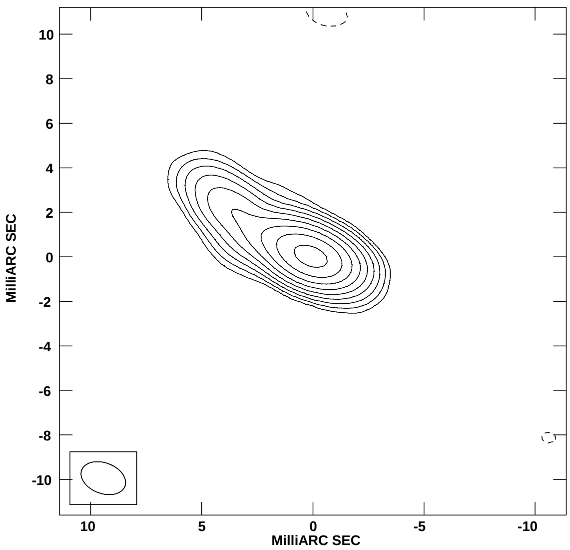

Fig. 2. EVN image of 0829+046. The peak flux density is 0.58 Jy/b. Logarithmic contours are given, the lowest being 1.76 mJy/b.

3. Perspectives and future work

At present we are adding the information on these 15 sources to the distribution of ΔPA, and we are carrying out our study through *(a)* imaging of the most interesting sources at higher frequencies for an unambiguous morphological classification, and *(b)* multi-epoch observations in search for possible proper motion along the jets.

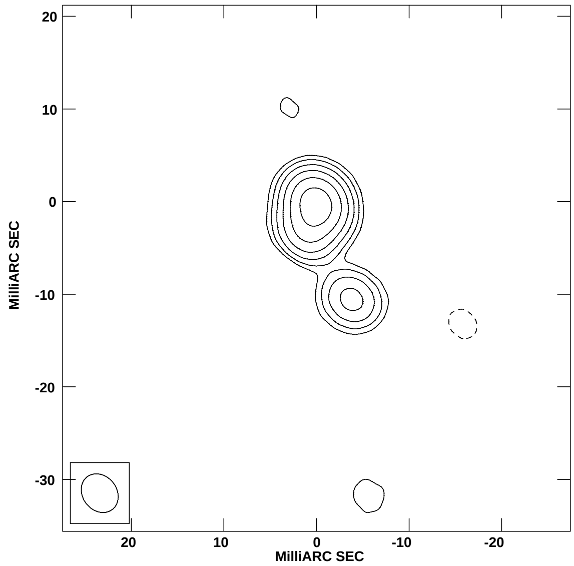

Fig. 3. EVN image of 0954+556. The peak flux density is 0.11 Jy/b. Logarithmic contours are given, the lowest being 2.27 mJy/b.

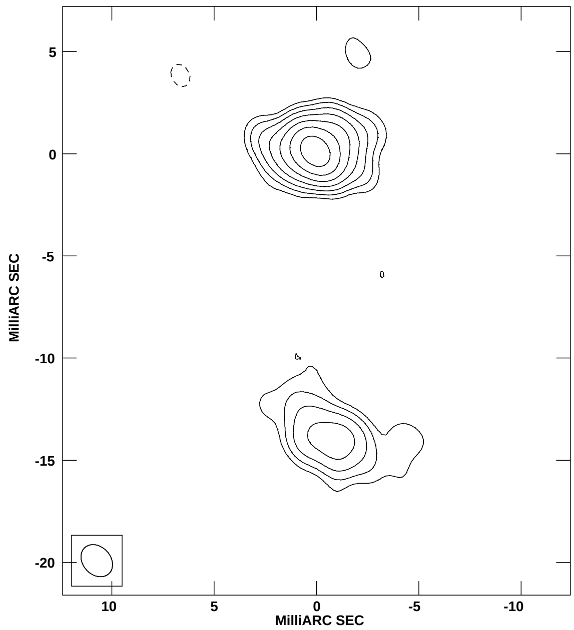

Fig. 4. EVN image of 2356+196. The peak flux density is 0.11 Jy/b. Logarithmic contours are given, the lowest being 2.27 mJy/b.

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