

Parsec-scale properties of GHz-Peaked Spectrum sources from 2.3 and 8.6 GHz VLBI surveys

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We investigate the sample of 213 GPS sources selected from simultaneous multi-frequency 1–22 GHz observations obtained with RATAN–600 radio telescope. We use publicly available data to characterize parsec-scale structure of the selected sources. Among them we found 121 core dominated sources, 76 Compact Symmetric Object (CSO) candidates (24 of them are highly probable), 16 sources have complex parsec-scale morphology. Most of GPS galaxies are characterized by CSO-type morphology and lower observed peak frequency (~ 1.8 GHz). Most of GPS quasars are characterized by “core-jet”-type morphology and higher observed peak frequency (~ 3.6 GHz). This is in good agreement with previous results. However, we found a number of sources for which the general relation CSO – galaxy, core-jet – quasar does not hold. These sources deserve detailed investigation. Assuming simple synchrotron model of a homogeneous cloud we estimate characteristic magnetic field in parsec-scale components of GPS sources to be $B \sim 10$ mG.

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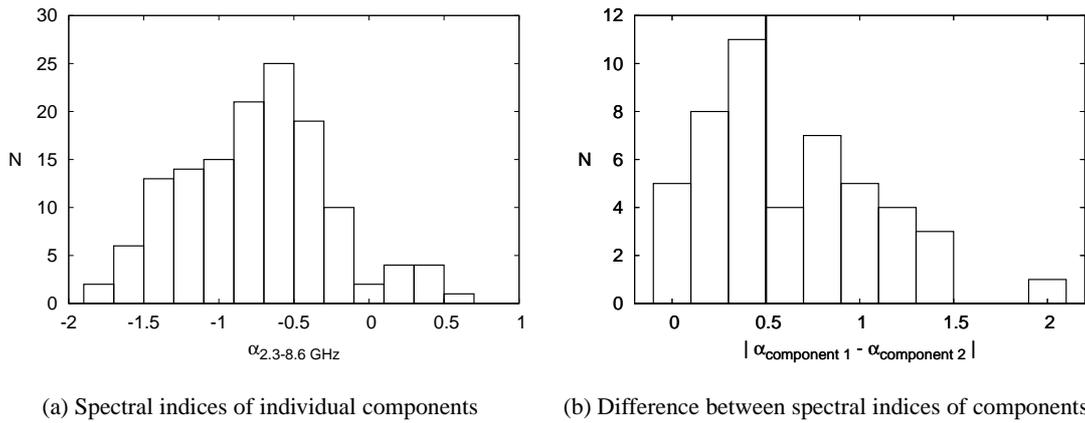


Figure 1: Distributions of 2.3–8.6 GHz spectral indices of VLBI components of CSO candidates.

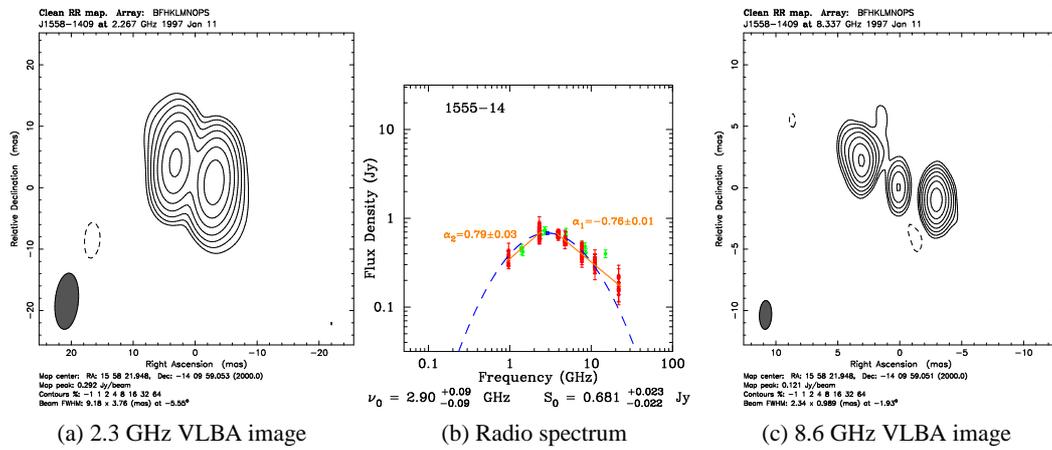


Figure 2: PKS 1555–140 – new GPS galaxy with CSO morphology at $z = 0.097$. Red points on the panel (b) denote RATAN–600 observations, green points represent literature data.

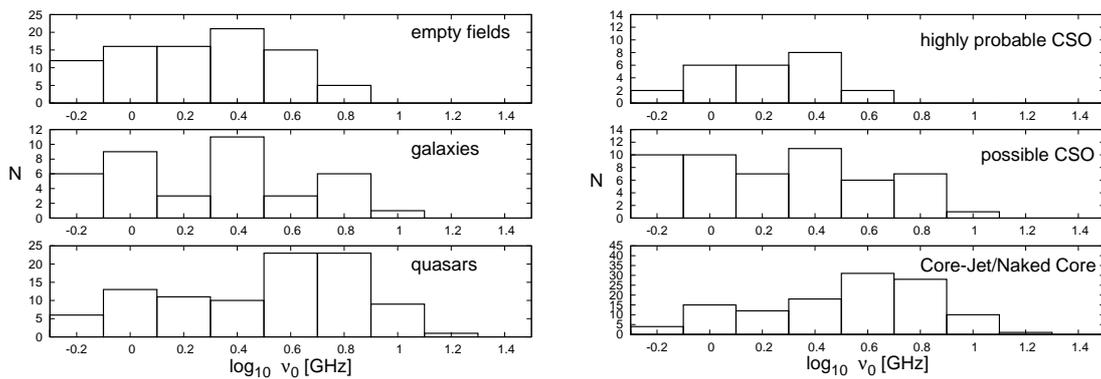


Figure 3: Observed peak frequency distribution for GPS sources with different optical identification and parsec-scale radio structure.

We use publicly available¹ 2.3 and 8.6 GHz VLBI data from the VLBA Calibrator Survey ([3] and references therein) and the Research and Development – VLBA (RDV, [2], [4]) project to characterize pc-scale properties of 213 GPS sources from the RATAN–600 sample [7]. After a visual inspection of the VLBI images we have divided the sources in to three groups: 1) “core-jet/naked core” sources, 2) possible Compact Symmetric Objects (CSO) and 3) sources with complex pc-scale morphology.

To further distinguish between true CSO and core-jet sources with two dominating components (a core and a jet feature), we have modeled the visibility data for all CSO candidates using *DIFMAP* package [5] with two circular Gaussian components. We have selected sources which have two components detected at both 2.3 and 8.6 GHz images and constructed the spectral indices (between 2.3 and 8.6 GHz) for each component (Fig. 1a). The distribution of difference between the spectral indices of two components of these sources is presented on Fig. 1b. Since two mini-lobes of a CSO are expected to have close spectral indices², we selected 24 sources with spectral index difference between two pc-scale components less than 0.5 as “highly probable CSO candidates”. Example of a newly identified GPS galaxy associated with a CSO is presented on Fig. 2.

Information about the optical identification for the sources was taken from [9] and from the NASA/IPAC Extragalactic Database. We found, with a few exceptions, that CSOs are associated with GPS galaxies and core-jet sources are associated with GPS quasars. This is in good agreement with previous results (e.g., [8]). The distributions of the observed peak frequency for GPS sources with different optical counterparts and with different pc-scale morphology are presented on Fig. 3. GPS sources associated with CSO are characterized by the lower observed peak frequency (~ 1.8 GHz) then core-jet sources (~ 3.6 GHz).

By combining the single-dish spectrum with VLBI angular size measurements we can estimate the magnetic field in pc-scale components of a radio source using simple synchrotron model (e.g., [6], [1]). We estimate the characteristic magnetic field in the pc-scale components of GPS sources to be $B \sim 10$ mG.

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¹Compilation of publicly available VLBI data at <http://lacerta.gsfc.nasa.gov/vlbi/images>

² $S_{\nu} \sim \nu^{\alpha}$