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Do Jets Exist in All Compact Extragalactic Objects?

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Abstract. New results of instantaneous spectra study confirms an old hypothesis that extragalactic radio sources have a double structure. Instantaneous 1–22 GHz spectra and their long-term variability for VLBI-compact extragalactic objects monitored during 1979–1997 at the RATAN–600 are used. Analysis of these spectra gives that a VLBI-compact continuous jet have to be by a general structure and spectra component of such objects. The observed multi component VLBI-structures are bound to be, as a rule, the brightest regions of such continuos jet. A second component is a relatively extended, optically thin cloud (a lobe or an envelope, connected with the jet), weaker to higher frequencies. Thus, the HF-component of such spectra, measured by VLBI and by a single dish antenna, have to be practically the same. Such jets can exist in about 200 compact objects of our sample and seem to exist in majority or even all extragalactic compact objects.

1. Results and Discussion

The long-term RATAN–600 monitoring and analysis of the variable and VLBI–compact objects from the catalogue by Preston et al. (1985) are carried out since 1979 (Berlin et al. 1992). An individual spectrum is measured at all frequencies during the interval of several minutes. Such "instantaneous" 1–22 GHz spectra at 5–7 frequencies have been monitored up to now for about 11 sources in 1979–1982 with 4 sets per a year, 50 sources in 1982–1987 (3–4 sets/year), 110 sources in 1987–1992 (3–4 sets/year), 200 sources in 1994–1996 (4–5 sets/year), 500 sources in 1997, March, 10–27 and June, 13–30. About 80% of the data obtained in the period of 1979–1996 are used in this study.

Practically all obtained instantaneous spectra can be presented as a combination of spectra of low-frequency (LF) and high-frequency (HF) components, which can be attributed to 2 components of the structure—a lobe or an envelope (LF) and a compact jet (HF). They generate more than 90% of the total centimeter and decimeter emission of the object. The HF-component can be considered as a spectrum of a continuous milliarcsecond jet with quasi-stationary ejection along the radial magnetic field following the Hedgehog model (Figure 1; the discussion see in Kovalev 1995a). A variability of the flow of relativistic particles from a nucleus to a jet and/or a precession of the jet provide the variability of the spectrum (following the work by Kovalev & Larionov 1994). As a rule, if a strong variability is observed, a transition (rapid or slow) between 2 states of spectra (initial and final) is observed, and each of them can be explained as a simple spectrum from a stationary jet in the double object (see Figure 1). The transition spectra itself can be more complicated, because a "wave of variability" moves from HF to LF, transforming the spectrum from the first to the next shape (following Berlin et al. 1992). Such behavior is consistent with a continuous jet idea.

First results of calculations of such model structure do not contradict to the typical maps of VLBI observations, including multi-component maps also. In the last case visible multi-component VLBI structure can represent a complex intensity distribution along the jet with variable ejection, indicating that such object must have the variable in time structure and spectra (Kovalev 1995b).

Such jets seem to exist in majority of other VLBI-compact extragalactic radio sources with "flat centimeter spectra" ($\alpha > -0.5$, $F_\nu \propto \nu^\alpha$), because of the completeness of our samples and the catalog used.

These conclusions are planned to be checked in 1997–2000, involving a new full sample of 555 sources from the same catalogue (with correlated flux more than 0.1 Jy at 13 cm inside declinations of $-30°$ to $+43°$). All earlier lists and the sources of VSOP survey inside these declinations have been included in the new list also. This mass monitoring has been started in March, 1997. It includes the most representative sample than ever before and is called to give the final answer to the question in the title of the paper. It is interesting to test this conclusion by the simultaneous spectra–structure observations for many sources, using VSOP and ground VLBI/VLBA networks.

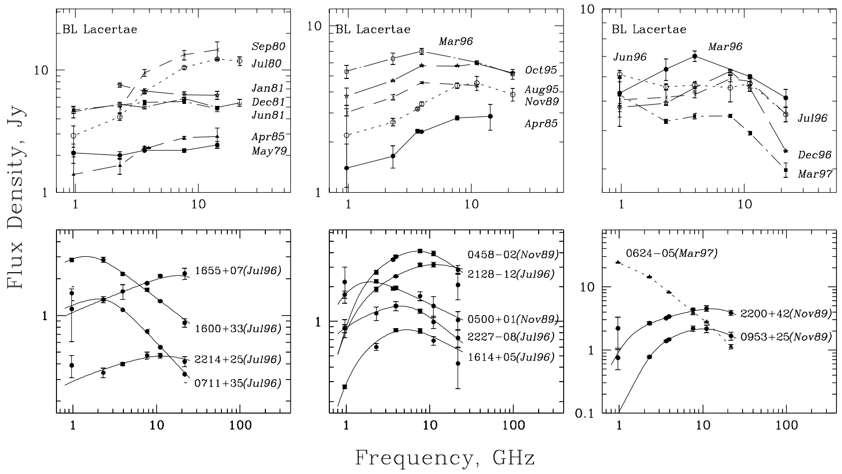

Figure 1. Some results of instantaneous spectra monitoring and model fitting. The top boxes show the observational data for BL Lacertae during 1979, May–1997, March, (connected points); the bottom boxes: observed spectra (points) as examples of various shapes of spectra together with jet model fits (lines). All spectra can represent a jet's nature of the objects and a connection of the jet with an extent lobe or envelope (more or less strong LF–spectra component, example for 0624–05). A typical total spectrum is similar to a sum of lobe's and jet's spectra of 0624–05 and 2200+42 (or 0953+25) with their various deposits (right bottom box).

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