JETS IN 20 AGNS WITH STRONG LONG-TERM VARIABILITY OF 1–22 GHZ SPECTRA

Yu.A. Kovalev[1], A.B. Berlin[2], Y.Y. Kovalev[1], N.A. Nizhelsky[2]

[1] Astro Space Center of the Lebedev Physical Institute
Profsoyuznaya 84/32, 117810 Moscow, Russia, *ykovalev@dpc.asc.rssi.ru*
[2] Special Astrophysical Observatory
Nizhny Arkhyz, Karachaevo-Cherkessia, 357147 Russia

ABSTRACT. Results of multifrequency broad band spectra observations and their interpretations by the Hedgehog relativistic jet model are presented for 20 strong variable radio sources. The many years strong variability of well known objects, including BL Lac and OJ 287 for 20 years, is analyzed. Instantaneous 5–7 frequency spectra were measured at the RATAN–600 radio telescope over the period from 1979 to 1999. The strong long-term variability of the spectra is explained by the variability of a continuous relativistic jet with a variable ejection of it from an active nucleus in quasi radial magnetic field.

Key words: galaxies: active — galaxies: jets — BL Lacertae objects: general — quasars: general

1. Introduction

The general final aim of any experiments is a study of an origin of processes, which give rise to the observational phenomenon. For the given case it is a study of an origin of variable extragalactic radio sources. The phenomenon of the variability can be qualitatively interpreted in terms of an activity of a central nucleus of a galaxy or a quasar. Nevertheless the problems exist for a quantitative explanation of the variability by a concrete physical model: the longer the temporal and the wider the frequency intervals of an analysis (as well as the more a number of frequencies), the worse the quantitative fit to the observational data, as a rule.

Earlier we had fitted a relativistic jet model of variable extragalactic radio sources to the instantaneous 1–22 GHz spectra at 6–7 frequencies for 79 variable sources at 1–2 epochs, as well as the similar explanation had been done for the observational shapes of about 200 VLBI-compact extragalactic objects (Kovalev & Kovalev, 1996, 1997). Now we report on successful results of a comparison of the same model with our multi epochs observations of instantaneous 1–22 GHz spectra for 20 well known variable radio sources.

2. Observations and the Model

Observations were carried out at the RATAN–600 radio telescope during 1979–1999 in the framework of our monitoring program to study the long-term spectra variability of extragalactic radio sources. Each individual spectrum was measured during several minutes at all frequencies and averaged on the set for a few spectra measurements. Observations were done with 3–4 sets per year, excluding several years because of modernizations of the antenna and other reasons. Duration of each set was 1–3 weeks. 1–22 GHz spectra were measured at 5-7 wave lengths of the following: 1.00/1.38, 2.08/2.7. 3.9, 6.0, 7.6, 8.2, 13 and 31 cm. The part of the presented data was published earlier. Details see in Kovalev (1998), Kovalev et al. (1999).

The following sources with strong long-term variability are included in the analysis:

1. BL Lac and OJ 287 (for 20 years), 3C 84, 3C 120, 3C 273, 3C 279, 3C 345, 3C 454.3, 4C 39.25, 1510−08, 2134+00 for 1979–1999;
2. CTA 102, 0528+13 (Nimfa), 1055+01, 1124−18, 1219+04, 1730−13, 1749+09, 2209+23 for 1989–1999;
3. 0109+22 for 1979–1999.

The typical amplitude of variability during the presented period was several times more than the minimal value of the flux density for these objects.

The Hedgehog jet model (Kardashev, 1969) is used to study an origin of these variable sources (full references see in Kovalev & Kovalev, 1996, 1997). To explain the observed quantities of the polarization by the model, we assume that the observed emission is strongly depolarized — for an example, by the Faraday rotation in the ambient magnetized plasma of the jet, an envelope or a lobe along the line of sight.

3. Results

Presented well known variable radio sources (quasars, galaxies, BL Lacs) with strong long-term radio variability from our many years multi epochs multifrequency measurements:

1. show the natural wave-like changes of the instantaneous spectra in centimeter-decimetre wave lengths on the scales from a few weeks to several years;
2. have one/two component shapes of the instantaneous spectra, the high frequency component of which is variable, and the low frequency component, if it is detected, is not variable;
3. can be explained in the framework of the Hedgehog relativistic jet model (with an accuracy about or more than 90%) by a variable persistent flow of relativistic particles from an active nucleus of an object in the strong quasi radial magnetic field.

The jet in the model is associated with the observed high frequency component of the spectra. The time scale of the spectra variability at higher frequencies is equal to the scale of the variability of the flow of relativistic particles from an active nucleus. Any short scale can be in the model, including the variability during a day, if it is permitted by a mechanism of the variability for the flow of the particles from the nucleus.

Acknowledgements. Observations are partly supported by the State Program of Science and Technology "Astronomy" (grant 1.2.5.1) in 1997–1999 and by the Russian Foundation for Basic Researches (grant 99–02–17799) in 1999. YAK thanks also his wife Zina for the partly support of travels to do the observations in 1994–1998 from the family budget.

References

Kardashev N.S.: 1969, Epilogue to the russian edition of the book Burbidge J., Burbidge M., *Quasars*, Mir, Moscow.

Kovalev Yu.A., & Kovalev Y.Y.: 1996, *Odessa Astron. Publ.*, **9**, 163.

Kovalev Yu.A. & Kovalev Y.Y.: 1997, *Astrophys. Space Sci.*, **252**, 133.

Kovalev Yu.A.: 1998, *Bull SAO*, **44**, 50.

Kovalev Y.Y., Nizhelsky N.A., Kovalev Yu.A., Berlin A.B., Zhekanis G.V., Mingaliev M.G., Bogdantsov A.V.: 1999, *Astron. Astrophys. Suppl.*, **139**, 545.