Flux densities and spectral indices of Relaxed Double radio galaxy 3C 84

Vesna Borka Jovanović[1], Duško Borka[1] and Predrag Jovanović[2]

[1]Department of Theoretical Physics and Condensed Matter Physics (020), Vinča Institute of Nuclear Sciences, P.O. Box 522, 11001 Belgrade, Serbia

[2]Astronomical Observatory, Volgina 7, P.O. Box 74, 11060 Belgrade, Serbia

VINČA INSTITUTE OF NUCLEAR SCIENCES

ASTRONOMICAL OBSERVATORY BELGRADE

e-mail: **vborka@vinca.rs, dusborka@vinca.rs, pjovanovic@aob.rs**

BPU11 CONGRESS

Motivation

Here we study the flux densities at 1380, 4908 and 15365 MHz, as well as the radio spectral index distribution of 3C 84, a Double Radio source Associated with Galactic Nucleus (DRAGN). 3C 84 is the dominant giant elliptical galaxy in the Perseus cluster, and thus very interesting for our research. This famous radio galaxy Perseus A has Relaxed Double classification because it has the large halo, with the lack of its compact structure. We calculated the radio spectral index distribution over the whole area of the source, which we then also used to investigate the nature and mechanisms of its radiation.

Data

- J. P. Leahy, A. H. Bridle, R. G. Strom, An Atlas of DRAGNs (2013): http://www.jb.man.ac.uk/atlas/

- NASA/IPAC Extragalactic Database: http://ned.ipac.caltech.edu/

Method

$$T_{\mathrm{b},\nu} = K\nu^{-\beta}$$

- $T_{b,\nu}$ - brightness temperature, ν – frequency, β - brightness temperature spectral index

$$S_\nu = K_1\nu^{-\alpha}, \quad \beta = \alpha + 2$$

- S_ν - flux density, α - flux density spectral index
- Radio spectral index α as negative value of coefficient of the line:

$$\log S_\nu = \log K_1 - \alpha \log \nu$$

(see details in [1-4])

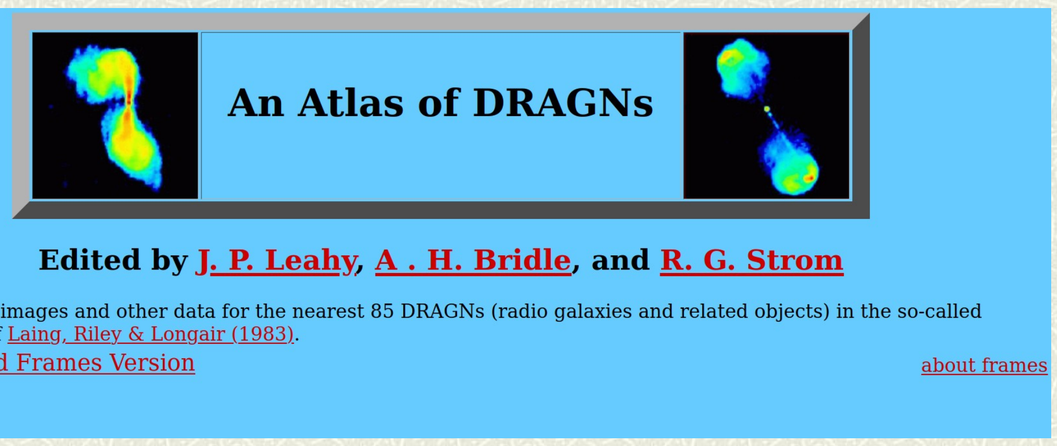

Figure 1. Leahy's Atlas of DRAGNs.

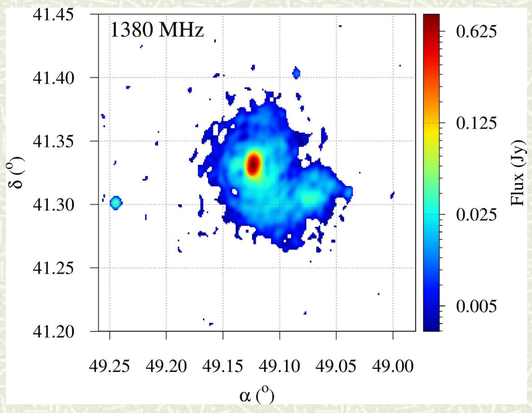

Figure 2. 3C 84 at 1380 MHz.

3C 84 is is the famous **radio galaxy** Perseus A, the dominant giant elliptical galaxy in the Perseus cluster.

Cross-identifications:
NGC 1275; Perseus A; UGC 02669; MRK 1505; MRK 9013.

Observations with the RadioAstron space telescope have shown that there are the core shifts in the jets, and also that its position may become frequency dependent. There are also strong indications for a precession of the 3C 84 jet. Therefore, the radio spectral index maps are calculated after image alignment.

3C 84 B0316+413

Basic Data

S_{178}	Alpha	FR	Class	ID	Spectrum	Best z	mag.	LAS	lg P_{178}	D
66.8	0.78	I	RD/SSC	Gal		0.0179	R(c) = 11.17	1350.00	24.52	454.0

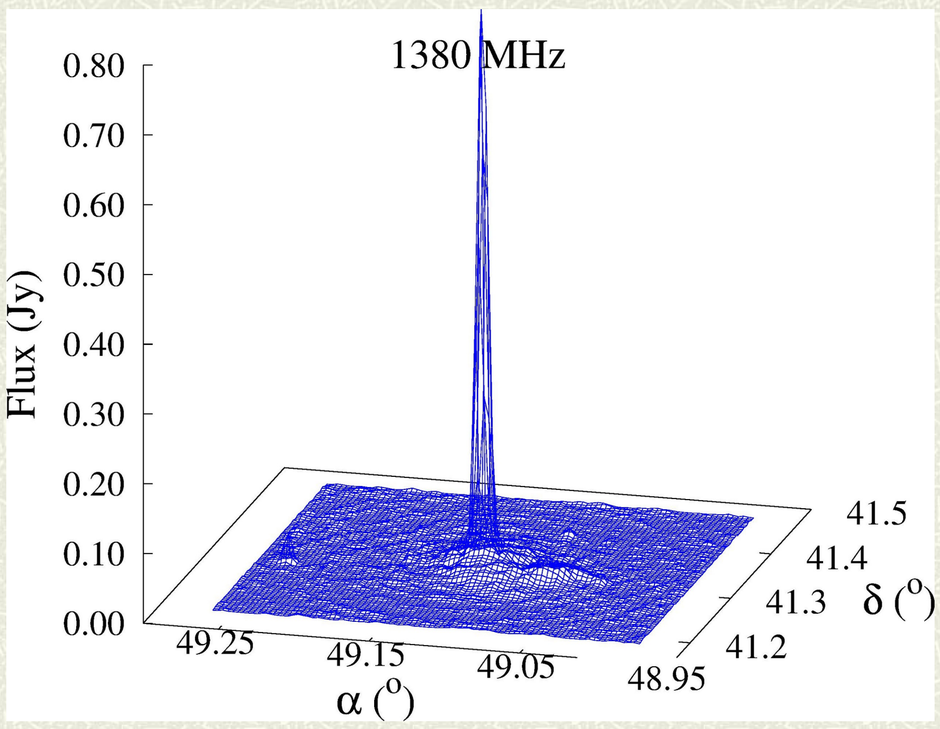

Figure 3. The flux density 3D plot for 3C 84 at 1380 MHz.

Results and conclusions

- ν_1 = 1380 MHz (22 cm) – obs. date 1984
- ν_2 = 4908 MHz (6 cm) – obs. date 1998
- ν_3 = 15365 MHz (2 cm) – obs. date 1995

We found that the non-thermal (synchrotron) radiation dominates over the area of the studied source.

We also calculated spectral indices of the nortnern and southern hotspots, between each pair of the three frequences:

- northern hotspot: α_{12} = 0.64, α_{13} = 0.92, α_{23} = 1.23
- southern hotspot: α_{12} = -1.42, α_{13} = -0.72, α_{23} = 0.06

References

[1] V. Borka Jovanović, *Estimation of brightnesses and spectral indices of radio loops*, Publ. Astron. Obs. Belgrade 91, 121-127 (2012).

[2] V. Borka Jovanović, D. Borka, R. Skeoch, P. Jovanović, *Spectral index distribution of radio AGNs: case study of 3C 349*, Publ. Astron. Obs. Belgrade 91, 255-260 (2012).

[3] В. Борка Јовановић, П. Јовановић, Д. Борка, *Расподела спектралних индекса код радио лобова: случај галаксије NGC 6251*, Зборник радова XII Конгреса физичара Србије, Врњачка Бања, Србија, 28. април - 2. мај, 367-370 (2013).

[4] V. Borka Jovanović, D. Borka, A. Arsenić, P. Jovanović, *Spectral index distribution over radio lobes of 4C 14.11 using astrophysical data in FITS format*, Adv. Space Res. https://doi.org/10.1016/j.asr.2022.05.062 (2022).