

Studies of the characteristics of the extended galaxy 4C 39.04 and the distribution of extragalactic sources around it

M.A.Hovhannisyan¹, V.A. Hovhannisyan^{*1,2}, S.A. Mkhitarian¹, L.A. Mahtesyan¹, and A.P. Mahtessian³

¹NAS RA Institute of Applied Problems of Physics, Armenia

²Yerevan State University, 1 Alex Manoogian Street, 0025 Yerevan, Armenia

³NAS RA V. Ambartsumian Byurakan Astrophysical Observatory (BAO), Armenia

Abstract

Studies are being conducted on the distribution of extended radio sources and extragalactic objects in their region. This work presents the results of the study of the distribution of extragalactic sources around the radio galaxy 4C 39.04. 4C 39.04 is a giant radio galaxy, both in terms of size and intensity. Within this source, there are numerous compact sources, and the appearance of the radio spectra of compact and extended sources differs significantly.

The distribution of extragalactic sources around the galaxy shows that the number of extragalactic sources near this radio galaxy is quite small. If this is not due to absorption by extragalactic matter, it can be concluded that there are very few extragalactic sources in this region, which distinguishes it from other regions. Thus, there is a deficiency of extragalactic objects around the radio galaxy 4C 39.04.

Keywords: *Quasar, radio galaxy, void, extended radio sources, radio spectrum, Universe*

1. Study of the Distribution of Extragalactic Sources Around the Giant Radio Source 4C 39.04

We conducted studies on the distribution of extended radio sources and the extragalactic objects surrounding them. This work presents the results of an investigation into the distribution of extragalactic sources around the radio galaxy 4C 39.04, selected from a catalog of radio sources with angular sizes of 20 arcminutes or more. Such sources are classified as giant radio sources.

Among these sources, 16 quasars and 19 radio galaxies have been identified. All of them are located in the northern sky and are considered giant radio sources. Although quasars are typically very compact extragalactic objects, the quasars in this list are surrounded by extended radio sources. In certain cases, associating a specific radio source with a quasar is quite challenging. However, some components of these radio sources are identified with quasars, and for that reason, we consider such quasars to be associated with the extended radio source surrounding them.

In the case of radio galaxies, the galaxy is located at the center of the radio source, and during our investigations, the extended radio source is considered to be physically associated with that radio galaxy Hovhannisyan et al. (2024), Hovhannisyan et al. (2025).

This study presents the results of an analysis of the radio galaxy 4C 39.04 and the distribution of extragalactic sources within its surrounding region.

2. Methodology

All available observational data were collected for the radio galaxy itself as well as for the distribution of extragalactic sources within a 6-degree radius around it. The distribution of galaxies, galaxy pairs, galaxy triplets, galaxy groups, galaxy clusters, and quasars within this 6-degree radius area has been examined. Radio observations of 4C 39.04 at different frequencies allow for determination of the galaxy's radio dimensions and radio spectrum (Bondi et al. (1993), Saripalli et al. (1996), Ishwara-Chandra & Saikia (1999),

*vahehovhannisyan173@gmail.com, Corresponding author

Schoenmakers et al. (2000), Konar et al. (2004)). The isophotal maps at various frequencies make it possible to determine the size of the radio source at each frequency, among other parameters. These multi-frequency isophotes studies provide a detailed understanding of the shape and intensity of the radio source. Furthermore, spectral analysis helps to estimate the age of the radio source (Healey et al. (2007), Kuźmierz et al. (2018)) The isophotes of this radio galaxy suggest that both extended and compact components are present around it (Figure 1). From the figure, we can see the size of the radio source, and that in addition to the extended component, compact radio sources are also present. This is also seen at other frequencies (Figures 2 and 3). Figure 3 shows the direction and magnitude of magnetic field polarization, which reveal the structure and intensity of the radio sources. Spectral studies show that the radio spectrum is fairly steep, with a spectral index of $\alpha = 1.1$, which is typical for extended sources and radio halos (Figure 4). The extended radio source also contains numerous compact components, whose spectra are relatively flat—indicating that these components are younger in nature.

3. Study of the Distribution of Extragalactic Objects in the Vicinity of the 4C 39.04 Radio Source

The studies were carried out on the basis of the data available in electronic databases {<https://ned.ipac.caltech.edu/>}. As in other works, the investigation of the distribution of extragalactic sources in the vicinity (within a 6° radius) of the radio galaxy 4C 39.04 was divided into two parts: all extragalactic sources and quasars separately. Figure 5 shows the distribution of all extragalactic sources by redshift, where it is evident that the sources are mainly located in the redshift range $z \in [0, 1]$. Therefore, it is not possible to discuss the distant universe on the basis of these extragalactic sources. Figure 6 presents the redshift distribution of quasars. In this range, there are only about 100 quasars, and the diagram of their distribution by redshift does not allow us to confidently determine whether the distribution is homogeneous or inhomogeneous.

In other regions, the number of quasars is considerably larger, which has allowed us to draw conclusions about the inhomogeneity of certain areas of the universe. Figures 3 and 4 show the distribution of quasars in the vicinity of the NGC 315 galaxy (Figure 7) and the quasar 0851+20 (Figure 8). These figures demonstrate how many quasars are present in those regions and how homogeneously they are distributed (Hovhannisyan et al. (2024), Hovhannisyan et al. (2025)).

4. Conclusion

1. The 4C 39.04 radio galaxy is a giant radio galaxy in terms of both size and intensity; numerous compact sources are present within that source.
2. The spectra of the compact and extended sources differ significantly.
3. The distribution of extragalactic sources around the galaxy is quite sparse, and unless this is due to absorption by extragalactic matter, we can conclude that there are very few extragalactic sources in that region.

5. References

References

- Bondi M., Gregorini L., Padrielli L., Parma P., 1993, *Astronomy and Astrophysics, Suppl. Ser.*, **101**, 431
- Healey S. E., Romani R. W., Taylor G. B., Sadler E. M., Ricci R., Murphy T., Ulvestad J. S., Winn J. N., 2007, *The Astrophysical Journal Supplement Series*, **171**, 61
- Hovhannisyan M. A., Mkhitarian S. A., Mahtessian L. A., Vardanyan J. P., Markosyan A. M., Minasyan A. M., Mahtessian A. P., 2024, *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, **1060**, 169098
- Hovhannisyan M. A., Mkhitarian S. A., Mahtessian L. A., Karapetyan A. P., Mahtessian A. P., 2025, *Nuclear Instruments and Methods in Physics Research Section A*, **1073**, 1700264
- Ishwara-Chandra C. H., Saikia D. J., 1999, *Monthly Notices of the Royal Astronomical Society*, **309**, 100
- Konar C., Saikia D. J., Ishwara-Chandra C. H., Kulkarni V. K., 2004, *Monthly Notices of the Royal Astronomical Society*, **355**, 845
- Kuźmierz A., Jamroz M., Bronarska K., Janda-Boczkar K., Saikia D. J., 2018, *The Astrophysical Journal Supplement Series*, **238**, 9
- Hovhannisyan M.A. et al.
doi: <https://doi.org/10.52526/25792776-25.72.1-84>

Saripalli L., Mack K. H., Klein U., Strom R. ;and Singal A. K., 1996, *Astronomy and Astrophysics*, [306](#), 708

Schoenmakers A. P., Mack K. H., de Bruyn A. G., Röttgering H. J. A., Klein U., van der Laan H., 2000, *Astronomy and Astrophysics Supplement*, [146](#), 293

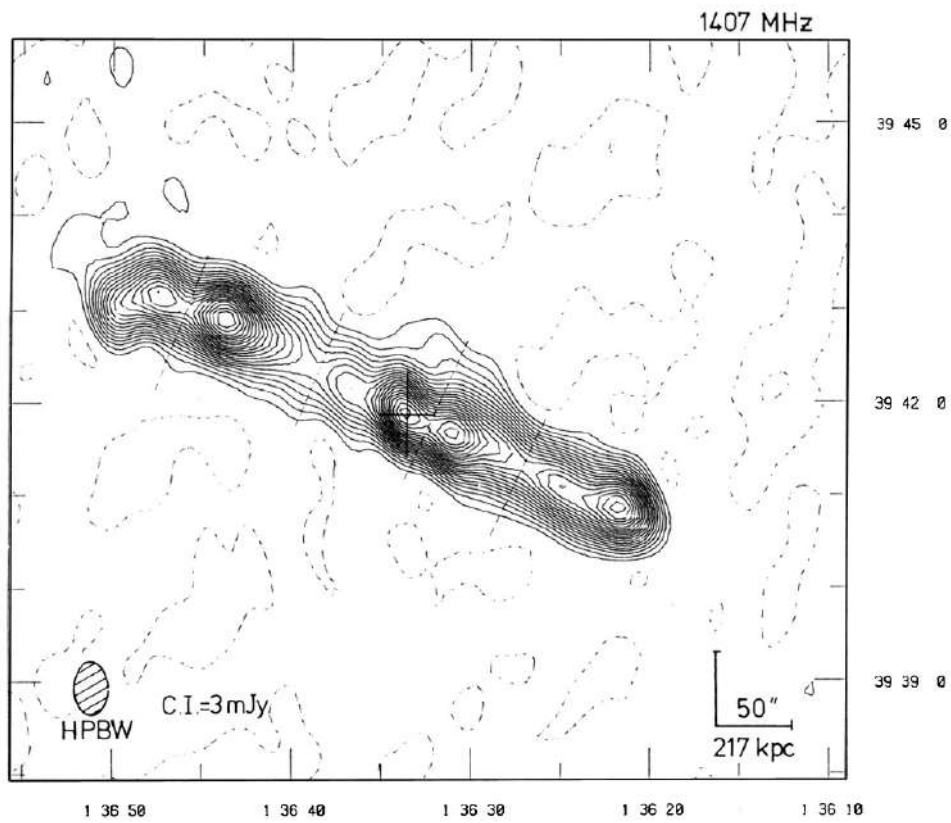


Figure 1. Isophotes of the radio source at 1407 MHz.

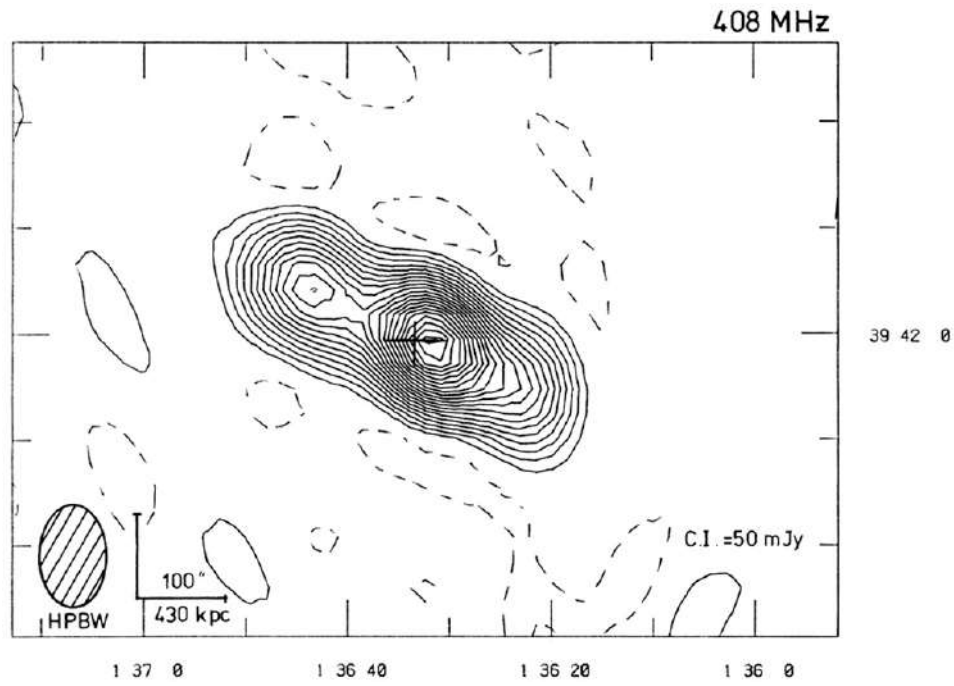


Figure 2. Isophotes of the radio source at 408 MHz.

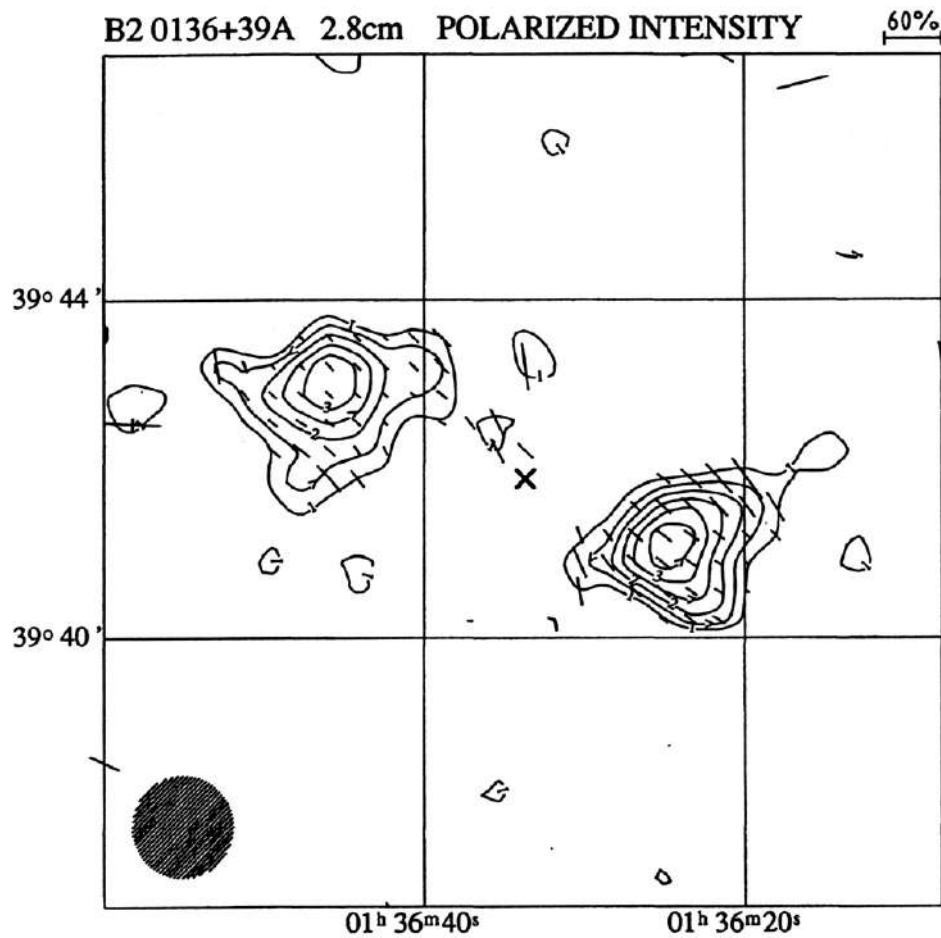


Figure 3. Isophotes of the radio source at 10.6 GHz.

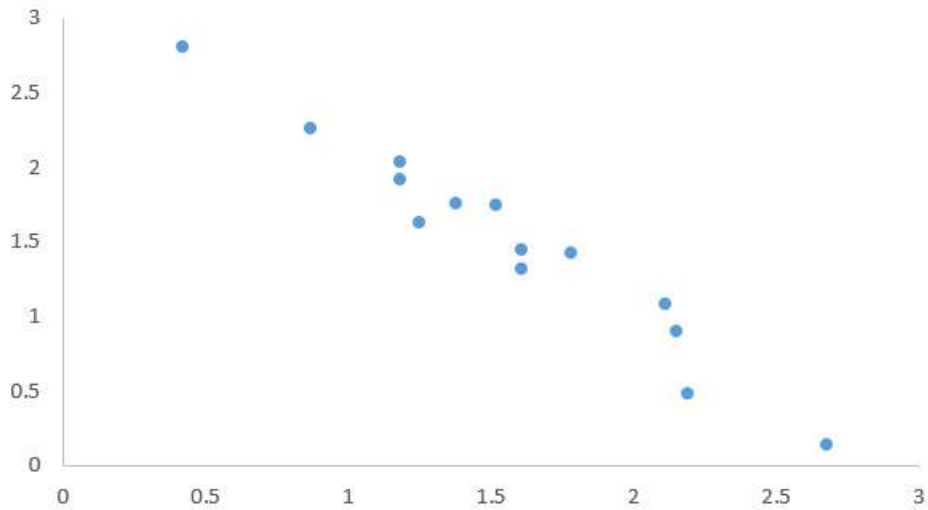


Figure 4. Spectrum of the extended radio source 4C 39.04 (error bars are not shown, as the image is very clear and uncertainties are unavailable for some data points).



Figure 5. Histogram of the distribution of extragalactic sources by redshift.

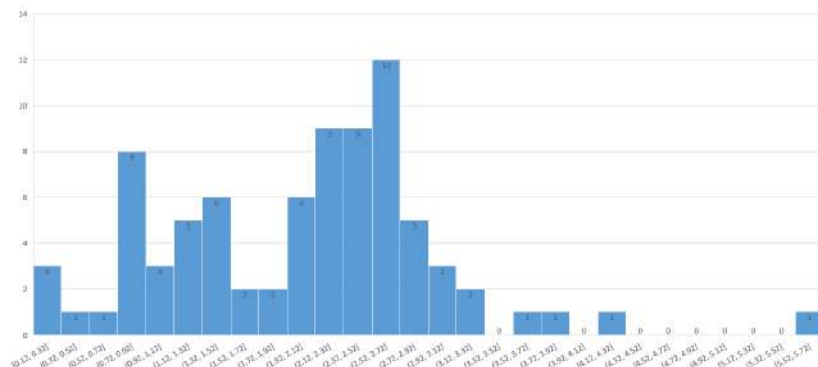


Figure 6. Histogram of the distribution of quasars by redshift.

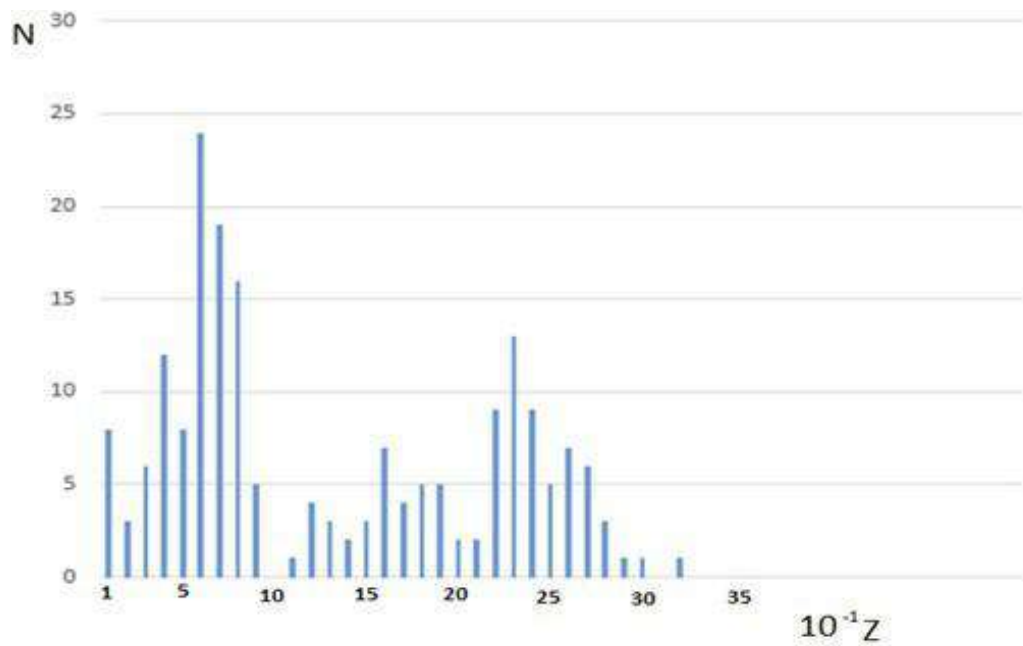


Figure 7. Histogram of the distribution of quasars by redshift (NGC 315).

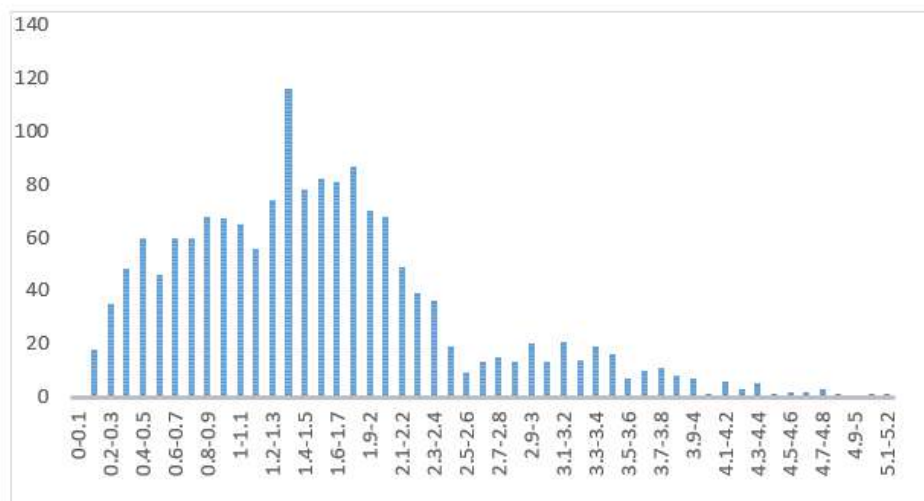


Figure 8. Histogram of the distribution of quasars by redshift (0851+20).

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