Multiwavelength radio analysis of 2 Mpc – size radio galaxies

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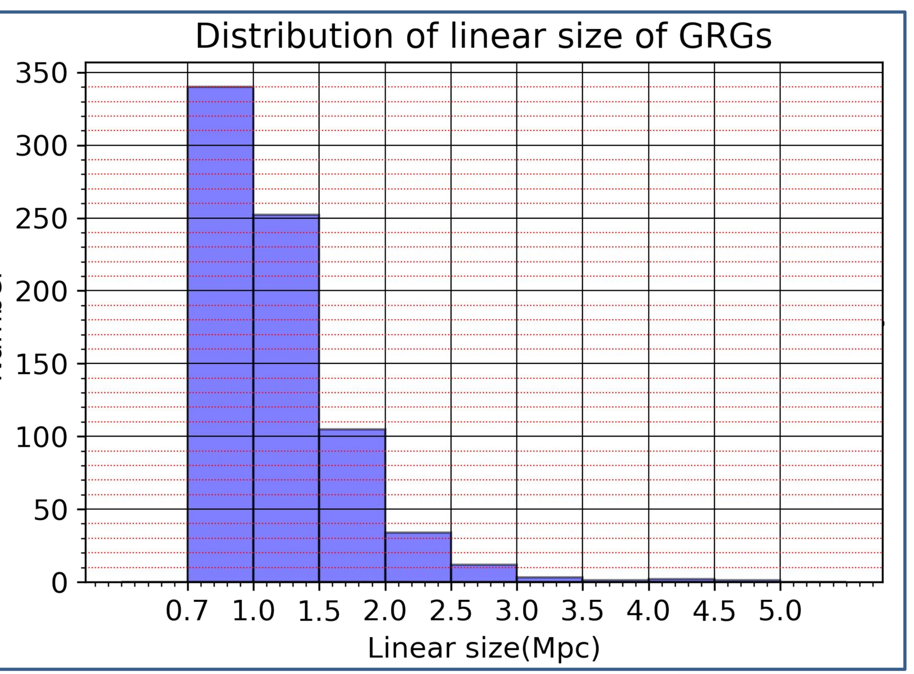
Abstract: A giant radio galaxy (GRG) is an extreme type of active galaxy that has radio jets of a size larger than 0.7 Mpc. Most of the known GRGs are of FRII type whose jets remain laminar and relativistic throughout their whole journey in a single phase of activity. How some radio galaxies evolve to such a large scale is still an unsolved mystery. The size of GRGs depends on mostly three factors, i.e. IGM density, jet power, and age of the source. It was believed that GRGs are born in a sparse environment. However, some GRGs were also found in clusters of galaxies. To determine the jet power and age of the largest GRGs it is crucial to analyze multi-frequency radio maps of proper uv-coverage, angular resolution, and sensitivity. In this poster, we present the radio properties of a 2 Mpc size GRG from our sample.

GRGs beyond 2 Mpc:

- There are only ~ 1000[1],[2],[6],[7] giant radio galaxies (GRGs) discovered compared to million radio galaxies (RGs). Dabhade et al. (2020a) discovered 182 GRGs over a 424 deg^2 sky area in the local universe (z ~ 0.6) which gives a GRG density ~ 0.4 GRGs per deg^2 sky area. This is the most robust sky density estimate of GRGs presently available. Only 7 out of these sources have size larger than 2 Mpc, which gives their density in the local universe ~0.015 GRGs per deg^2 sky area. Therefore, we decided to take a closer look at these extreme 2 Mpc size RGs.
- We would like to investigate physical conditions of those selected sources along with analysis of their spectral and dynamical age.

1)


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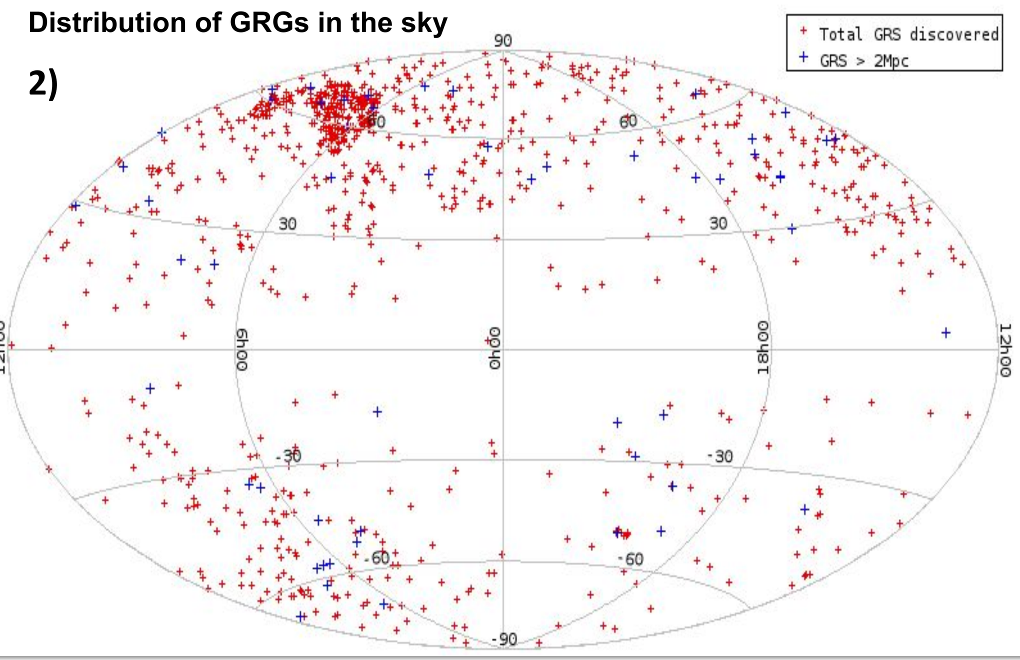


Spectral age:

- Can be calculated from radio spectrum;
- Radio continuum spectrum in different parts of radio source contains crucial information;
- Relies on single characteristic break frequency;
- We can obtain radiative age using SYNAGE[9] algorithm;
- Spectral break and steepening of the spectrum beyond this break not entirely due to radiative ageing.

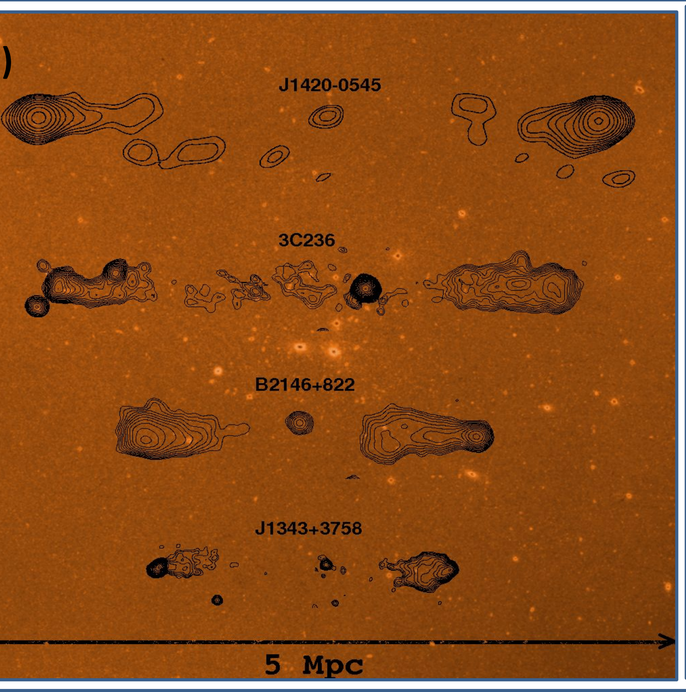
3)


Image description:

- *Fig. 1*: Distribution of 933 GRGs according to size.
- *Fig. 2*: Distribution of 933 GRGs over the sky.
- *Fig. 3*: The image shows a comparison of four GRGs. Radio contours are overlaid on the optical image of the Coma cluster of galaxies.

Sample selection:

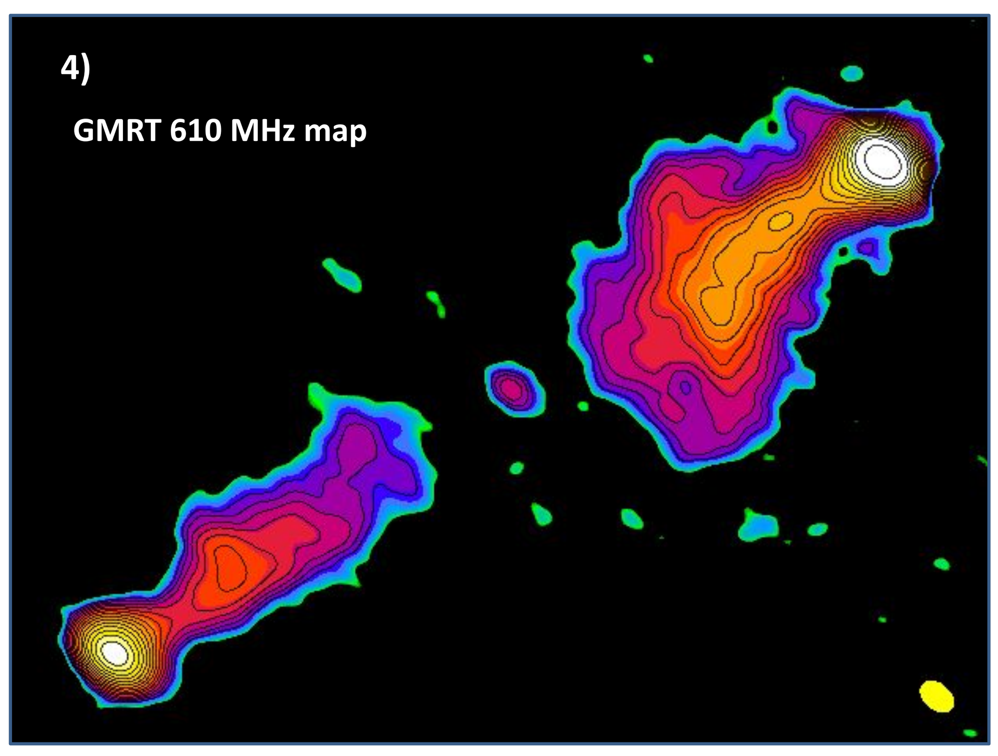
- FRII type;
- Total integrated flux ≳ 0.5 Jy (at 1.4 GHz);
- Angular size ~ 4.8 arc minutes;
- Redshift ≲ 0.6;
- Total power ≳ 10^{25} W/Hz (at 1.4 GHz).

Dynamical age:

- A possible role of magnetic field structure and evolution, back flow process of the cocoon material and difficulty in disentangling various energy losses of the radiating particles considered in the dynamical ageing;
- KDA[4][5] model-> self-similar model of the cocoon's dynamics;
- Electron energy losses in both radiative and adiabatic form;
- We can obtain dynamical ageing, jet power and IGM density etc. Can be performed using DYNAGE (8) algorithm.

Result: multiwavelength radio analysis of a 2 Mpc GRG with quasar host (HE 1127–1304) from our sample.

- *Fig. 4*: The GMRT 610 MHz total intensity map. The noise level is 0.5 mJy/beam.
- *Fig. 5:* The GMRT 235 MHz total intensity map. The noise level is 0.8 mJy/beam.
- *Fig. 6*: The 1.4 GHz NVSS total intensity contour (white) and 3 GHz VLASS total intensity contours (red) overlaid on the Pan-STARRS r-band map.
- Beam size is marked by yellow filled circle/ellipse in all figures.
- *Fig. 7*: Radio spectrum of the target source represented. We have done the spectral analysis for this source using SYNAGE[9] algorithm. We fitted the continuum injection model (CI) to the radio spectrum and obtained the break frequency, ν_{br} = 3.06 GHz, alpha injection, α_{inj} = 0.784, equipartition magnetic field, B_{eq} = 1.45 µG and the resultant average spectral age = 11.6 Myr of the source. Using the age and the size of the source 2.02 Mpc we have obtained the lobe average advanced velocity is 0.25c.

4)


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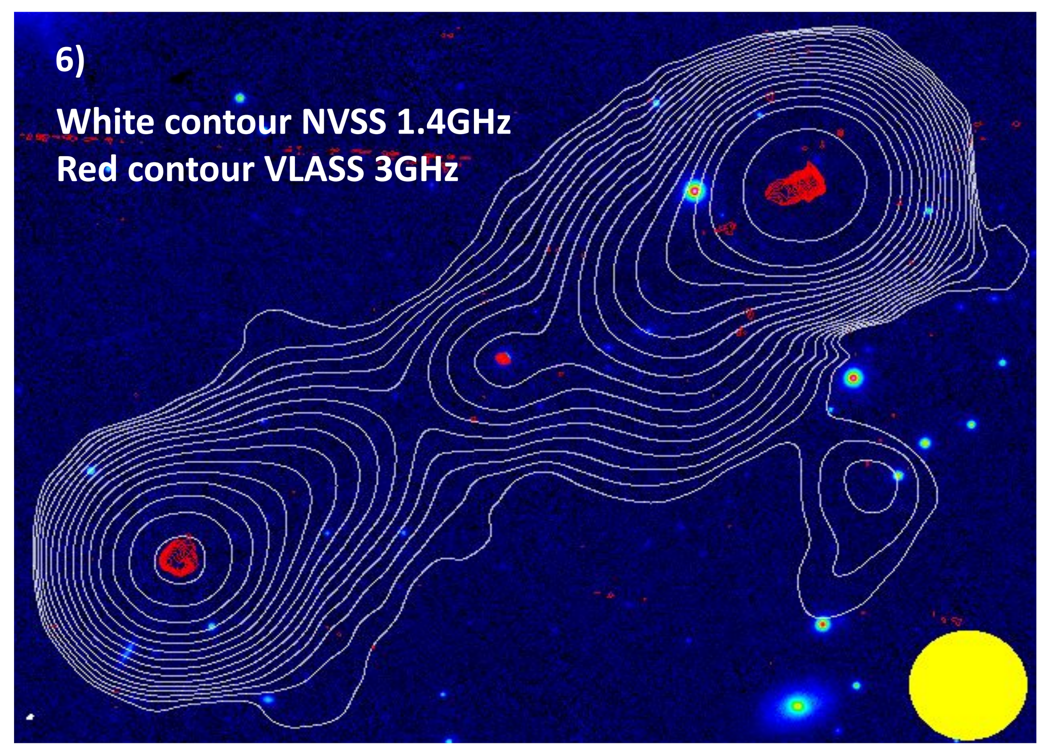

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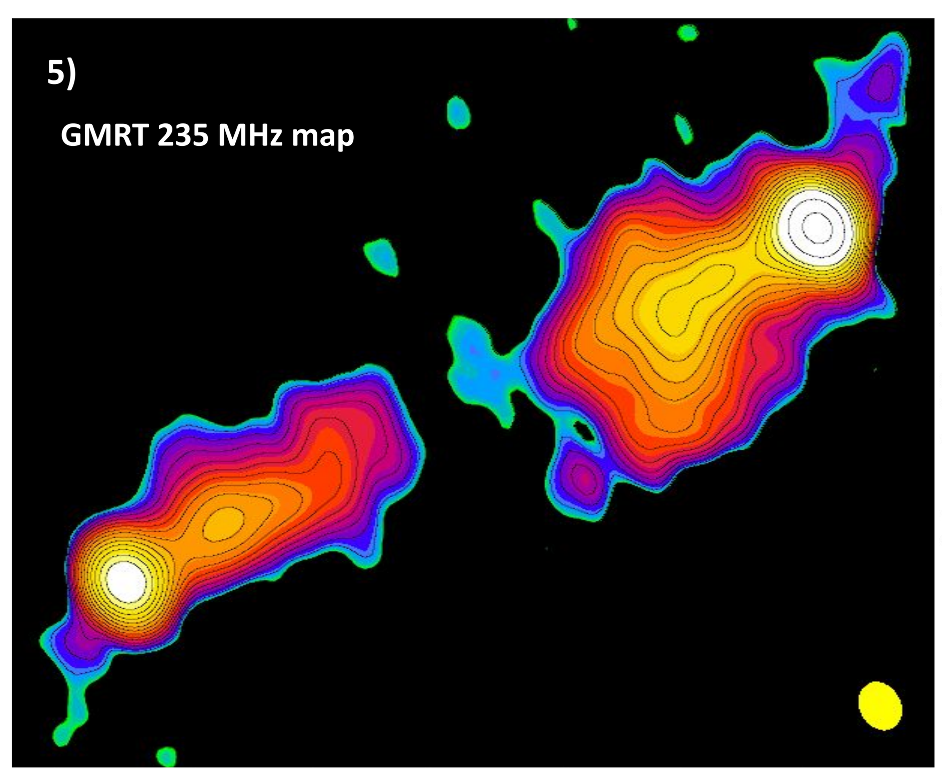

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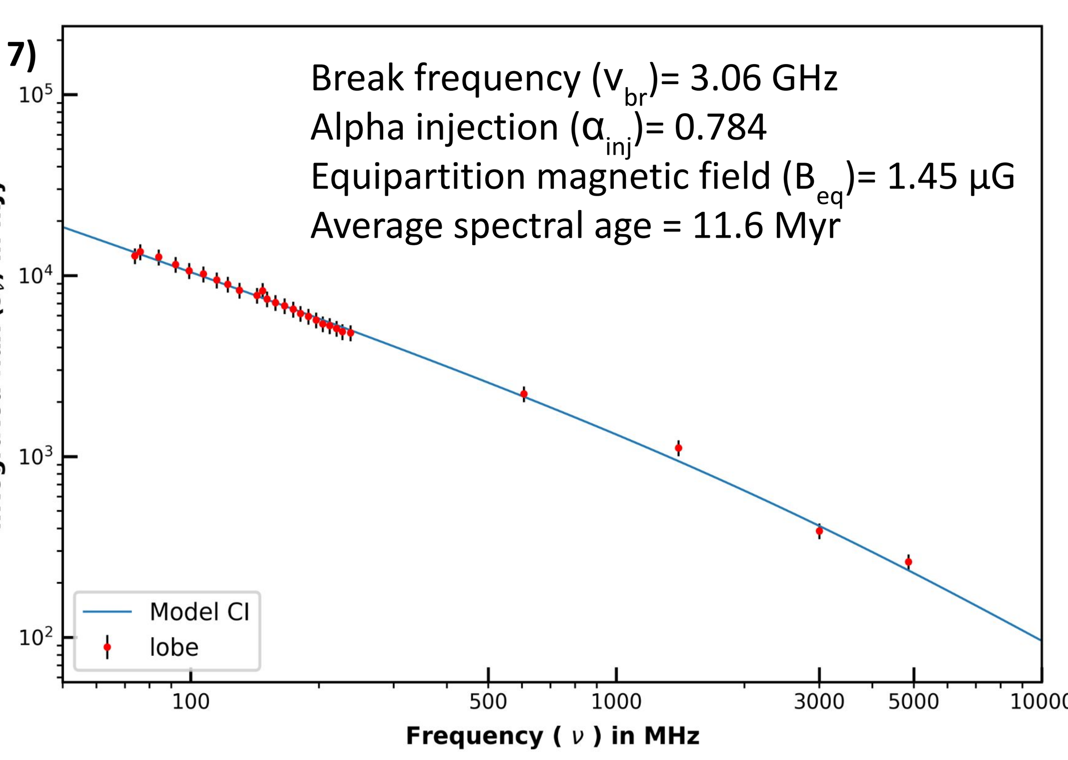

Summary:

- To determine the jet power and age of the largest GRGs it is crucial to analyze multi frequency radio maps of proper uv-coverage, angular resolution and sensitivity.
- Finally we will proceed for dynamical ageing analysis of the sources. We will address the ageing problem between spectral and dynamical ageing.
- We will perform similar analysis for other sources in our sample.

Reference:

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