A Study of Radio Sources with High Rotation Measures

Alice Pasetto[1], Alex Kraus[1], Karl-Heinz Mack[2], Carlos Carrasco-González[3], Gabriele Bruni[1]

[1] Max Planck Institute for Radio Astronomy (MPIfR) Bonn, Germany; [2] Institute for Radio Astronomy (IRA-INAF) Bologna,Italy; [3] Centro de Radioastronomía y Astrofísica (CRyA-UNAM) Morelia, Mexico

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Abstract

This project aims at studying a sample of **high Rotation Measures (RM)** sources located in a redshift range of 0.3-3.2. This sample of strong and compact radio sources has been compiled of those sources in the NVSS catalogue **without detected polarisation at 1.4 GHz**. The non-detection in polarisation strongly suggests a **depolarisation in a dense medium** of the source itself or from the intracluster medium of a primordial cluster. Studying the Faraday rotation is a very powerful tool to **understand the density distribution of the interstellar (and intergalactic) medium, its clumpiness and the components of the magnetic field**. Here we briefly present the scientific background, the source selection in some detail and the first results from the follow-up observations performed using the **100-m Effelsberg** telescope and the **Jansky VLA** interferometer.

Scientific background

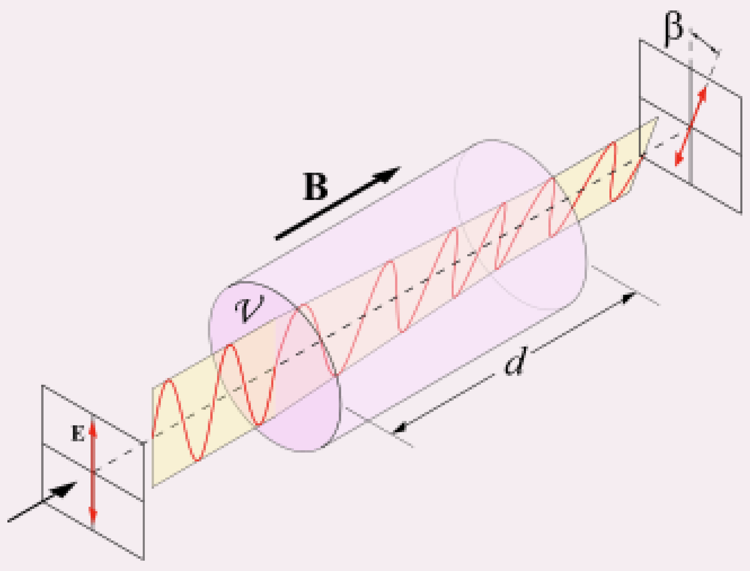
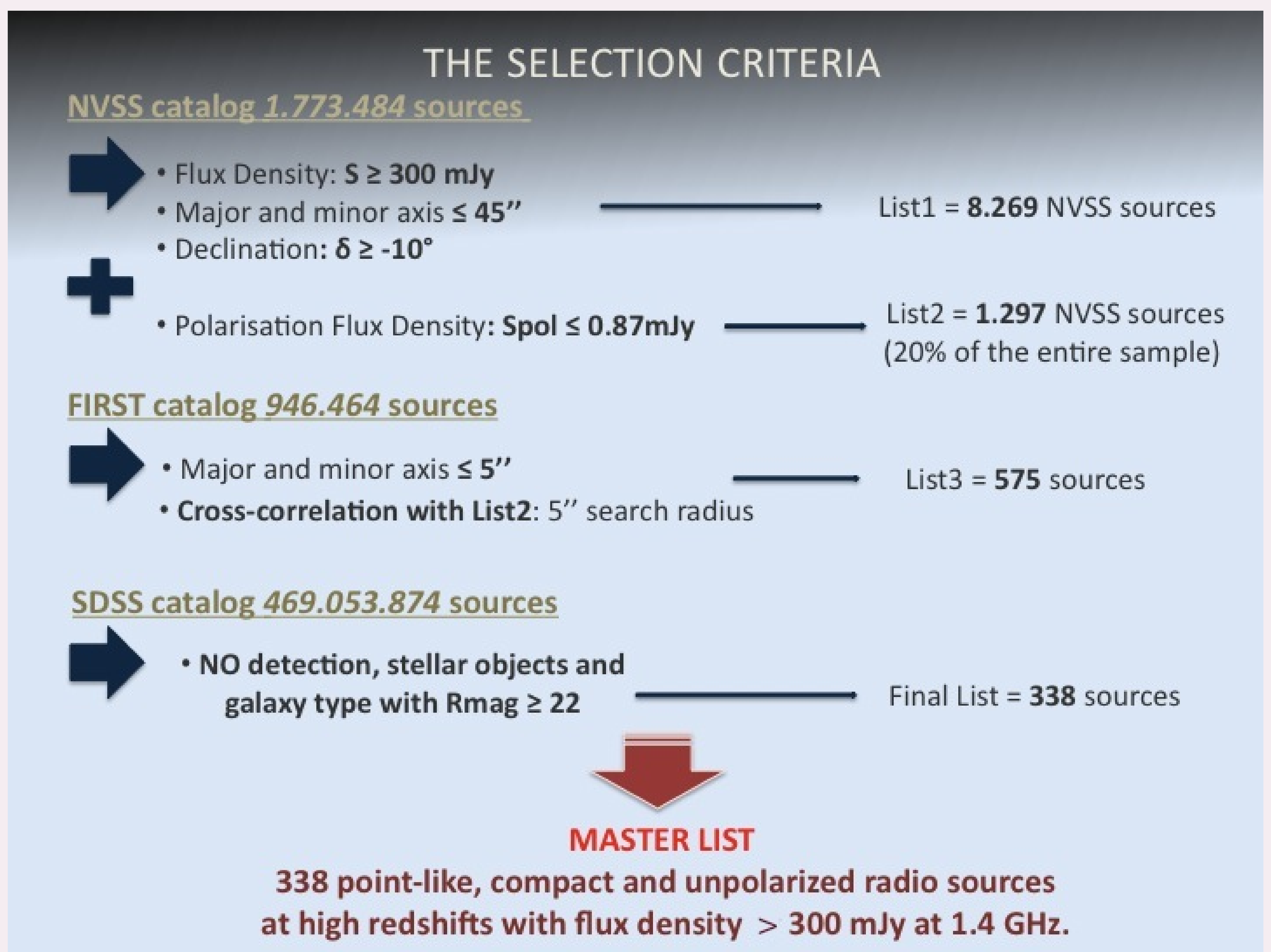


Figure : Polarisation rotation due to the Faraday effect. When linearly polarised waves pass through a magneto-ionic material (i.e. plasma containing magnetic field) they can be decomposed into opposite-handed circularly polarised components. These two waves have different phase velocities within the material and a rotation of the polarisation plane occurs.

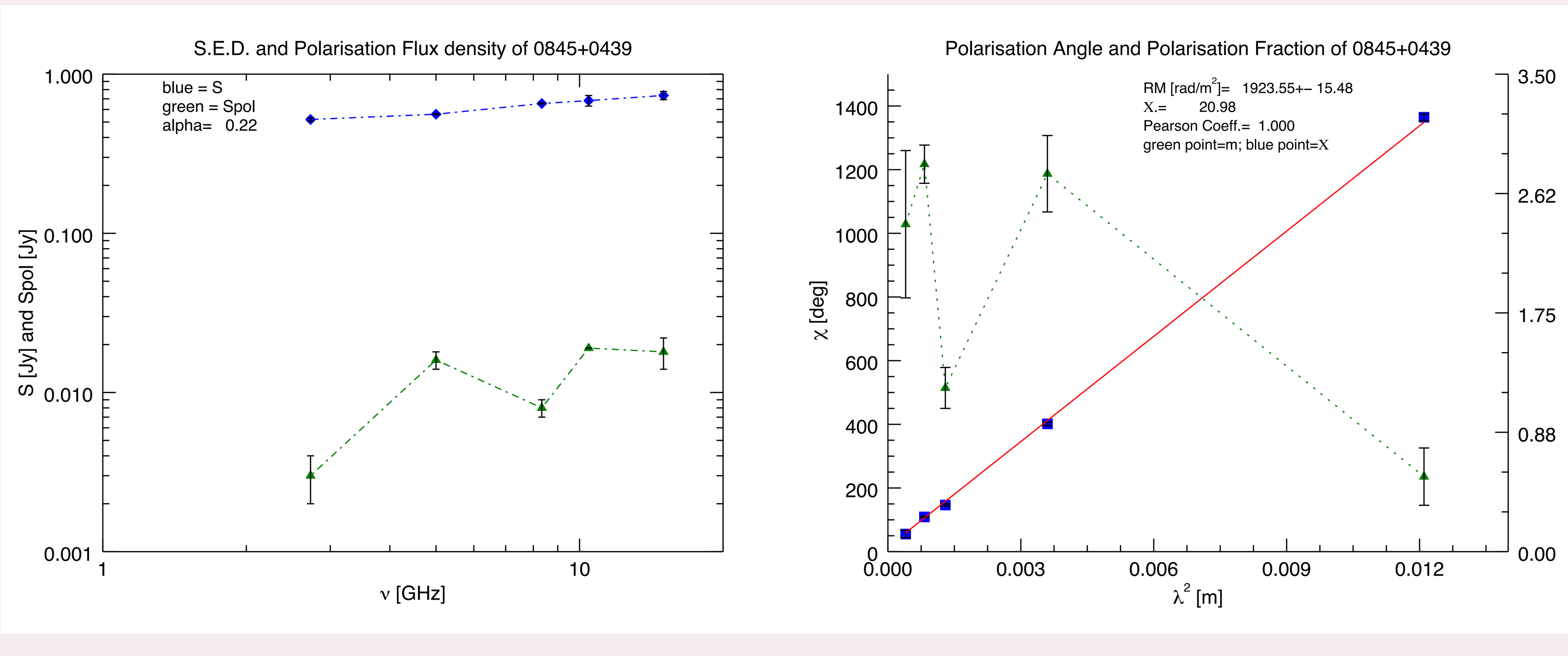
Through the variation of the polarisation angle of the polarised waves it is possible to determine the RM, where $RM[rad \cdot m^{-2}] = 8.1 \cdot 10^5 \int_L n_e B_{\parallel} dL$ thus to have information on the magnetic field. Moreover foreground Faraday screens, common and probably the major causes of depolarisation in radio sources, change the properties of the polarised emission. The intrinsic brightness of the Faraday depth varies between source and observer over the telescope beam (Tribble 1991, MNRAS 726, 736).

The sample



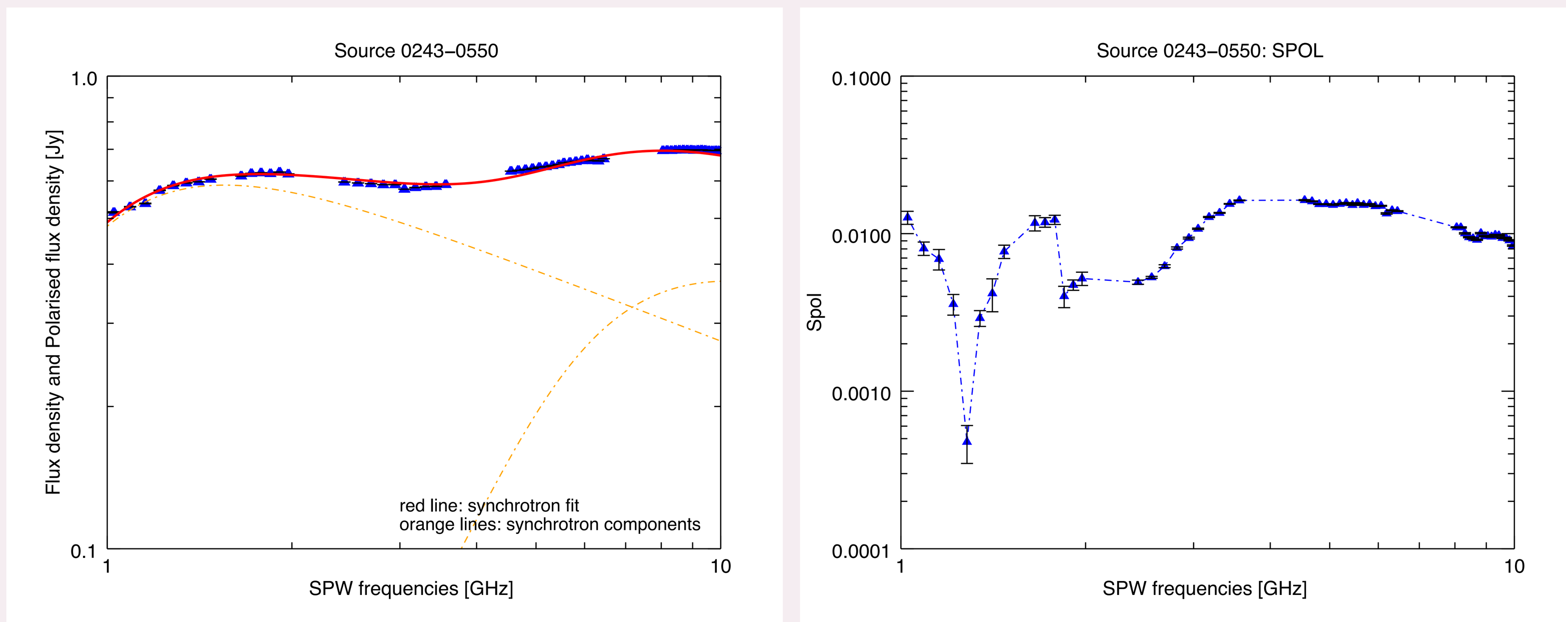
The Effelsberg data

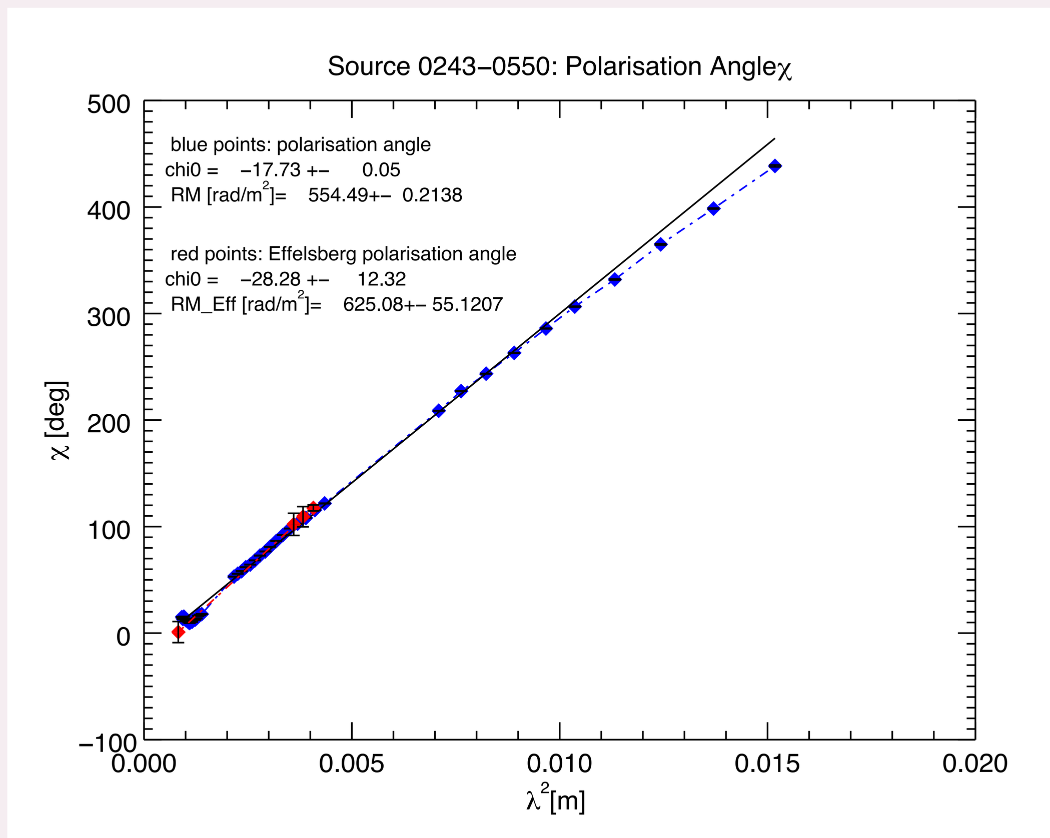
As first step, **all the 338 sources** were observed at **high frequency** using the Effelsberg 10.4-GHz receiver. A considerable amount of polarisation flux density has been detected for **30 sources** of the initial sample (∼10%). On these high-RM candidates, a **follow-up programme** was then performed at different frequencies: 2.6GHz, 4.8GHz, 8.6 GHz, 10.45GHz, 15GHz. The figures show an example of the Effelsberg data: SED, polarisation flux density behaviour, polarisation percentage and the polarisation angle with its relative Rotation Measure value.



The JVLA data

In order to confirm the high-RM nature of our targets, they have been observed with the Jansky VLA interferometer. Thanks to its wide band capability, we were able to have a **well sampled spectrum** of some of our targets, to reach **higher sensitivity** and thus **higher precision on the Stokes parameters** with respect to the Effelsberg ones. Thus the RM determination now is less affected by the $n\pi$ ambiguities. The high-RM targets have been observed at L, S, C and X bands.
The plots show the total power and the polarisation flux density (upper figure) and the polarisation angle behaviour with its relative RM fit value (lower figure). In the lower figure, the red points are the values measured with the single dish data, confirming the RM value determined with Effelsberg.





Status and future work

A first analysis of our data allows us:

- to make rough **estimation of the magnetic field**;
- to study the **depolarisation behaviour** using different models ("Slab" model and/or "Tribble" model);

Furthermore, the ongoing **VLBA and EVN** observations will allow us to resolve the source structures and to perform several studies on the physical environment, such as:

- **spectral index map** at high frequencies of the different components;
- estimate of the **maximum linear size** and morphological study;

Moreover, the detected polarisation information will allow us:

- to produce detailed high frequencies **polarisation maps** of the targets;
- to understand how their **polarisation angle are distributed** and which are the components contributing to the already detected high-RM.