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## 1. General

In the context of the current project a significant number of ~6000 extragalactic radio sources are observed at 2 frequencies quasi-simultaneously with the 100-meter radio telescope in Effelsberg. The sample is extracted from the NVSS catalog and consists of all the radio sources brighter than 2.5 mJy that happen to be in the fields targeted by the CBI experiment. The motivation for that is to study their spectra and from that to identify those that should be “vetoed out” from the CBI data since they may be causing severe contamination. However, being such an extended sample it can also serve as an excellent basis for reliable radio sources statistics and more.



Figure 1: The CBI instrument in its “compact” configuration optimized for polarization measurements (courtesy of R. Bustos).

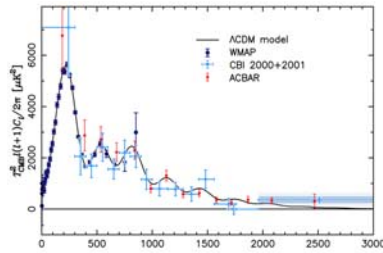


Figure 2: The power spectrum of the anisotropies of the CMBR (Readhead et al. 2004).

## 4. Some Facts

It is known from the NRAO VLA Sky Survey at 1.4 GHz (NVSS, Condon et al. 1998) that within the CBI fields exist as many a ~6000 extragalactic radio sources with flux density at 1.4 GHz larger than 2.5 mJy.

## 5. The Solution

A very efficient way to resolve the problem is the study of the spectral behavior of the candidate sources by measuring their flux density at 2 different frequencies, 4.85 and 10.45 GHz, as a complementary to the 1.4 GHz measurements from the NVSS catalog. Having those three flux densities available one can calculate the spectral index of the targeted sources. Consequently, it is possible to identify the sources that are too steep to cause any contamination at the 30 GHz regime contrary to those not steep enough or even of inverted spectrum that should necessarily be excluded from the CMBR data (see figure 4).

## 6. Practicalities

For the realization of the project the multiple beam 4.85 and 10.45-GHz receivers at the 100-m telescope (figure 5) have been employed. The observations are done with the beam switching mode allowing elimination of linear atmospheric effects. The data analysis is done with the “CBlonon” package developed to particularly suit the needs of this project from scratch. New methods have been applied for the data reduction allowing the detection of very weak (~5 mJy) sources within very short integration times (1 min for the 4.85 GHz receiver and 4 min for the 10.45 GHz one).

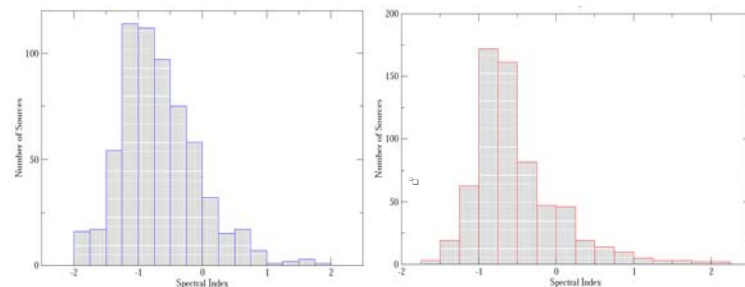


Figure 6: Spectral Index distributions. Left: the distribution of the spectral index between 10.45 and 4.85 GHz. Right: the distribution for the index between 1.4 and 4.85GHz.

## References

- Padin, S., Shepherd, M. C., Cartwright, J. K., Keeney, R. G. et al. 2002PASP...114...83P  
 Readhead, A. C. S., Mason, B. S., Contaldi, C. R. et al. 2004ApJ...609..498R  
 Condon, J. J., Cotton, W. D., Greisen, E. W. et al. 1998AJ....115.1693C

## 2. The Cosmic Background Imager (CBI)

The CBI (Padin et al. 2002) is an interferometer made of 13 90-cm elements operating between 26 and 36 GHz (figure 1). Its ultimate goal is the determination of cosmological parameters from the study of the statistical properties of the anisotropies in the Cosmic Microwave Background Radiation, hereafter CMBR (figure 2). It observes within 4 “windows” in the sky separated by 6 hours in Right Ascension from one another carefully selected to be least affected by galactic radiation and covering in total ~130 deg<sup>2</sup>.

## 3. The Problem

In general, the CMBR photons are subject to several possible factors of contamination (foregrounds) among which are the compact radio sources. The necessity of high accuracy measurements demands that either (a) the CMBR data at the positions of identified radio sources are discarded, or (b) their flux density at the observing frequency is exactly estimated and then discard only those that appear to have significant contribution. Until the initiation of the current project, the first option has been applied resulting though a severe loss of important information. The current project is exactly the realization of the second option.

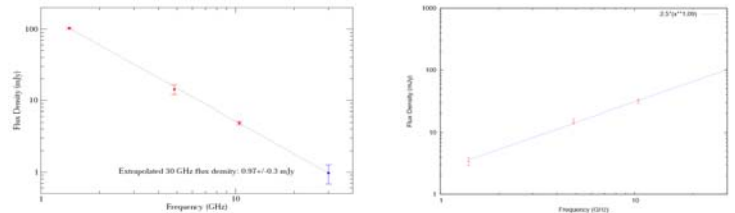


Figure 4: Two extreme cases of target sources. In red are the observed measurements at 4.85 and 10.45 GHz plus the NVSS flux density at 1.4 GHz. The blue line is the fitted model of the form  $S \propto F^{-\alpha}$  with  $\alpha$  being the spectral index. The blue point is the extrapolated flux density at 30 GHz which is the central frequency of the CBI experiment. One sees that the source on left hand side plot need not be vetoed from the data since the extrapolated flux is well below 1 mJy. The source on the right hand side should though be excluded.



Figure 5: The 100-meter radio telescope at Effelsberg.

## 7. Conclusions

The study of the CBI foregrounds is not the only benefit from this project. As a matter of fact having a sample of ~6000 measured at 3 frequencies gives handle a series of important studies. For examples:

- Studies of the high frequency spectral index.
- Investigations of the cosmological evolution of radio sources.
- Discovery of inverted spectrum sources (see figure 6).
- Studies of properties of sources peaking at high frequencies.
- Deep understanding of the system due to the need of high sensitivity combined with high efficiency.

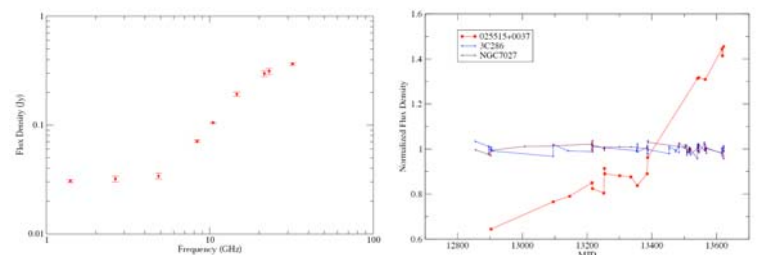


Figure 6: Example of a newly discovered inverted spectrum source (025515+0037). Left: its spectrum between 1.4 and 32 GHz. Right: the light curve of its normalized flux density at 10.45 GHz along with that of 2 main calibrators for comparison showing that the sources is at a flaring stage demanding further investigation.