MINI-PROJECT # 2 - ESTIMATION OF THE EOR SIGNAL FROM RADIO-INTERFEROMETRIC DATA

Description of the data :

The data B are composed of incomplete Fourier measurements of multi-channel noisy data X_n, which are composed of 10 channels.

To further ease the processing of the data, the measurements B (either in *Fourier_Measurements*) is a 256 x 256 x 10 complex array that has been obtained by applying a binary mask in the Fourier domain.

Each channel has a different sampling in the Fourier domain. The binary masks are given in in *Fourier_Sampling*.

The original data are corrupted with additive white Gaussian noise, which is further independent from one channel to the other. The files *Noise_single_simulation* provide a noise realization for each channel (before computing the Fourier samples).

The multichannel data are also modeled as **the linear mixture of two astrophysical components** : the synchrotron and dust emission, which can be assumed to have a sparse distribution in the wavelet domain.

What might be useful is that the spectral signatures of these components can be described by power laws. More precisely, the data are observed at the frequencies $\nu = [100, 110, 120, 130, 140, 150, 160, 170, 180, 190]$ and the spectral signatures (i.e. columns of the mixing matrix) can be modeled as :

$$a[j] \propto e^{\beta \frac{\nu[j]}{\nu[1]}}$$

where β is called the spectral index. It has to be noticed that the synchrotron emission has a negative spectral index while the dust emission has a positive spectral index.

Goal of the mini-project :

This project aims at providing an estimation of the cosmological signal at the epoch of reionization (EoR signal) from the LOFAR data. To that purpose, one first needs to remove the spurious astrophysical foregrounds that contaminate the data.

The goal of this project is to propose a solution to provide an

accurate estimation of each of the two astrophysical components that compose the data..

EVALUATION :

The final mark will be based on a **document** that reports :
— the scientific protocol you propose to tackle the problem.
— illustrations of the numerical experiments you carried out during the mini-project.
— discussion of the limitations of your approach, the bottlenecks you are facing, and what you would propose to overcome these limitations.

All the necessary mathematical tools have been studied during the course, the mini-project can therefore be solved with these tools only. This does not preclude taking any inspiration outside the scope of the course.

In case you have questions : *jbobin@cea.fr*