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# Denoising cosmic rays radio signal using Wavelets techniques

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*Fourier* transform of a signal $f$ computes the correlation between $f$ and the (frequency ranged) orthogonal basis of sines. Although this brings relevant information, the limitation is clear when we want to detect singularities in the signal. The uncertainty principle states that the energy spread of a function and its *Fourier* transform cannot be simultaneously arbitrarily small. As the *Fourier* transform, the *Wavelet* transform computes the correlation between $f$ and the orthogonal basis of a *Wavelet* mother. In other words, a single wavelet mother is stretched, expanded, and translated in time. It can measure the time-frequency variation of spectral components, but it has a different time-frequency resolution, allowing the characterization of transients with a zooming procedure across scales.
The estimation of a signal embedded in noise requires taking advantage of any prior information about the signal and noise. Until recently, signal processing estimation was mostly Bayesian and linear. Non-linear smoothing algorithms existed in statistics, but these procedures were often ad-hoc and complex. Donoho and Johnstone proved that a simple thresholding algorithm on an appropriate basis can be a nearly optimal non-linear estimator. A radio signal induced from cosmic ray, is very well described, for example, by the Daubechies wavelets as a basis, allowing the thresholding to be as safe (or more) as a linear estimation. The performance of thresholding may also be improved with the best basis search or a pursuit algorithm that adapts the basis to the noisy data.
This work presents the wavelets as a denoising technique both for narrowband and gaussian background reduction in radio signals induced from cosmic rays, presenting its efficiency in energy reconstruction.

## Keywords

radio signals cosmic rays, denoising, wavelets

## Collaboration

## other Collaboration

## Subcategory

Experimental Methods & Instrumentation

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