PRACTICAL WORK # 1 - A SPECIAL TYPE OF UNDECIMATED WAVELET TRANSFORM : THE STARLET

We strongly advise the use of either **Matlab** or **Python** for these practical works. Participants that opt for Python will find the following modules helpful :

- ipython
- scipy/numpy
- matplotlib
- scikit-learn
- pyfits.

Most of them can be set up with easily using standard porting tools (apt-get, macport ... etc).

All the necessary material is available at http://jbobin.cosmostat.org/master-2-mva

Undecimated isotropic wavelet transform, aka the starlet

• *Write a code that computes the convolution of an image with a 2D separation filter of the form :*

$$H_{2D}(x, y) = H_{1D}(x)H_{1D}(y)$$

In the next, you will take $H_{1D}(x) = [1/16, 1/4, 3/8, 1/4, 1/16]$.

• *Write a code that implements the "à trous" algorithm to perform the forward isotropic wavelet transform.*

• *Write a code that implements the backward isotropic wavelet transform.*

Illustration ... and validation

• *Take the wavelet transform of a Kronecker ("Dirac") with amplitude* 1 *and check that :*

- *each wavelet scale should have a zero mean*
- *each wavelet scale contains a wavelet function*
- *the Dirac can be reconstructed exactly by summing all scales*

• *Take the wavelet transform of the galaxy NGC2997 and check that :*

- *each wavelet scale should have a zero mean*
- *the galaxy can be reconstructed exactly by summing all scales*

Coefficient normalization

• *Take the wavelet transform of a Gaussian noise with a standard deviation equal to 1. Compute the standard deviation of the noise at each scale. Are these values equal to the input noise level ?*

•*Is there a way to automatically determine the noise levels in the different scales ?*