

## Minutes of the 2<sup>nd</sup> Cosmic Meeting - 01/23/2017

**Participants:** Carole Lazarus (2<sup>nd</sup> year PhD student NeuroSpin), Loubna El Gueddari (1<sup>st</sup> year PhD student in MR image reconstruction, NeuroSpin), Ming Jiang (3<sup>rd</sup> year PhD student, Cosmostat), Antoine Grigis (Research engineer, NeuroSpin), Jean-Luc Starck (Cosmostat leader) and Philippe Ciuciu (Nsp group leader).

**Absents:** Alexandre Vignaud (NeuroSpin), Fabrice Poupon (NeuroSpin) and Florent Sureau (CosmoStat).

### Objectives:

1. Prepare the visit of the DRF Impulsion staff on the 19<sup>th</sup> of April 2017 at NeuroSpin.
2. Demonstrate at this occasion the synergy between the two teams ie CosmoStat & NeuroSpin in both sides.

### Steps:

- **Philippe:** Improve website. Deliver a first visible version on late February. Local Interaction & help given by **Christine Doublé** at NeuroSpin.
- Arrival of an intern, **Hamza Cherkaoui**, on the 1<sup>st</sup> of April up to the 31<sup>st</sup> of August at NeuroSpin. He will be working on the 3D CS-reconstruction framework (if the steps described afterwards are already completed and the milestones achieved. If not, the intern will start with some specific aspects on 2D reconstruction).
- Scientific objectives (synergy: CosmoStat → NeuroSpin):
  1. In February: Update the Condat-Vu reconstruction algorithm to deal with complex-valued and possibly non Cartesian data. Managed by **Loubna El Gueddari & Ming Jiang**.
  2. In March: Replace the Starlet isotropic dictionary which is well adapted to reconstruct blobs by undecimated 7/9 Daubechies wavelets, which are known to perform very well in image restauration. Rely on Python code as far as possible
  3. Later on: Test curvelets and shearlets in 2D for MR image reconstruction. Compare the results with undecimated wavelets.
  4. Noise Characterization in the Fourier domain and adapt the data fidelity term in the reconstruction L2 term using Frobenius norm (reweighting by the inverse covariance matrix which will be supposed diagonal for the first trial). Carole will look at that quite soon to see its impact on image quality.
- Software objectives (synergy: NeuroSpin → CosmoStat):
  1. Meeting between **Antoine Grigis** (task leader) and **Jean-Luc Starck**. Idea: set up a new Python package to be used in both worlds (Astrophysics and MRI) based on the old fashion ISAP (Interactive Sparse Astronomical data analysis Package) IDL-based package. Term the new package pISAP or PyISAP? Important questions: select the basic ingredients to be included in PyISAP.
  2. Set up a common github repository (select the Cosmostat's one).
  3. Optimize Python code to improve numerical efficiency. Make use of cython acceleration and implement multithreading based on openMP for instance. The idea is to be able to take advantage of multiple CPU on your own laptop.
  4. To further speed up the code and gain in numerical efficacy, we should interact at some point with **Fabrice Poupon**, who is an expert in MPI and GPU-based acceleration of C++ code. This should be investigated after profiling the Cython-based acceleration.
  5. Tests on clusters for preparing a follow-up to our DRF Impulsion project based on 3D & HPC as well as the continuation of this brand new software package PyISAP.