10.2.2 WP 1-6X1: SZ signal extraction from future CMB data

PROJECT: **Studi di Cosmologia**		**WP REF.: 1-6X1**
WP TITLE: **SZ signal extraction from future CMB data** **CONTRACTOR**: **Dipartimento di Fisica, Università Tor Vergata** **START EVENT**: KO **END EVENT**: RF **WP MANAGER**: **Pasquale Mazzotta**		**Sheet**: 1 **of** 1 **Issue Ref**: 1 **Issue Date**:01/09/2016

1. INPUTS

- Hydro N-body simulations
- Planck Frequency Maps
- Instrumental responses of the relevant instruments
- Specification of noise level for the relevant instruments

2. TASKS

Main collaborations: Astronomical Observatory of Trieste

Through this project, we will develop and test a new imaging algorithm aiming at restoring the SZ signal to the highest resolution allowed by the local signal-to-noise ratio. This goal will be achieved following a multiscale approach combining datasets at different frequencies, each of them being characterized by its own spatial resolution. Beyond the data analysis of space observatories (e.g. Planck or Core+), this approach will be relevant for combining the observations of space observatories with balloon-born and ground instruments working in several bands with different angular resolutions, such as ACT, SPT and the future CCAT. Moreover, the restoration of the bi-dimensional distribution of a local parameter estimated via spectroscopy is a general problem with applications at other wavelenghts: among them are the restoration of temperature maps in X-ray astronomy or spectral index maps in radio-astronomy. Inspired from recent development in radar imaging, we propose to solve this problem from a coupling between bayesian inference and multi-scale analyses. Multi-scale algorithms being routinely used for many applications in image denoising and compression, this approach might also apply outside astronomy.

This project will make use of advanced cosmological hydrodynamical simulations of galaxy clusters, which will include astrophysical processes, such as radiative cooling, star formation and the effect of feedback from supernovae and AGN. These simulations, which will reproduce basic X-ray observational properties of the intra-cluster medium (ICM), represents the starting point to produce detailed maps of pressure and of the Compton-y parameter, by including both the thermal and the kinematic components. These maps will be "observed" in realistic conditions, by producing SZ mock observations at different frequencies, beam smearing, realistic level of signal-to-noise, contaminating backgrounds and point sources. Producing the same maps in the X-ray band will further allow exploring the synergies between the next generation of mm and X-ray telescopes in tuning galaxy clusters as precision tools for cosmology.

3. OUTPUTS

Deliverables

- Pressure and Compton-y maps of simulated clusters at different redshifts
- Mock SZ observations
- fully parametric component separation algorithm and software package,

- SZ map reconstruction software package that includes, curvelet analysis, denoising and Image deconvolution

Timelines

First Year, 1st Semester:

- Hydrodynamical simulations
- Development of the fully parametric component separation algorithm,

First Year 2nd Semester:

- Development and implementation of instrument-optimized denoising algorithm,
- Implementation of curvlet analysis on sky patches.

Second year, 1st Semester:

- Production of idealized maps
- Test and optimization of the Algorithms on Planck data,
- Implementation of Image deconvolution,

Second year, 2st Semester:

- Production of mock SZ observations
- Development of new techniques to identify and reconstruct anisotropic features in atmosphere of clusters of galaxies.

Third year 1st Semester:

- Implementation of the multi-instrument (Space, Ballon-Borne and Ground) SZ signal extraction,
- Extension of the algorithm on the celestial sphere

Third year 2st Semester:

- Extension of the algorithm for the component separation of polarization maps.