10.2.14 WP 7-6X1: Astroparticle and fundamental physics

PROJECT: **Studi di Cosmologia**		**WP REF.: 7-6X1**
WP TITLE: **Astroparticle and fundamental physics** **SUB-CONTRACTOR**: **Dip. Fisica / Università di Ferrara** **START EVENT**: KO **END EVENT**: RF **WP MANAGER**: **Paolo Natoli**		**Sheet**: 1 **of** 1 **Issue Ref**: 1 **Issue Date**:01/09/2016

1. OBJECTIVES

- Forecasts and constraints for neutrino parameters (mass, hierarchy, effective number) in standard and non standard scenarios
- Forecast and constraints for primordial nucleosynthesis in standard and non-standard scenarios.
- Tests of fundamental symmetries, cosmological constraints on non standard electrodynamics, constraints on polarization rotation (cosmological birefringence)
- Provide numerical codes to constrain the model parameters: CMB likelihood and other approaches.
- Study the implications for the physics of the early universe of primordial features in the CMB and their connection to so-called anomalies.

2. INPUTS

- Theoretical modeling and predictions on CMB anisotropy
- Data from CMB experiments, including Planck's legacy
- Simulated data for experimental setups

3. TASKS

Main collaborations: Padova, SISSA, RM2, Bologna
High quality constraints on astroparticle and fundamental physics are a major expected return from next generation CMB surveys, with the potential to uncover new physics. The main purpose of this WP is to study how to maximize the return of present and future CMB experiment to these objective. The WP is organized around four main tasks:

- We will review theoretical predictions, selecting relevant models and identifying their significant parameters. We will then make sure that numerical CMB anisotropy predictions can be derived from parameters, and in case modify the publicly available Boltzmann codes.
- We will check that the simulation tools for the CMB signal involved are adequate and, where needed, develop appropriate tools to simulate the effect. We will then incorporate these simulation into realistic pipelines for current and forecasted experiments, conjunction with other relevant units (e.g. Bologna for satellite missions)
- We will develop appropriate tools to constrain the effects under study. This may range from state-of-the-art CMB likelihood machinery, to be incorporated in standard Monte Carlo Markov Chain sampling, to specific estimators when the former path is not feasible or

convenient. The expertise from other units (in particular SISSA and Padova) on component separation is key to properly fold in the component separation layer

- We will apply tools and simulations to allow for improved reanalysis of existing data, in particular relying on the Planck legacy dataset, focusing on models untested in the mainstream analysis. We will also compute realistic forecasts for future experiment, aiming in particular to assessing the feasibility and convenience of planned instrumental efforts, as well as optimizing their configuration towards science return gravitational waves).

4. OUTPUTS

Deliverables

- Inference on relevant model parameters, based on existing data.
- Forecasts for future experiments
- Numerical codes to provide constraints and accompanying realistic simulations
- Contributions to feasibility studies, final reports for the projec, white papers and scientific publications.

5. SCHEDULE

First Year, t0+6months

- Review of theoretical model, assess parameters, planning of activities.

First Year, t0+12months

- Set up simulation pipeline for theoretical signal and realistic sky model.
- Set up data analyses on Planck legacy, validation checks
- Set up of relevant tools for likelihood modeling and other forms of parameter constraints

Second year, t0+18months

- Set up of analysis pipeline in view of a selection of experiments present and planned
- Begin of folding of component separation activities,

Second year, t0+24months:

- Continue with component separation, integration into parameter estimation pipelines

Third year, t0+30months:

- Production of constraints on legacy data.
- Production of forecasts, especially in view of feasibility studies for future ground based, balloon borne or satellite missions, as part of this project
- Start writing up results and contribution to reports

Third year, t0+36months:

- Finish with production of constraints
- Finalize write up of papers and reports, including feasibility studies for future missions
- Write documentation for software to be distributed