1 RATIONAL OF THE PROJECT

This WP is dedicated to the analysis of existing data for what concerns the diffuse polarized emission from our own Galaxy (foregrounds), as well as the development of data analysis software needed for their characterization, control and removal (component separation). This is particularly important since the signal from foregrounds on the degree angular scales, where the contribution from cosmological gravitational waves is maximum in the B-modes, is expected to dominate at all frequency, in all sky locations, according to the present data. The activity directly supports experimental design of forthcoming and future CMB probes for what concerns their capability of controlling and removing the foreground emission. The WP is articulated in **Tasks**; each task has leaders, specific purpose and status of activities as summarized below.

Task 9-6X1.1: Support to Experimental Design

- **Purpose**: support of forecasting component separation for feasibility studies using semi-analytic techniques
- **Leaders**: Carlo Baccigalupi, Davide Poletti
- **Status**: software ready, exploitation in progress

Task 9-6X1.2: Diffuse Polarized Foreground Data Analysis

- **Purpose**: analysis of existing datasets for constraining polarized foreground emission
- **Leaders**: Nicoletta Krachmalnicoff, Francesca Perrotta
- **Status**: derivation of constraints on synchrotron, dust-synchrotron cross-correlation, from the S-PASS radio survey and Planck data is in progress

Task 9-6X1.3: Diffuse Polarized Foreground Modeling

- **Purpose**: 3D modeling of Galactic diffuse polarized emission, comparison with data
- **Leaders**: Francesca Perrotta
- **Status**: modification of codes for simulating the 3D distribution of Galactic diffuse Synchrotron emission ongoing

Task 9-6X1.4: Polarized Component Separation

- **Purpose**: production and testing of foreground cleaning data analysis software finalized to polarization and B-modes
- **Leaders**: Davide Poletti, Carlo Baccigalupi

- **Status**: implementation of parametric fitting for component separation with python and c++ interfaces done, testing and applications are in progress

Task 9-6X1.5: Data Analysis & Simulations

- **Purpose**: production and testing of foreground cleaning data analysis software finalized to polarization and B-modes
- **Leaders**: Carlo Baccigalupi
- **Status**: analysis of the following data Planck data for the 2017 data release is ongoing, analysis of S-PASS data in combination with Planck and WMAP data for new constraints on Galactic polarized diffuse synchrotron emission is ongoing, study of constraints on low frequency foregrounds from composition of S-PASS, LSPE, QUIJOTE in progress, analysis of extra-Galactic sources from the Planck Compact Source Catalogue as B-mode foreground is in progress, analysis of data from PolarBear is ongoing.

2 RESULTS EXPECTED AFTER SIX MONTHS FROM THE KO-MEETING

The required product of the first six months from the KO-meeting is the development and implementation of semi-analytic techniques capable of forecasting the performance of component separation (9-6X1.1), given the present knowledge of the foregrounds and taking as input the main chatracteristics of a given instrumental design. The product has been delivered and is being exploited, as discussed below.

Moreover, in the first six months of from the KO-meeting, several other activities have started and are progressing, including the analysis of ongoing experiments, and exploitation of existing data for investigating the foregrounds for improving the modeling of them, and the overall simulation setup for component separation. This is also briefly described below.

3 RESULTS OBTAINED AFTER SIX MONTH FROM THE KO-MEETING

3.1 Semi-analytic techniques for Component Separation

The existing forecasting approach to component separation (Stompor, Errard, Poletti, Phys.Rev.D 94, 083526, 2016 and references therein) is based on a maximum likelihood technique, capable of parametrizing the main foreground unknowns, and providing estimates of them through parametric fitting, building up a mixing matrix given the existing modeling of the foregrounds, and taking as input the main instrumental characteristics, such as angular resolution, instrumental sensitivity and number and location of frequency bands. Based on these investiagions, a semi-analytic package has been implemented for estimating the level of residual in CMB mps derived from multi-frequency data and forecasting their impact on cosmological parameters. The method accounts for discrepancies between the foreground model assumed and the true one, including differences in scaling laws and spatial variations. Therefore, estimates and uncertainties include both systematic and statistical effects, which can be propagated to the main observables of the experiments. The method is computationally efficient, capable of forecasting the impact from hundreds of foreground realization on a single CPU. This is particularly relevant for the low frequency foregrounds where existing

data have less sensitivity and where operating experiments are expected to have a most important impact. The method is now being applied to forecasting the performance of the fortchoming experiments, and their combination.

3.2 Data analysis of ongoing experiments and exploitation of existing data

During the first six months of from the KO-meeting the data analysis (Task 9.6X1.5) progressed in three main directions, concerning the use of the S band Polarization All Sky Survey (SPASS), the investigations concerning foregrounds in the Planck data, the analysis of the PolarBear data after two years of observations. We briefly describe these progresses below.

3.2.1 SPASS

The 2.4 GHz SPASS maps represent faithful tracers of the low frequency (synchrotron) component, in particular at high Galactic latitudes were the Faraday rotation is expected to be negligible. The analysis has the purpose of investigating the synchrotron in opposite regimes with respect to the existing data from Planck, i.e. at considerably lower frequency, and in high signal to noise regime, in order to gain insight into this component. The work is in collaboration with the team of scientist working at the SPASS data rendering.

3.2.2 Planck

The Planck data are being used for investigating particular aspects of the foregrounds, i.e. the cross-correlation between dominating at the low (synchrotron) and high (thermal dust) frequency, as well as the de-correlation of each of them, i.e. their possible multi-component composition, and space variation of physical parameters.

3.2.3 PolarBear

The PolarBear experiment (The PolarBear Collaboration, arXiv:1705.02907, submitted to the Astrophysical Journal) has just completed the analysis of two years of data, with specific contributions from members of our groups (Poletti et al., Astron. & Astrophys. 600, A60, 2017, Puglisi et al., arXiv:1701.07856, MNRAS in press). One of the most important novelty of the present analysis is constituted by the improved constraints on foregrounds, and their impact on the B-modes. The analysis is continuing while the observatory, located in the Atacama desert, is being provided by two extra-telescopes, expected to become operational in 2018.

4 PEOPLE INVOLVED

Francesca Perrotta (leader), Carlo Baccigalupi, Nicola Bartolo, Alessandro Buzzelli, Nicoletta Krachmalnicoff, Michele Liguori, Davide Maino, Domenico Marinucci, Davide Poletti, Giuseppe Puglisi, Maurizio Tomasi