Definition and exploitation of the cosmological sample of Planck SZ clusters

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Clusters of galaxies are powerful cosmological probes. Their properties are sensitive at the same time to characteristics of the dark matter (which they are mostly composed of) and of the dark energy (through their abundance). The Planck satellite is the most sensitive and highest resolution full-sky Cosmic Microwave Background surveyor ever built. After a 30-month mission, using the Sunyaev-Zel'dovich (SZ) effect, it performed the first all-sky galaxy cluster survey since the X-ray satellite ROSAT in the 1990's. This survey will become the workhorse for many cluster and cosmological studies. Since the beginning of my P2IO postdoc, I have been involved in two critical aspects of cosmological studies with clusters in Planck: the reliable estimate of cluster physical properties and of cluster counts. The work is done within the Working Group 5 of the Planck collaboration in main collaboration with M. Arnaud (CEA/SAp), J.-B. Melin (CEA/SPP), M. Douspis and N. Aghanim (IAS).

The extraction of clusters in Planck data is done by filtering Planck maps using the SZ spectrum and our current knowledge of the cluster pressure profile, over a range of cluster sizes. Because of Planck limited resolution, the cluster size is poorly determined and a strong degeneracy exists between the size of the cluster and its SZ flux. Prior to my arrival, Monique Arnaud had proposed a new way to circumvent this degeneracy by including the extra knowledge of the cluster redshift (either coming from already existing data or follow-up X-ray/optical observations). The first part of my work consisted in exhaustively testing this new method, in the frame of different Planck cluster samples. First results indicate that the method allows a significantly better estimate of both the cluster size and the SZ flux, thus paving the way to the use of the full potential of the Planck cluster catalog.

In addition to knowledge of cluster properties, cosmological studies need two crucial elements: the definition of the cluster sample that will be used and cluster counts predictions that will link the observed cluster sample to the cosmological model. In order to address those two points, I have developed simple codes for predicting cluster counts in terms of redshift or SZ flux. Those will now be used, firstly, for cross-checks with independent codes; then, they will help us define the best way to use the available information for cosmological studies (e.g. investigating the optimal binning of the observed counts, see the impact of unknowns in cluster physics, figure out the best way to use clusters for which there is no available redshift estimate, etc.). Those will then be further-developed in order to include physics beyond the standard ΛCDM model and be incorporated in cosmological parameter estimation codes.