Observations of high-z galaxies with Planck and Herschel

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In the recent past, sub-mm and mm-wave surveys have led to the discovery of very luminous high-z galaxies, with star formation rates $\sim 10^3 M_\odot$/yr. The bright portion of number counts of these sources appears to be declining steeply with increasing flux density, reflecting the exponential fall of the dark-halo mass function foreseen by the Press & Schechter formula; moreover, preliminary data show that they are strongly clustered. The current astrophysical explanation (e.g., Granato, G.L., *et al.*, 2004; ApJ, 600, 580) is in terms of very massive proto-spheroidal galaxies undergoing their main phase of star formation at substantial redshift (typically $z \simeq$ 2-3). Given the wide redshift range spanned by them, proto-spheroids will provide a unique opportunity to investigate the formation and evolution of large-scale structure up to high redshift. Moreover, they have a substantial optical depth for gravitational lensing and the effect of lensing results strongly amplified by the steepness of their bright counts.

In this scenario - in which massive proto-spheroidal galaxies live in strongly overdense regions - a low resolution instrument, like Planck, cannot measure the flux of individual objects but the sum of fluxes of physically related sources in a resolution element (an unresolved "source clump"). Analytic estimates as well as numerical simulations (Negrello, M., *et al.*, 2005, MNRAS, 358, 869; González-Nuevo, J., *et al.*, 2005; ApJ, 621, 1) show that several clumps should be detectable by Planck surveys at the $\sim 5\sigma$ confidence level: the High Frequency Instrument (HFI) on board of Planck should provide a catalogue of $\sim$40-70 candidate proto-clusters per steradian, in the redshift interval $1 \leq z \leq 5$. Given the spectral properties of high-z proto-spheroidal galaxies and the higher resolution and sensitivity of the Herschel channels, we expect that observations with Herschel/SPIRE at 250 μm will resolve each proto-cluster into its brighter members down to fluxes ~ 30 mJy, the Herschel confusion limit. Herschel data will then determine the sub-mm fluxes of the bright active star-forming galaxies making up the proto-cluster and will also precisely locate them for further analyses. By measuring the redshift of these galaxies, it will then be possible to determine the redshift evolution of the sub-mm luminosity function and of the star formation rate.