PANEL A4: FIRST/PLANCK SYNERGY

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Abstract

Potential observing programs that could exploit synergy between Planck and FIRST were discussed, and several were identified.

Key words: Planck, FIRST, synergy

1. Introduction

Eleven workshop members attended.

Perhaps the single most important thought to keep in mind in considering Planck/FIRST synergies is that Planck will be the first unbiased survey in the submillimeter wavelength range. The relation between Planck and FIRST will be somewhat analogous to that between IRAS and ISO, except that the FIRST follow-up on Planck discoveries will have to be done more rapidly, because of FIRSTs limited lifetime.

2. Projects that were discussed

1. A shallow FIRST/SPIRE survey over an area of 400 square degrees near the ecliptic poles, to a 100 mJy level at 5-sigma, in all three SPIRE bands. The purpose of this survey is to measure foregrounds that Planck will see in the parts of the sky which it crosses most frequently. Planck will need this foreground information to improve algorithms to separate cirrus emission from cosmological signals. The time required for this FIRST/SPIRE effort is ∼21 days. PACS would be able to also carry out such a survey in somewhat shorter time. Whether the two surveys could be carried out simultaneously is currently under review. These surveys would, in addition, provide extended wavelength coverage and flux levels on compact sources.

2. A deeper survey with FIRST/SPIRE to the confusion limit of 15−20 mJy at 5-sigma in all three bands is predicted to take 2 days per square degree. An total area of 100 square degrees should be mapped to this limit if time permits, but not all of this area has to be contiguous. This actually is the main SPIRE survey, carried out independent from Planck, but symbiotic with it. This deeper survey would further elucidate the Planck survey, while also helping to better understand the far infrared isotropic extragalactic background measured by COBE, by showing the effects of foregrounds to greater depths, and looking for them at different Galactic latitudes. Total observing time needed 200 days for 100 square degrees, but less if this much cannot be justified.

3a. A very deep survey to one half the confusion limit, 7.5 to 10 mJy at 5-sigma, in all three bands. This is to be carried out in regions with the very lowest cirrus, where studies in other wavelength ranges have already been carried out or are planned. This will be the deepest survey to be undertaken by FIRST/SPIRE and will also help to elucidate both Planck and isotropic background measurements. The survey will take 8 days to map one square degree. Total observing time 8 days.

3b. A similar study should be carried out by PACS to its confusion limit and will cover 1/5 of a degree in < 1 day at 170 microns, though > 10 days at 75 / 100 microns. Nominally, the PACS mapping speed is ∼3 days per square degree at 170 microns to the confusion limit, at 5-sigma [10 mJy]. To map 1 square degree to a level of 5 mJy, equivalent to half the confusion limit, would take ∼12 days. Coverage by PACS will increase the wavelength range of the Spectral Energy Distribution (SED) over which sources seen in the Planck and deep SPIRE surveys are detected, and will also shed further light on Planck observations as well as separating the Galactic from the extragalactic isotropic background in the PACS wavelength region. Total observing time 8 days.

4. An effort to characterize the Interstellar Medium (ISM) power spectrum at intermediate and low Galactic latitudes which Planck will be including should, like the shallow FIRST/SPIRE survey, cover several tens of square degrees. Here the fluxes to be observed are brighter. The total observing time needed will be several days.

5. The Planck Early Compact Source Catalogue will be available1 to 1.5 years after the start of the survey, and will contain some extremely luminous high-redshift sources. The redshift will be gauged from the Planck SEDs and, if possible, determined more precisely with further observations from the ground for a firmer redshift and positional definition. Many of these sources might be lensed; others could be intrinsically highly luminous; some may be both. The fifty brightest of these could be selected, and SPIRE would define their positions to within 1 or 2 arcseconds, if the absolute pointing goal for FIRST is realized. Each source would be imaged with both SPIRE

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and PACS. Spectroscopy with SPIRE at the 100mJy level would take an hour or two per source. These investigations would help in identifying the nature of these highly luminous sources. Total time required to include SPIRE as well as PACS observations, 100 hours or ∼5 days.

6. Subsequent higher resolution spectroscopy on PACS or HIFI would need to be preceded by ground-based redshift measurements, which would have to be separately organized and could be a substantial effort. SPIRE spectroscopy might also be attempted. The time required for a PACS spectrum is ∼70 hours per source.

7a. The Early Compact Source Catalog will also contain galaxy clusters. Among the 500 high- redshift clusters expected to be detected by Planck, those unidentified members should be imaged by SPIRE looking at a 4 x 4 square arcminute field. With overheads each field would take 30 minutes to reach the confusion limit. To look at all 500 fields would take a total time of 12 days. Some thought is being given to cover 8 x 8 square arcminute fields, which would take up to 4 times longer, though some of the overheads would not scale up that rapidly.

7b. Similar imaging of the same fields by PACS at 175 microns would require a total time of 12 days as well.

8. The coldest sources in molecular clouds will be identified by Planck in its unbiased survey. Following up on these with FIRST, and particularly HIFI spectroscopy, would teach us what kind of sources these might be. The time required for these follow up observations could be quite open ended.

9. While the following project is not specifically a Planck/-FIRST project it came up in discussion and is interesting: Among Sunyaev-Zeldovich radio sources found at 1.1 and 2 mm wavelengths by the Large Millimeter Telescope, LMT, in Mexico, FIRST should examine both optically detected and undetected clusters using OSIRIS at the GTC telescope. SPIRE observations going to the confusion limit at 5-sigma would again require 30 minutes per 4 x 4 square arcminute field.

10. Total power measurements by HIFI could potentially provide integrated measures over the entire intermediate frequency 4GHz band and yield a polarization cross calibration for Planck. For a 1 hour 5-sigma observation, the flux limits obtained would be 0.3 Jy or 0.7 mK at 800 GHz, and 0.9 Jy or 2 mK at 1600 GHz. In these respective bands the line flux limit would be 3 and 14 in units of 10^{-19} Wm^{-2}.

11a. Planck sources that are bright in the radio region and are variable, principally blazars, should be followed up by FIRST as targets of opportunity. Such observations might yield high- precision light curve measurements for specifically targeted sources selected for more extensive studies.

11b. GHz-peak sources should be followed up in the same way. Some of these may be variable AGNs and may already become known ahead of time through the MAP survey.

12. Planck and SPIRE are planning to cross-calibrate in common wavelength ranges, both for intensity and pointing. This will be an important link between the data products of these two missions.