PROCEEDINGS OF SCIENCE

All-sky MEM harmonic space-based component reconstruction development

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ABSTRACT

An harmonic-space MEM algorithm (FastMEM) is presented for separating the emission from different physical components in all-sky observations by the forthcoming Planck satellite. The analysis is performed at full Planck resolution, with a pixel size of 1.7 arcmin, up to $l_{max} \sim 6000$. The simulated temperature-only Planck data include emission from the CMB, the kinetic and thermal Sunyaev-Zel'dovich (SZ) effects from galaxy clusters, as well as Galactic dust, free-free and synchrotron emission. Foreground separation for the low-resolution polarized maps (pixel size of 13.6 arcmin, $l_{max} \sim 750$) is also considered.

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1. Introduction

An harmonic space-based MEM foreground separation technique is developed by Cambridge Planck Analysis Centre members and is inteneded for large all-sky multi-frequency data set analysis that are expected by Planck experiment.

1.1 MEM harmonic space-based reconstruction code state

There are several version of the code avaliable:

- MPI-based pipelined intensity-only code (under testing);
- MPI-based intensity-only development code (heavily used);
- OpenMP-based intensity-only development code (used occasionally for testing);
- OpenMP-based polarized development code (under testing).

The structure of the foreground separation mini-pipeline is shown below on Fig. 1.

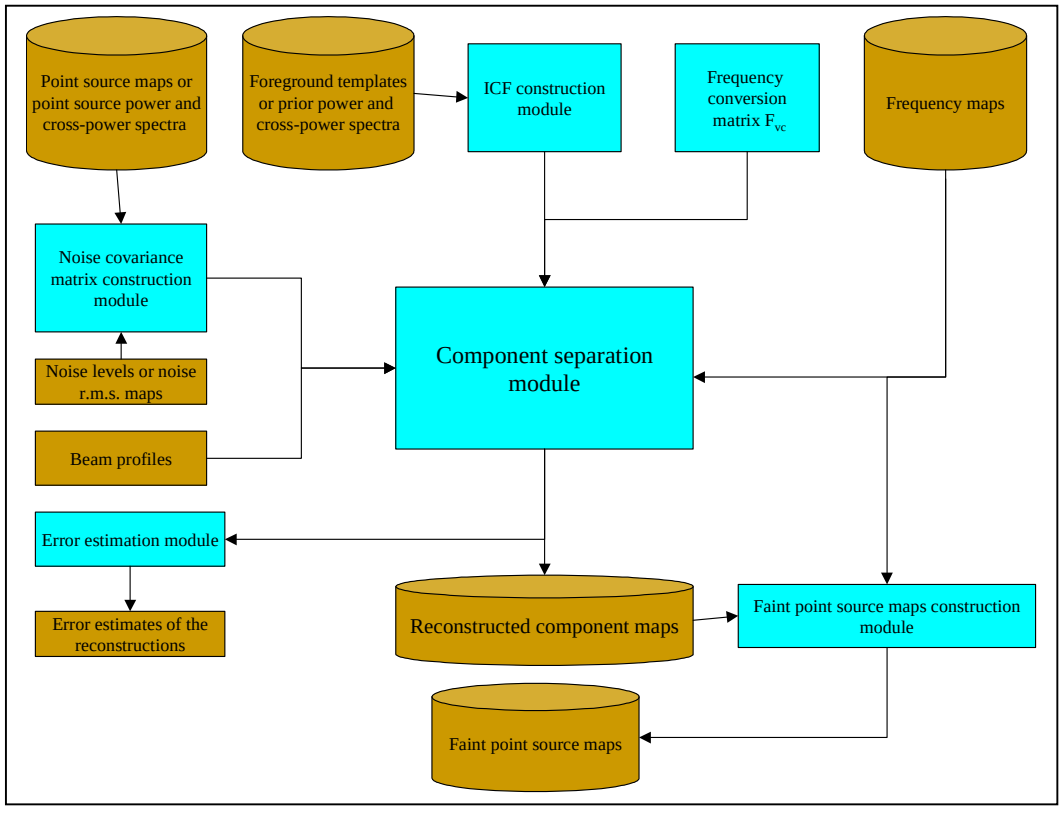

Fig. 1. The structure of the foreground separation mini-pipeline.

All development codes can be included into the pipeline; it's only a matter of I/O module modification. It is also useful to point out some other features of the software:

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- All codes are written in Fortran90 using FITSIO and HEALPix libraries;
- All codes can be compiled by different compilers (NAG, Portland, Intel v.7.x – v9.x);
- All codes can be executed on different computers (PC, Sun, SGI Origin, SGI Altix, etc) with various operational systems (Linux IA32/IA64, IRIX, Solaris, MS Windows), MPI codes can use different MPI libraries;
- MPI codes can be used on any cluster, homogeneous or heterogeneous);
- It takes about 2-3 hours and 16-20Gb of RAM to perform full-scale component separation for Planck experiment up to l≈6000 using 32 CPUs on COSMOS mainframe in DAMTP (SGI Altix 3700).

1.2 An example of CMB power spectrum reconstruction

An example of recovered CMB power spectrum for Planck frequency coverage, symmetrical beams and uniform noise is shown on Fig. 2. The cosmological model used in the simulations is LCDM, Ω_m=0.35, h=0.65, $\Omega_b h^2$=0.02, n=1.

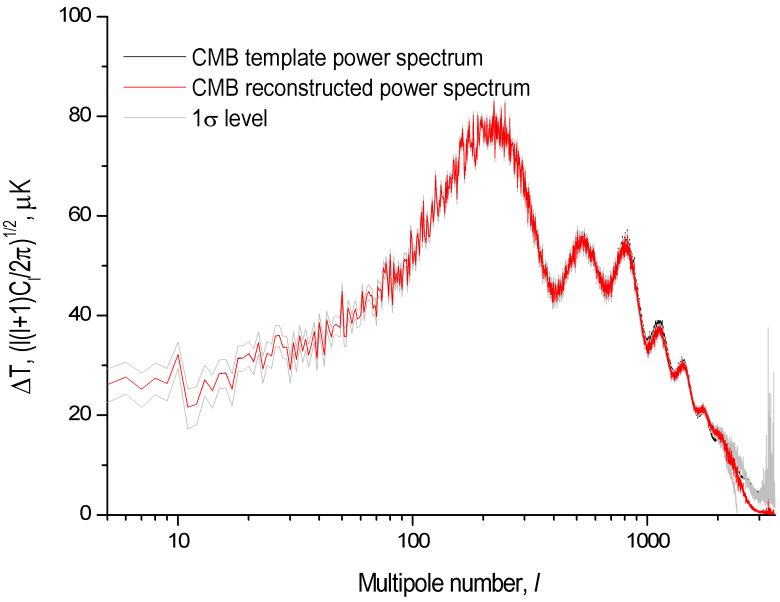

Fig. 2. An example of CMB power spectrum reconstruction.

1.2 Foreground separation of the polarized data set.

Foreground separation for the polarized data sets is more complicated task since polarized signal is very weak. However, the performed separation tests show that it is possible to recover CMB maps and power spectra in polarization with high accuracy. An example of CMB polarized map reconstruction is shown on Fig. 3, and power spectra recovery for CMB, dust and synchrotron is shown on Fig. 4.

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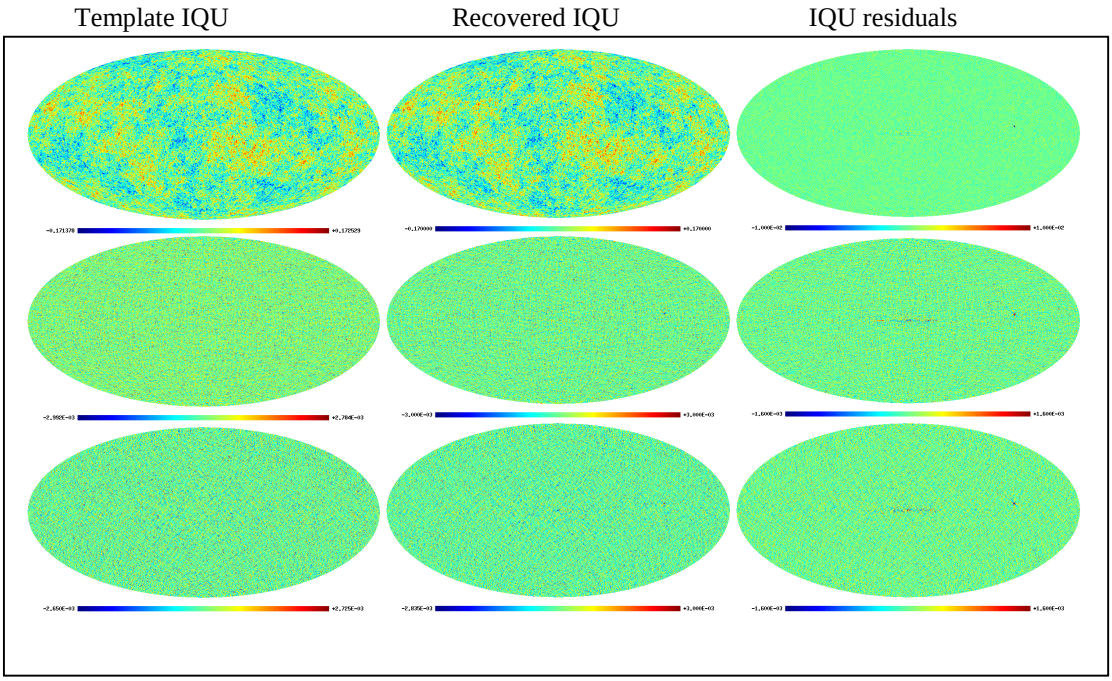

Fig.3. An example of CMB polarized maps recovery; units are of MJy/Sr at 300GHz.

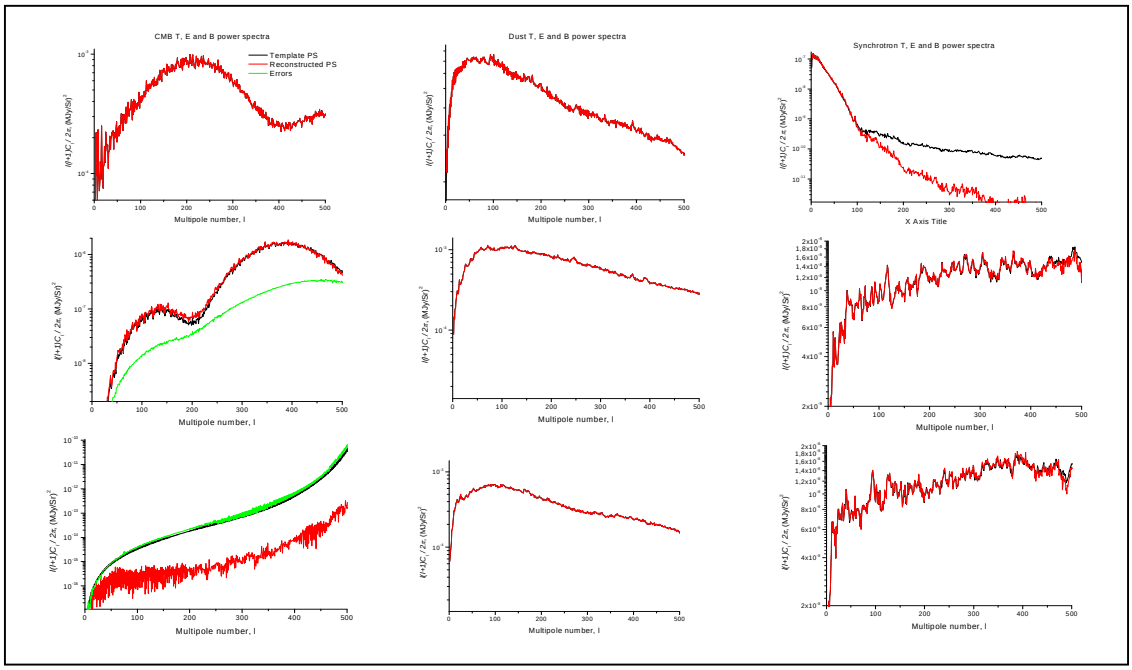

Fig. 4. An example of TEB power spectra recovery for CMB (left), dust (central) and synchrotron (right) components.

References

[1] V.Stolyarov, M.Hobson, M.Ashdown, A.Lasenby, *All-sky component separation for the Planck mission*, *MNRAS* **336** (2002) 97 [astro-ph/0105432]

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