C-BASS:
The C-Band All-Sky Survey
Luke Jew
The C-Band All-Sky Survey

All-sky map

5GHz (bandwidth 1GHz)

Resolution ~0.73 degrees

Stokes I, Q & U

High S/N (0.1mK beam$^{-1}$)
1. Overview of project

2. Current Status

Whistle stop tour of C-BASS
1. Overview of project
   • Science case
   • C-BASS basics
1. Overview of project

- Science case
- C-BASS basics
CMB B-modes, foregrounds are a problem!

Even in the total intensity case, still large degeneracies between low frequency foregrounds

Figure from Baumann et al. (2009)
1. Overview of project

The lines indicate the r.m.s. fluctuation level in each continuum component from the Planck 2015 X model.
Simulated parametric fitting process for individual mock datasets with different levels of foreground contamination chosen to represent different sky regions.

<table>
<thead>
<tr>
<th>Synchrotron</th>
<th>Free-free</th>
<th>AME</th>
<th>Thermal dust</th>
<th>CMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude</td>
<td>EM ((T_e) fixed @ 7000 K)</td>
<td>Amplitude Peak frequency</td>
<td>Amplitude Temperature Spectral index</td>
<td>Amplitude</td>
</tr>
<tr>
<td>Spectral index</td>
<td></td>
<td></td>
<td></td>
<td>Taken from model power spectrum with typical cosmological parameters &amp; (r=0.1)</td>
</tr>
</tbody>
</table>

To avoid biasing the results of the fitting process by individual noise realisations we didn’t add noise to the mock data. Instead we used the noise levels to calculate the likelihood in the fitting process.

How well can we recover the parameters

1. Overview of project
AME Region

- synch
- free-free
- thermal dust
- AME
- CMB

Brightness temperature [K]

Frequency [Hz]
AME Region

Planck+WMAP+Haslam
Planck+WMAP+Haslam + C-BASS
Synchrotron Region
Typical of NPS

Graph showing brightness temperature [K] against frequency [Hz] with curves labeled synch, free-free, thermal dust, AME, and CMB.
Synchrotron Region
Typical of NPS

Planck+WMAP+Haslam
Synchrotron Region
Typical of NPS

Planck+WMAP+Haslam + C-BASS
Free-free Region
Typical near Orion
Free-free Region

Typical near Orion

Planck+WMAP+Haslam
Free-free Region
Typical near Orion

Planck+WMAP+Haslam + C-BASS
The lines indicate the r.m.s. fluctuation level in each continuum component from the Planck 2015 X model.
The lines indicate the r.m.s. fluctuation level in each continuum component from the Planck 2015 X model.
Foregrounds (Polarisation)

The lines indicate the r.m.s. fluctuation level in each continuum component from the Planck 2015 X model.
+ve curvature

Planck
LiteBird

+ C-BASS
$A_s$ @30 GHz [$\mu$K$_{RJ}$]

$\beta_s$

$C_s$

$A_d$ @353 GHz [$\mu$K$_{RJ}$]

$\beta_d$

$T_d$ [K]

Planck+LiteBird

+ C-BASS

$A_{CMB}$ [$\mu$K$_{RJ}$]
1. Overview of project

• Science case
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1. Overview of project

C-BASS North
OVRO, California

- 6.1 m Gregorian telescope.
- Side baffles to minimise ground spill.
- Designed to minimise cross-polarization.
C-BASS South
Karoo Desert, South Africa

• 7.6 m Cassegrain telescope.
• Performance matched to C-BASS North
• Under-illuminated dish to minimise ground spill.
• Designed to minimise cross-polarization.
• 128 channel spectral backend
2. Current Status

- Data
- Early science
2. Current Status

- Data
- Early science
Northern Intensity Map
2. Current Status

Northern Polarization Map
2. Current Status

chuck in all the data

All-Sky Intensity Map
2. Current Status

• Real drive to produce preliminary science quality map
• Jackknifing and digging into systematics
• Focusing on a reduced dataset that is easiest to deal with
• First science and maps from Northern survey later this year
2. Current Status

- Data
- Early science
2. Current Status

White: Synchrotron
Red: Steep synchrotron
Cyan: Free-free
Blue: AME

3-Colour Map
2. Current Status

Focus on NCP region, highest C-BASS S/N
Template fitting

Template fitting in NCP region
2. Current Status

Template fitting in NCP region
2. Current Status

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Template fitting in NCP region
2. Current Status

- Turtle et al. 1962
- Find region of sky where emission dominated by power law
- Plot value in one map against value in the other
- Slope of straight line determined simply by spectral index

\[ T_1 = \left( \frac{\nu_1}{\nu_2} \right)^\alpha T_2 + \left[ B_1 - B_2 \left( \frac{\nu_1}{\nu_2} \right)^\alpha \right] 1 \]

\[ \alpha = \frac{\log a}{\log \frac{\nu_1}{\nu_2}}. \]

T-T Plots
T-T Plots
(Polarization)
T-T Plots

Rician distribution (Polarization)
T-T Plots
(Temperature)
Voronoi binning the sky
⇒ Regions of equal S/N

**T-T Plots**
(Temperature)
2. Current Status

COMMANDER
Gibbs sampling software
Used by Planck collaboration
Performs a pixel based parametric component separation

Working with Hans-Kristian Eriksen & Ingunn Wehus to repeat the Planck intensity analysis but including C-BASS.

New C-BASS map gives an extra free parameter to play with.
Summary

• Northern survey complete. Southern survey has started.

• First science and maps from Northern survey later this year.

• Final maps will be made public.

• C-BASS is great :)