Overview of CAPMAP Experiment

Collaboration between U. of Chicago, Princeton, U. of Miami, and JPL

Three observing seasons from 2003-2005 at the Crawford Hill 7-meter antenna in Holmdel, New Jersey. Third season consisted of 1658 hours from December 2004 through April 2005.

Sixteen HEMT-based correlation polarimeters:
12 operating at 90 GHz (3.3' FWHM)
4 operating at 40 GHz (6.5' FWHM)

E-mode polarization measured in 7 bins from $200 < \ell < 3000$ with total detection significance of $11\sigma$

B-mode polarization 95% confidence upper limit of $4.8\mu K^2$
CAPMAP Ring Scan

Circular scan about the NCP with 0.725° radius and 21 second period

Good noise uniformity and complete parallactic angle coverage every 12 hours

Ring scan introduces a large signal in total power data
Removal of Atmospheric Modes

Five parameter fit to each 21 second orbit

$$M(\theta) = A_0 + A_1 \sin \theta + A_2 \cos \theta + A_3 \sin 2\theta + A_4 \cos 2\theta$$
Removal of Atmospheric Modes

Five parameter fit to each 21 second orbit

\[ M(\theta) = A_0 + A_1 \sin \theta + A_2 \cos \theta + A_3 \sin 2\theta + A_4 \cos 2\theta \]

<table>
<thead>
<tr>
<th>TP</th>
<th>100K</th>
<th>500mK</th>
<th>0</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pol</td>
<td>&lt;150mK</td>
<td>&lt;5mK</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Removal of Atmospheric Modes

Five parameter fit to each 21 second orbit

\[ M(\theta) = A_0 + A_1 \sin \theta + A_2 \cos \theta + A_3 \sin 2\theta + A_4 \cos 2\theta \]

Bad weather was identified using the goodness of fit for the five parameter model to total power data on two time scales
Removal of Atmospheric Modes

Five parameter fit to each 21 second orbit

\[ M(\theta) = A_0 + A_1 \sin \theta + A_2 \cos \theta + A_3 \sin 2\theta + A_4 \cos 2\theta \]

After removing the model, polarization data is consistent with a \( \chi^2 \) distribution, indicating that no additional filtering is necessary.
Null Test Suite

Thirty-six different null maps were constructed from different divisions of the data and analyzed.

Results of the nulltest suite were used to tune weather cuts, gain models, etc, for a "blind" analysis.
Null Test Suite

Full null test results show no evidence of contamination

$$\chi^2 = 77.8$$ for 72 degrees of freedom (P.T.E. = 30%)

Not included in the null test suite is the null map made from differencing the 40 GHz and 90 GHz data, which provides evidence that foregrounds are not contributing significant power.
Results from Two Independent Pipelines

Separate analyses produced consistent results using complementary methods.

Systematic errors are estimated from many full season simulations and found to be sub-dominant.

<table>
<thead>
<tr>
<th>Band</th>
<th>Responsivity</th>
<th>Beams</th>
<th>Pointing</th>
<th>Angles</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.6</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
<td>0.7 (0.15σ)</td>
</tr>
<tr>
<td>2</td>
<td>1.4</td>
<td>0.5</td>
<td>0.7</td>
<td>0.3</td>
<td>1.7 (0.18σ)</td>
</tr>
<tr>
<td>3</td>
<td>1.8</td>
<td>1.2</td>
<td>1.3</td>
<td>0.9</td>
<td>2.7 (0.21σ)</td>
</tr>
<tr>
<td>4</td>
<td>2.5</td>
<td>1.7</td>
<td>1.9</td>
<td>2.0</td>
<td>4.1 (0.27σ)</td>
</tr>
<tr>
<td>5</td>
<td>4.8</td>
<td>3.4</td>
<td>3.9</td>
<td>3.7</td>
<td>8.0 (0.37σ)</td>
</tr>
<tr>
<td>6</td>
<td>6.6</td>
<td>4.0</td>
<td>4.5</td>
<td>4.8</td>
<td>10.1 (0.29σ)</td>
</tr>
<tr>
<td>7</td>
<td>5.3</td>
<td>3.1</td>
<td>3.7</td>
<td>3.0</td>
<td>7.8 (0.29σ)</td>
</tr>
</tbody>
</table>