Partor C-Band All-Sky Survey (C-BASS)

CCCCC



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مدينة الملك عبدالعزم الملوم والتقنية الملك

P_{hysics} C-Band All-Sky Survey (C-BASS)



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Collaboration meeting, Oxford, July 2011



C-BASS - Overview



Sky-coverage	All-sky	
Angular resolution	0.73 deg (43.8 arcmin)	
Sensitivity	< 0.1mK r.m.s	
Stokes coverage	I, Q, U, (V)	
Tsys	~20K, including sky	
Frequency	1 GHz bandwidth, centered at 5 GHz	
Northern site	OVRO, California	
	Latitude, 37.2 deg	
Southern site	MeerKAT site, Karoo, South Africa Latitude -30.7 deg	





C-BASS - Science Goals



Primary aims:

- To provide all-sky maps in I, Q and U at 5 GHz for the community.
- To allow more accurate subtraction of the polarized Galactic synchrotron emission from e.g. WMAP, Planck and future B-mode experiments.

Secondary aims:

- To map the local (≤1 kpc) Galactic magnetic field and improve our understanding of the the propagation of cosmic rays through it.
- To further study the distribution of anomalous dust.
- To improve the modeling of Galactic total intensity emission and hence allow CMB experiments to access the currently inaccessible region close to the Galactic plane.
- Help our understanding of / belief in the Galactic Haze....







Why a 5 GHz survey?







Why a 5 GHz survey?









- Halfway (in log v) between surveys at 1.4 GHz (Stockert, Reich & Reich) and 23 GHz (WMAP).
- Expected high-latitude Faraday rotation a few degrees, c.f. ~30° at 2.3 GHz.
- Below main emission from anomalous dust, so predominantly synchrotron.
- Signal still strong enough (few mK) to measure in a reasonable time (< 1 year) with a single receiver.
- 'Planck 5 GHz channel' (© R Davis)

P_{hysics} Impact on Planck results (1)



	Planck	Planck+CBASS	Typical high latituda 1 dag piya
Stokes I			Mean synch amplitude 80 uK@
CMB mean error (µK)	5.4	4.0	23 GHz MCMC reconstruction
Synch amp error (µK)	1.4	0.44	
Synch index error	0.29	0.03	
Dust amp error (µK)	3.4	2.8	25% improvement
Dusts index error	0.26	0.29	\times 3 improvement
Stokes Q,U			$\times 10$ improvement
CMB mean error (µK)	3.6	2.7	25% improvement
Synch amp error (µK)	0.67	0.17	\times 4 improvement
Synch index error	0.29	0.03	× 10 improvement
Dust amp error (µK)	1.3	0.97	
Dust index error	0.26	0.29	









The C-BASS Survey







C-BASS North Telescope





- 6.1-m dish, with Gregorian optics
- Secondary supported on foam cone
- Receiver sat forward of the dish
- Very clean, circularly-symmetric optics
- Absorbing baffles to minimize spillover



Dxford C-BASS North: beam measurements







(see Holler et al. 2011, arXiv:1111.2702v2)



C-BASS North Receiver





- Analogue correlation polarimeter
- Correlate RCP & LCP \rightarrow Q, U
- Difference RCP & LCP separately against internal load \rightarrow I, V

Survey Parameters



- 360° scans at constant elevation.
- Deep NCP scans for check of systematics.
- Survey data at 2 elevations
 - Through NCP

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- Through NCP + 10 °
- Scan speed of 4 deg/s \rightarrow scan in 90s
 - Need fknee < 10 mHz ($\sqrt{\text{Receiver works}}$)
- Pointing and opacity and flux calibration every 2 hours.
- Continuous gain monitoring via noise diode injection.
- Estimate of 6 months continuous observing for full hemisphere survey down to 0.1mK.



Simulation of single elevation scans through NCP and SCP.

- Daytime only for 6 months.
- Random drop-outs added.
- Very good coverage at poles and overlap region.
 - NCP + 10° and SCP +10° fill in mid declinations.



C-BASS North Site (1)









C-BASS North Site (2)





C-BASS North: Early maps





- Full survey operations started Nov. 2011
- Busy digging deep into the data....
- Example of ~2 weeks night-time only data
- Only internally calibrated, almost raw data
 - No astronomical calibration
 - No opacity correction
 - No destriping



C-BASS North: Early maps







- Tau A
- Internally calibrated
- Polarization measured at expected value





- DR21
- Internally calibrated
- No polarization detected - as expected
- Raw cross-polar leakage < -20dB

(Prediction from optics alone is < -50dB)



- CBASS South in the Karoo desert, South Africa
- 7.6m ex-telecoms dish
- Cassegrain optics

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C-BASS South





QuickTime[™] and a decompressor are needed to see this picture.



•Performance matched to CBASS North

•No need for baffles - dish is very underilluminated

C-BASS South Receiver

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- Digital correlation polarimeter two down-converted channels of 500 MHz sampled in 1st and 2nd Nyquist zones
- 2 x ROACH FPGA board each with 4 x 1 GS/s ADC inputs
- 64-channel spectrometer per ROACH -- 128 channels in total

Current Status



• C-BASS North observing...

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- C-BASS South comissioning in Oxford
- ~ May 2012 ship C-BASS South to SA
- ~ Oct 2012 start CBASS South survey
- ~ Dec 2012 end of C-BASS North
- ~ Apr 2013 1st northern survey papers
- ~ Oct 2013 end of C-BASS South
- ~ Apr 2014 1st full survey papers
- ~ Oct 2014 plan for first data release
- Project, receiver description and commissioning papers coming soon
- See Melis Irfan's poster too!



Charles Copley testing C-BASS South in Oxford

