AME characterisation in the Taurus Molecular Clouds with the QUIJOTE experiment

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ESA/ESTEC, 23 June, 20156

OBSERVATIONS OF THE TAURUS MOLECULAR CLOUDS WITH THE MFI:

- Data were obtained with the MFI and the QT1 during march and july 2015

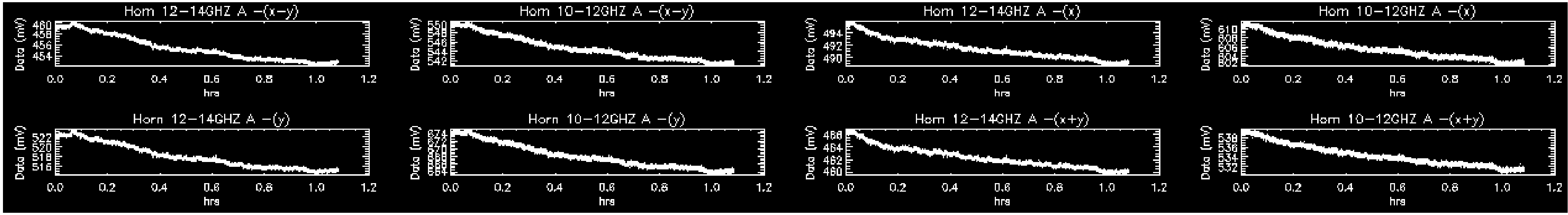
- 407 raster scan observations of size ~15° by 15° centered on Taurus with modulator angle at position 0°, 22.5°, 45° or 67.5° (Positions A, B, C or D)

- Scan speed : 1deg/s

- Beam FWHMs : ~ 0°.87 at 11 and 13 GHz and ~ 0°.65 at 17 and 19 GHz

- Common area to all horns of about 7° by 7°

- Final total integration time of ~ 423 hours.

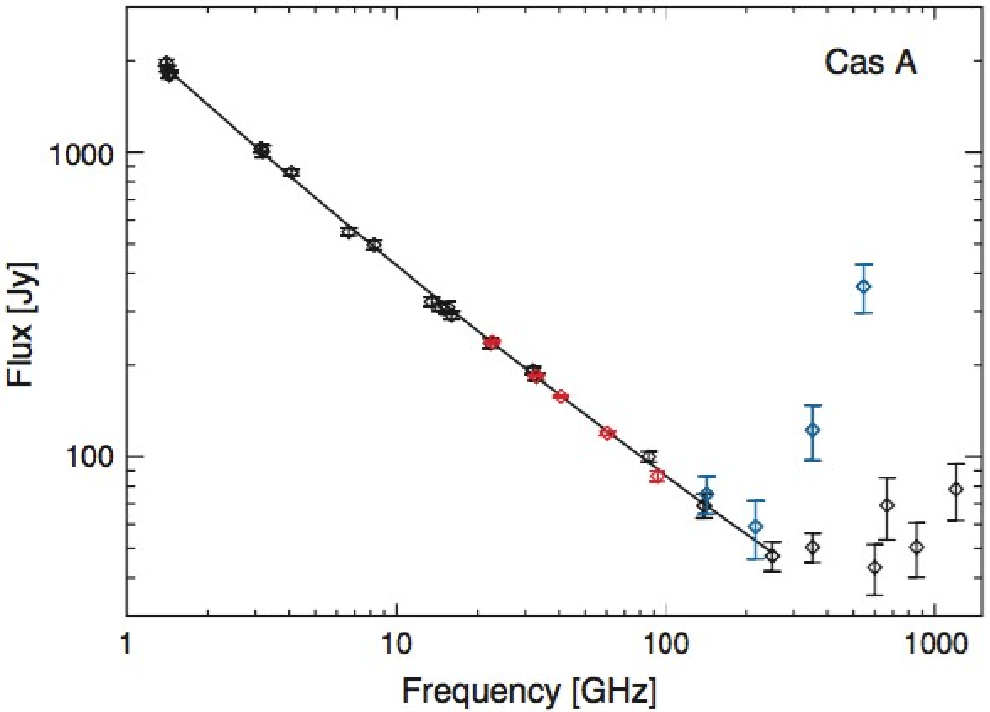


TOD TAURUSC-150419-1149 - Taurus region observation with the MFI horn1

DATA CALIBRATION : Amplitude Calibration

- Gain calibration factors (mV to temperature on the sky) obtained using total intensity measurements of Cas A
- Bright object with low polarisation degree
- Daily 25 minutes raster scans of 10° by 10°
- Secular decrease of 0.5%/yr taken ito account (Hafez et al. 2008)

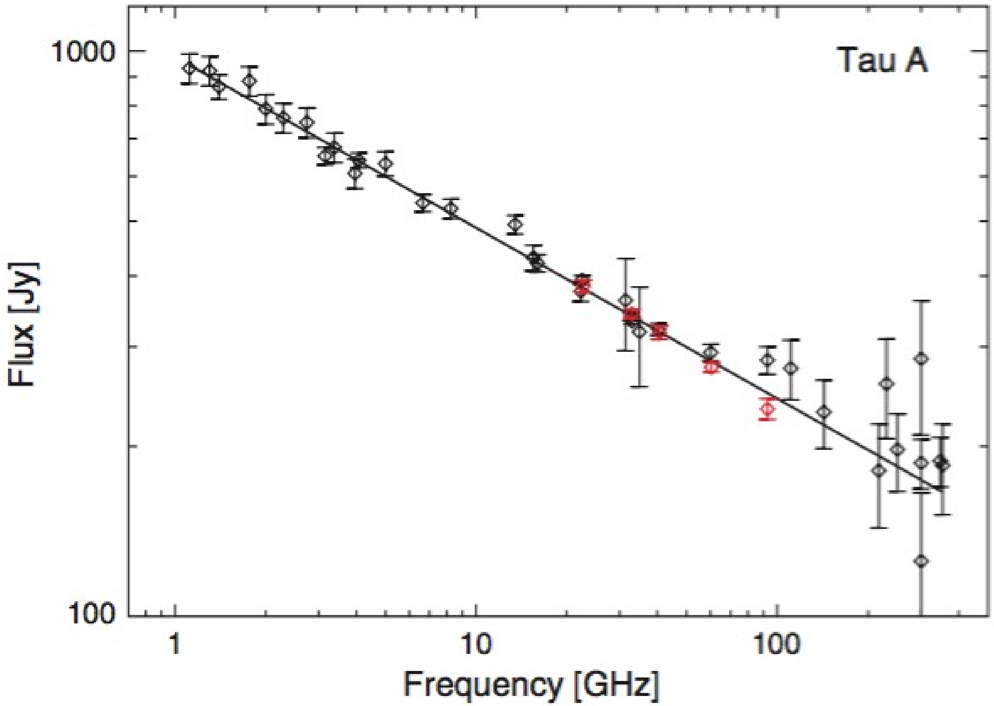
Modelled spectrum of Weiland et al. (2011)



DATA CALIBRATION : Polarisation Calibration

- Polarisation angle calibration with Tau A (Crab Nebula)
- Daily 25 minutes raster scans of 10° by 10°
- WMAP measurements at 22.7 GHz used as a reference to extrapolate a lower frequencies
- Q/I and U/I vary < 2% between 23 and 94 GHz assumed consistent with MFI error of measurements between 10 and 20 GHz

Modelled spectrum of Weiland et al. (2011)



DATA SELECTION AND FLAG OF BAD DATA

Automatic flag at the pipeline level of all data affected by :
- out of range nominal values
- geostationnary satellites emission and their near-sidelobes imprints (All data less than 5$\circ$ from any satellite on the plane-of-sky)
- transients sources like the sun or the moon and other planets

Data showing glitch type variations or uncommon variations of the TOD :
- detection was opetared for each of the 32 channels
- bunch of data of size 1 minute for which dispersion to the mean of their baseline was higher than a threshold value observed in chuncks of good data were removed

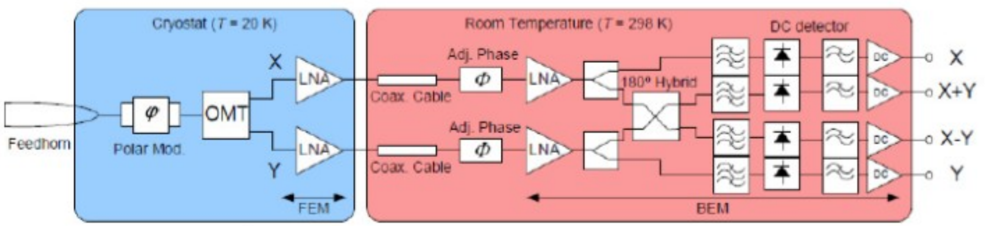
All flagged data are not used in this study.

After flagging, the final effective observing time was respectively 275, 226, 285 and 239 hours for horns 1, 2, 3 and 4 respectively (total integration time for each Horn was of 423 hours).

MAP-MAKING

2 map makers at IAC :
- One with median filter correction (intensively used)
- One with median filter correction + destripper

MFI channel response



$$V_x = s_x g_1^2 \frac{1}{2}(I + Q\cos(4\theta) - U\sin(4\theta))$$

$$V_y = s_y g_2^2 \frac{1}{2}(I - Q\cos(4\theta) + U\sin(4\theta))$$

$$V_{x+y} = s_{x+y}\frac{1}{2}\Big(\frac{g_1^2+g_2^2}{2}I + \frac{g_1^2-g_2^2}{2}(Q\cos(4\theta) - U\sin(4\theta)) + g_1 g_2(Q\sin(4\theta) + U\cos(4\theta))\Big)$$

$$V_{x-y} = s_{x-y}\frac{1}{2}\Big(\frac{g_1^2+g_2^2}{2}I + \frac{g_1^2-g_2^2}{2}(Q\cos(4\theta) - U\sin(4\theta)) - g_1 g_2(Q\sin(4\theta) + U\cos(4\theta))\Big)$$

$$V_x + r_u V_y = s_x g_1^2 I$$

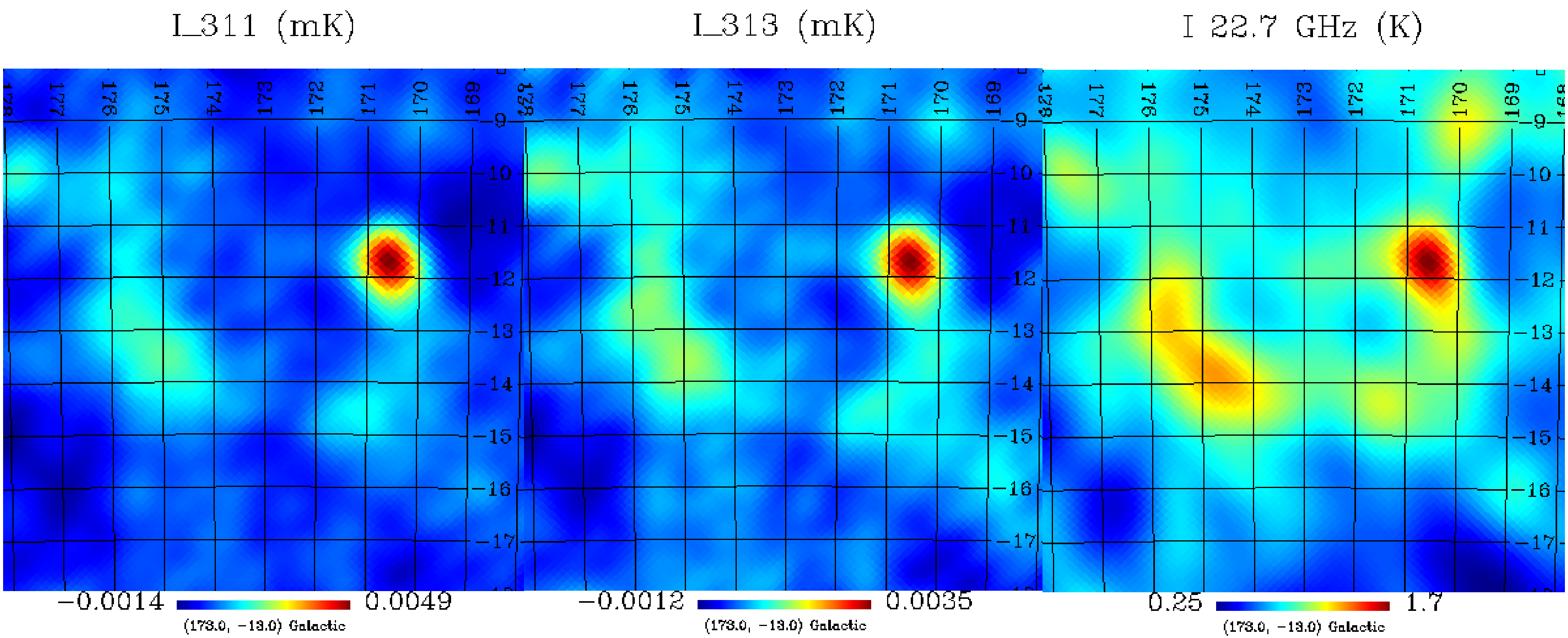
$$V_x - r_u V_y = s_x g_1^2 (Q\cos(4\theta) - U\sin(4\theta))$$

$$V_{x+y} + r V_{x-y} = s_{x+y}\Big(\frac{g_1^2+g_2^2}{2}I + \frac{g_1^2-g_2^2}{2}(Q\cos(4\theta) - U\sin(4\theta))\Big)$$

$$V_{x+y} - r V_{x-y} = s_{x+y} g_1 g_2 (Q\sin(4\theta) + U\cos(4\theta))$$

See Ricardo Genova-Santos' Talk for more details on the experiment

MAPS

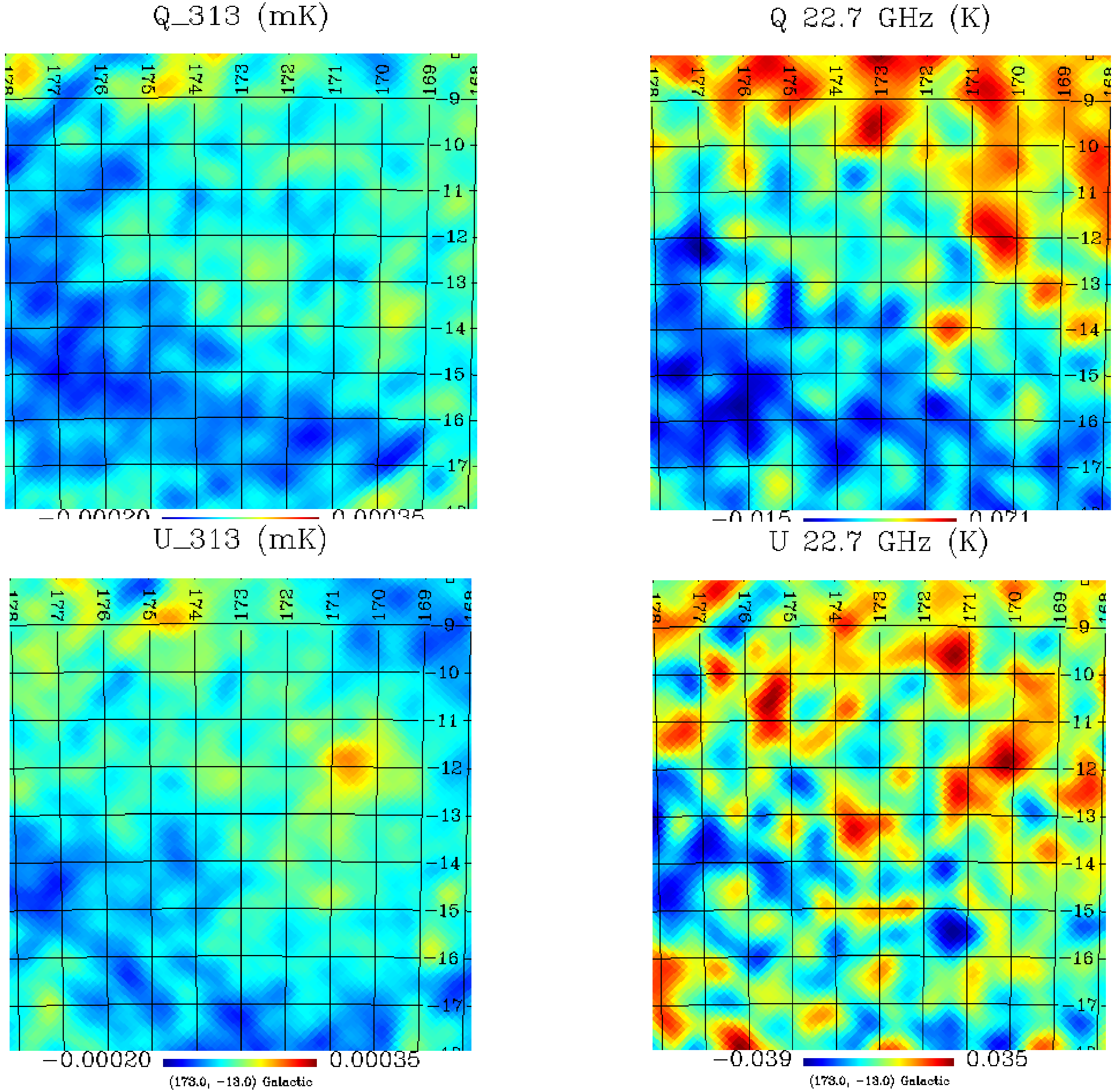


QUIJOTE 11 GHz QUIJOTE 13 GHz WMAP 22.7 GHz

Our best intensity maps are obtained with the destripper from Horn 3 at 11 and 13G Hz (see above) but in the following we will show results obtained with no destripping since the current destripper produces gradients in Q and U maps that need to be corrected for.

MAPS

QUIJOTE



WMAP

JACKKNIFE TESTS and MAPS SENSITIVITY

Data separated in 2 subsets as a function of time :

Horn	Freq. (GHz)	σ_I (μK/beam)		σ_Q (μK/beam)		σ_U (μK/beam)		$\sigma_{Q,U}$ (mK $s^{1/2}$)
		Map	JK	Map	JK	Map	JK	JK
1	11	77.3	57.1	21.1	16.3	24.4	18.9	1.0
1	13	54.7	41.5	17.0	12.2	15.8	12.4	0.7
2	17	132.5	89.4	30.6	20.9	21.4	21.6	1.1
2	19	193.8	138.2	34.3	32.4	34.0	40.2	1.8
3	11	87.8	66.8	26.4	17.9	26.9	18.5	1.0
3	13	65.6	50.2	27.2	19.5	27.5	20.7	1.1
4	17	147.7	103.8	23.3	17.5	23.4	19.6	0.9
4	19	201.9	140.6	34.5	22.6	30.1	29.8	1.3

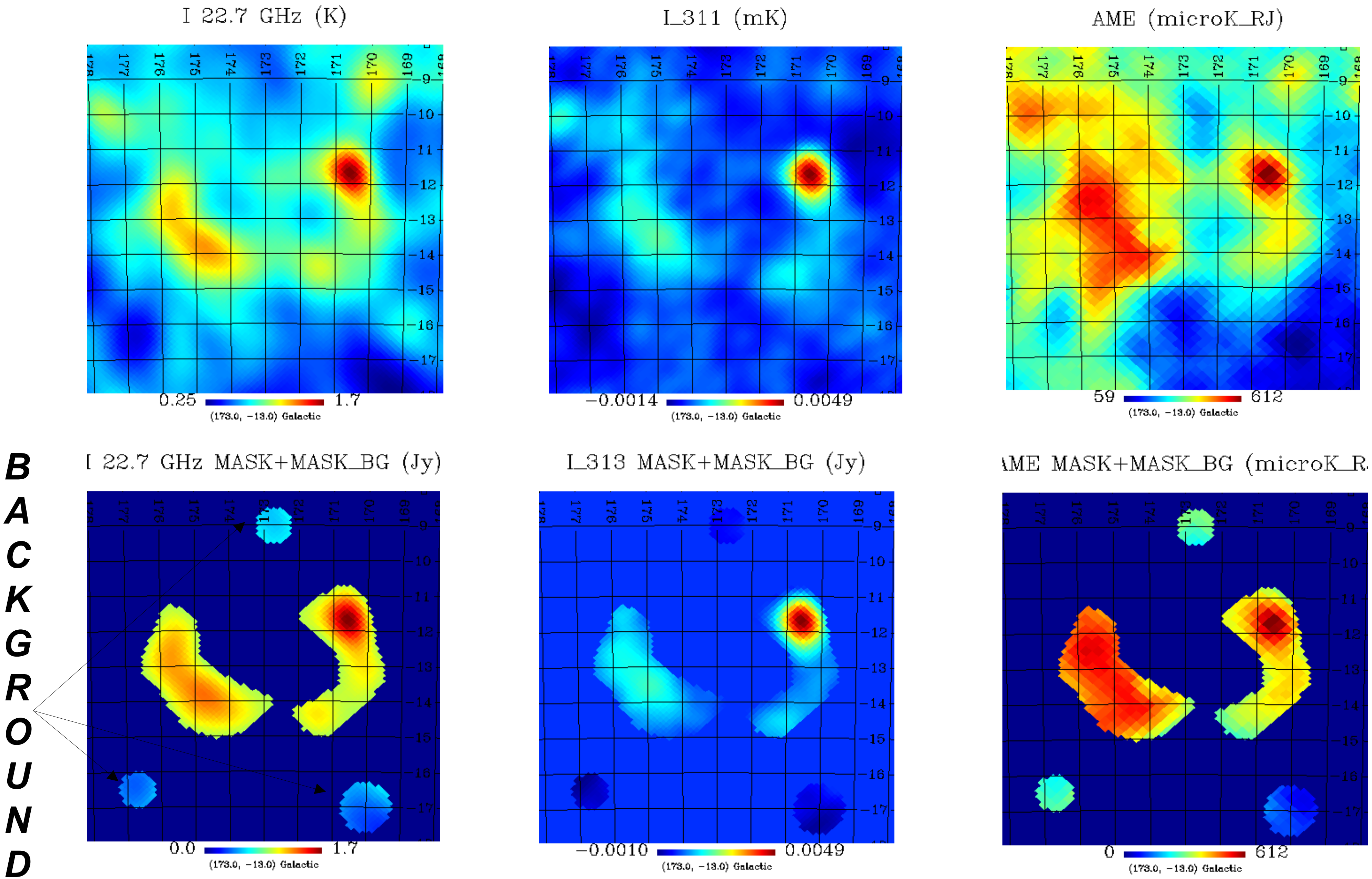
RMS per beam, in intensity and in polarisation, calculated on the QUIJOTE maps in a circular aperture of diameter 1◦ around Galactic coordinates (l,b) = (172◦,−10◦). For each Stokes parameter, I,Q,U, the RMS estimated from the original maps and from the difference of the two jackknife maps divided by two are shown. The RMS obtained from the original maps should be representative of the combined background and instrumental noise uncertainties while the RMS calculated from the combination of the jackknife maps should be indicative of the level of instrumental noise only. In the last column we display the instrument instantaneous sensitivities in polarisation obtained by normalising the averaged Q and U noise estimates calculated from the jackknife maps by the averaged integration time per beam.

LIST OF MAPS USED TO CALCULATE SEDs

SURVEY	FREQUENCY (GHz)	RESOLUTION (arcmin)
Haslam	0.408	51
Dwingeloo	0.820	72
Reich	1.42	34.2
HartRao	2.33	20
QUIJOTE	11.22	53.2
QUIJOTE	12.89	50.8
WMAP - yr9	22.7	51.3
Planck	28.4	33.1
WMAP - yr9	32.9	39.1
WMAP - yr9	40.6	30.8
Planck	44.1	27.9
WMAP - yr9	60.5	21.0
Planck	70.4	13.1
WMAP - yr9	93.0	14.8
Planck	100	9.7
Planck	143	7.3
Planck	217	5.0
Planck	353	4.9
Planck	545	4.8
Planck	857	4.6
Dirbe	1249	37.1
Dirbe	2141	38.0
Dirbe	2997	38.6

All maps have been smoothed to 1°

CLOUDS and BACKGROUND REGION MAPS



WMAP 22.7GHz **QUIJOTE 13 GHz** **AME (COMMANDER)**

SEDs Multi-Component Parametric Model :

PRELIMINARY

Parametric model :

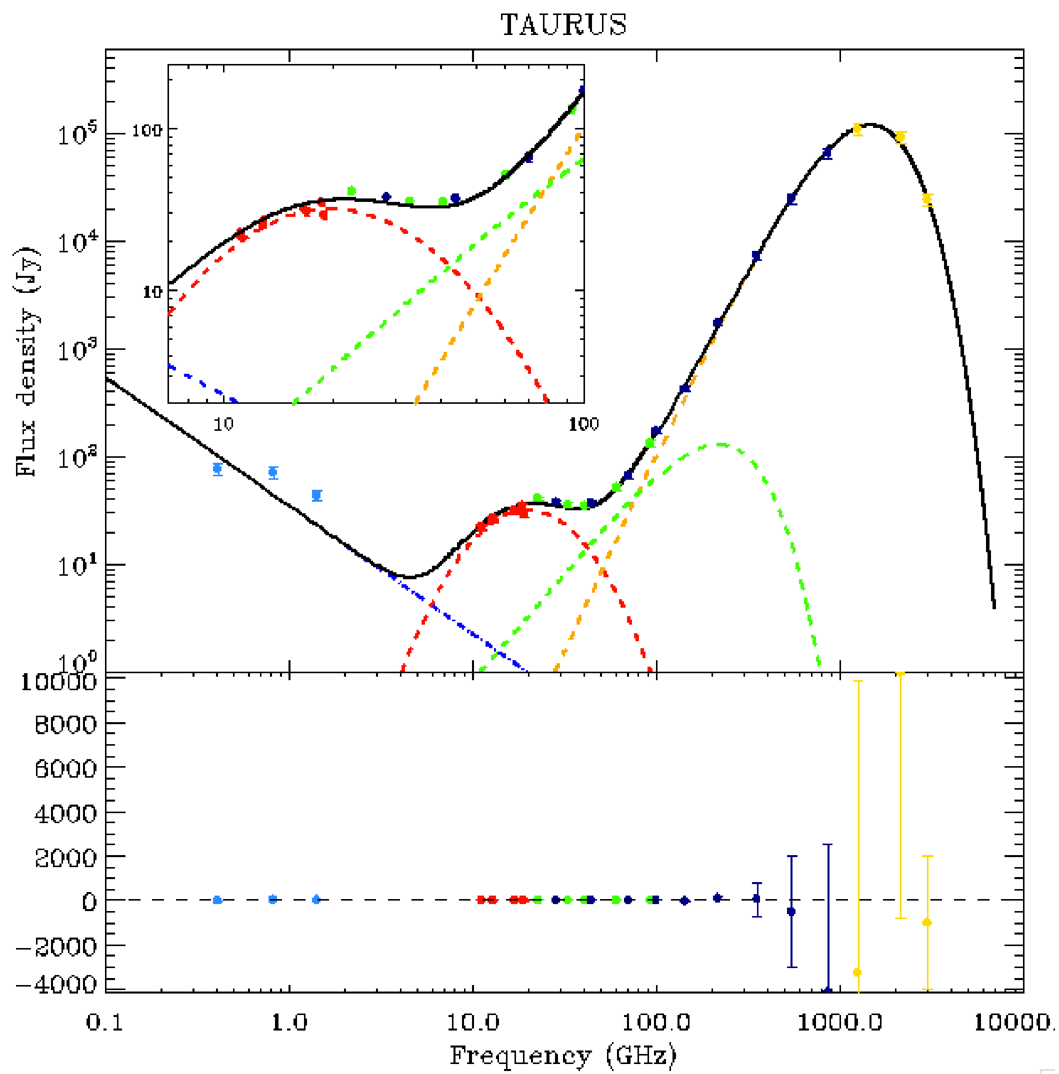
Follows method displayed in PLANCK ER XX (2011)

S=Sff+Std+Ssynch+Scmb+Same

(*) Amplitude of the synchrotron at 1 GHz (Jy) : 35.1 +/- 6.6
(*) Beta of the synchrotron at 1 GHz : -1.19 +/- 0.20
(*) Frequency of the peak of the spinning dust emission (GHz) : 20.0 +/- 0.0
(*) Maximum spinning dust emission (Jy) : 31.7 +/- 0.0
(*) Tdust (K) : 14.9 +/- 1.0
(*) beta dust (K) : 1.75 +/- 0.18
(*) tau250 (K) : 0.0021 +/- 0.0008
(*) dtcmb : 279.03408 microK
(*) Reduced chi2 of the intensity SED fit : 5.2047335

Spinning dust component fitted with Bonaldi et al. (2007) geometric model.

Fit and parametric model definitively have to be improved, in particular at low frequencies.

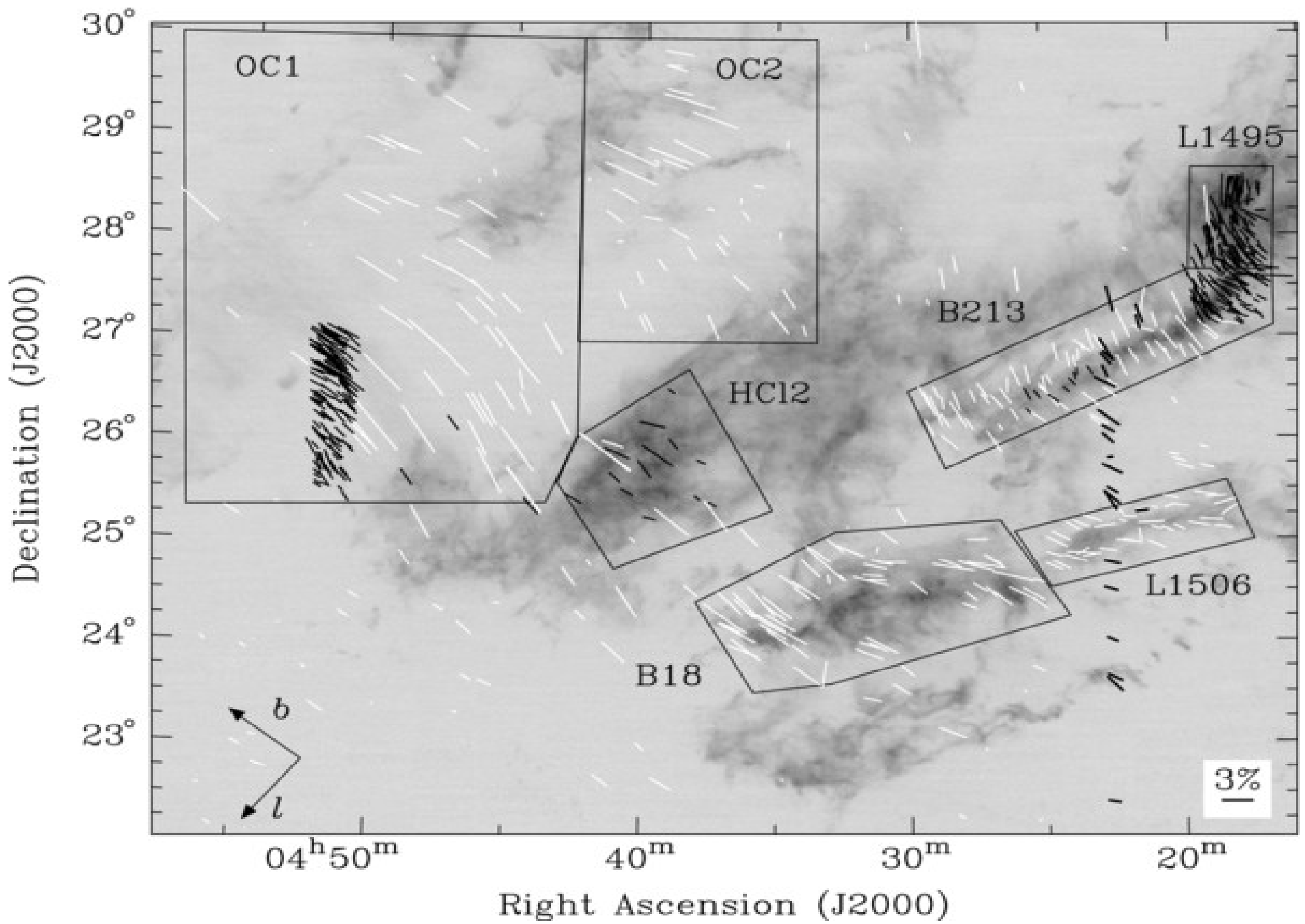


MAGNETIC FIELD IN THE TAURUS AS SEEN FROM THERMAL DUST

Chapman et al. 2013

polarization map showing the large scale magnetic field structure in the Taurus molecular Clouds as probe with Thermal dust.

See also well ordered structure In emission from PLANCK maps.



SUMMARY

- Observation of the Taurus Molecular Cloud at 11, 13, 17 and 19 GHz with the QUIJOTE experiment.

- I,Q,U maps are added to ancillary, PLANCK, WMAP and DIRBE maps.

- SEDs parametric model show strong emission of AME in the TAURUS region.

- Future work will explore polarization properties of the AME component.

- Polarization separation component will be investigated...

Thank you for your attention !