Polarized Low Frequency Foregrounds

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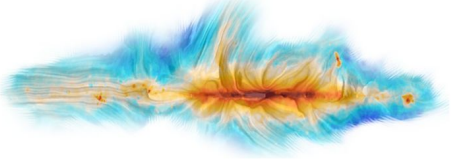
RADIO FOREGROUNDS

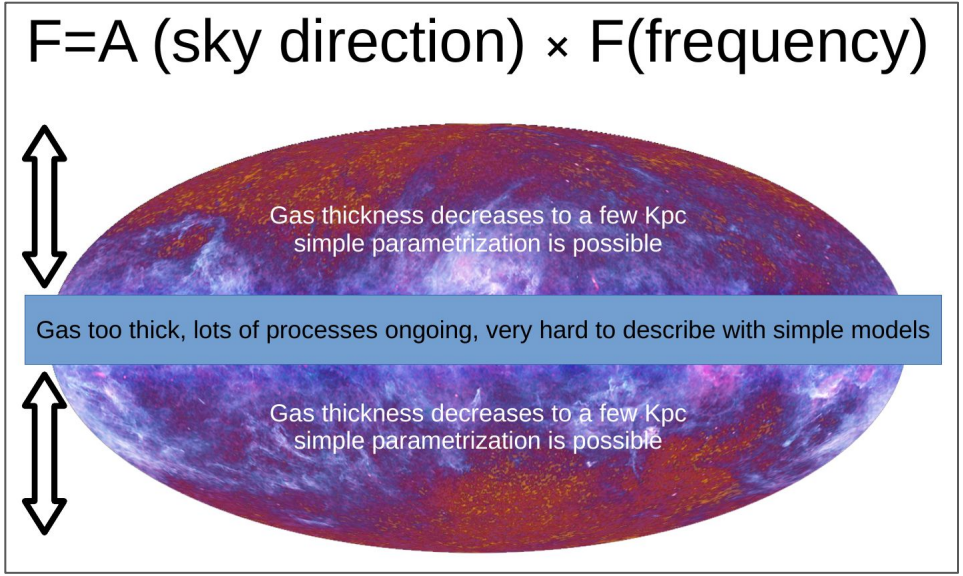


Outline

- Present observations of Polarized Low Frequency Foregrounds
  - Planck & WMAP
  - QUIJOTE
  - Radio Surveys
- Contamination to B-modes
- Observations till 2020
- Southern Hemisphere
- Northern Hemispheren
- Conclusions

Polarized Galactic Synchrotron at intermediate and high latitudes

- **Spatial distribution of amplitudes:**
  - **super-degree**
  - **degree**
  - **sub-degree**
- **SED in poilarization**
- **Contamination to CMB B-modes**
- **SED break**
- **Dust Correlation:**
  - **Super-degree**
  - **degree**
  - **Sub-degree**
- **de-Correlation**



Polarized Galactic Synchrotron at intermediate and high latitudes

- Spatial distribution of amplitudes:
  - super-degree (Planck & WMAP)
  - degree
  - sub-degree
- SED in poilarization
- Contamination to CMB B-modes (Planck & WMAP):
  - 0.05<rFG<0.1
  - 60 GHz < minimum frequency < 90 GHz
- SED break
- Dust Correlation:
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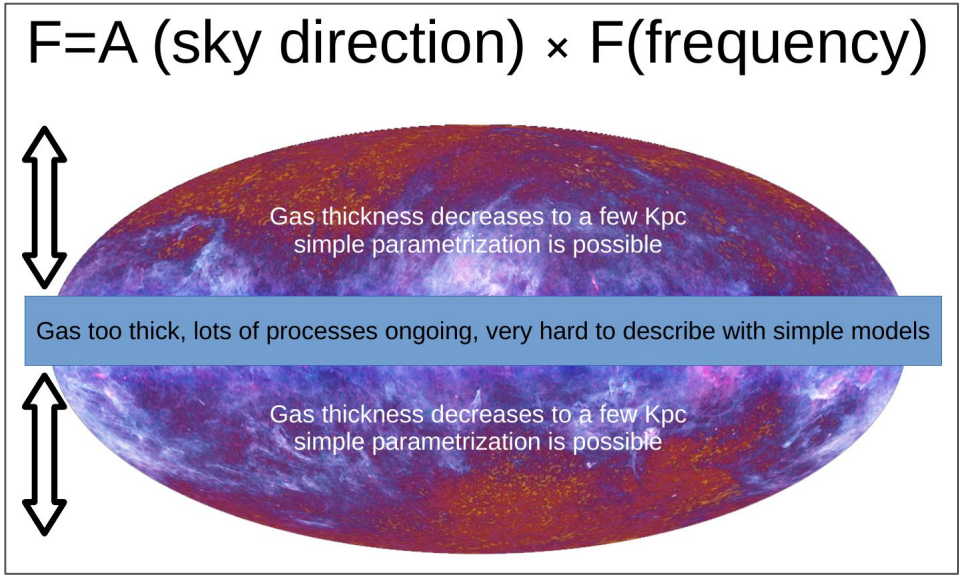
  - degree
  - Sub-degree
- de-Correlation



Polarized Galactic Synchrotron at intermediate and high latitudes

- Spatial distribution of amplitudes:
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  - degree (next talk)
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- SED in poilarization (next talk)
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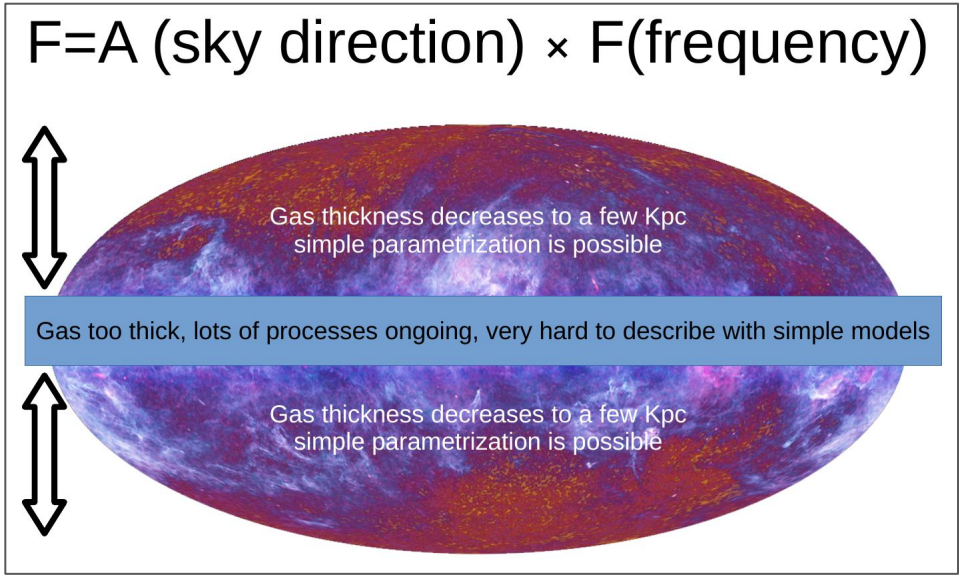
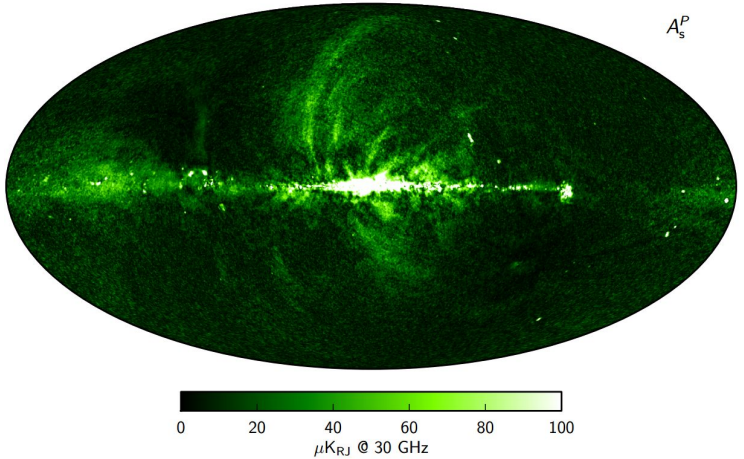
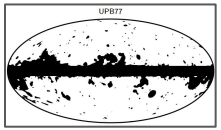
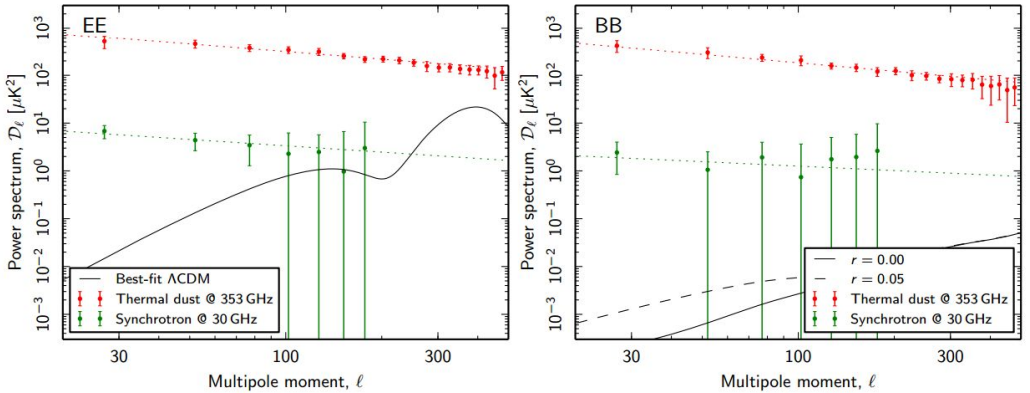


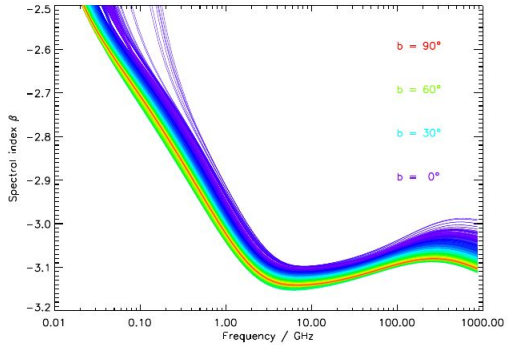
Planck & WMAP Synchrotron

- Fitting Q and U Synchrotron using spectral index from intensity
- Neglected components:
  - anomalous dust emission, expected to be less than 1% (Rubino-Martın et al., 2012)
  - polarized COs (Puglisi et al. 2016)
- Updated results coming in the third release of data



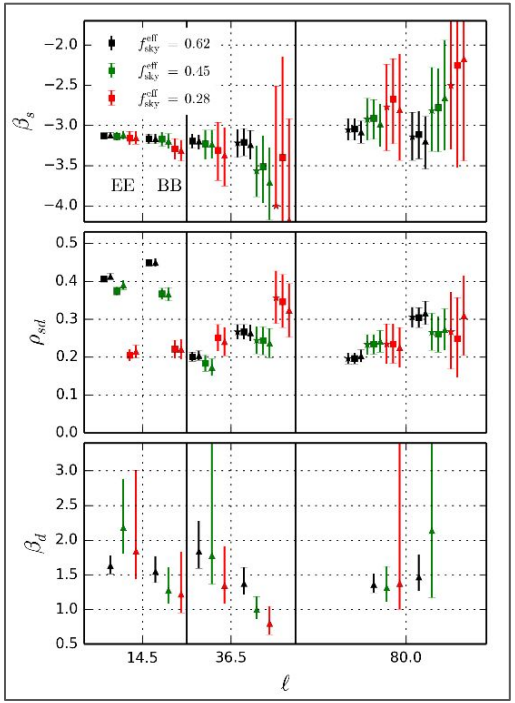


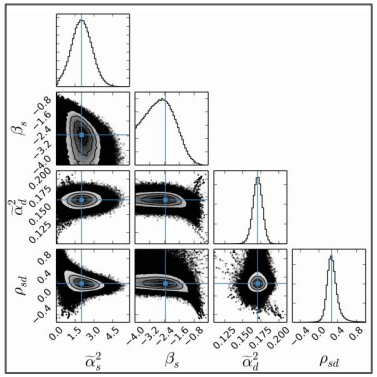


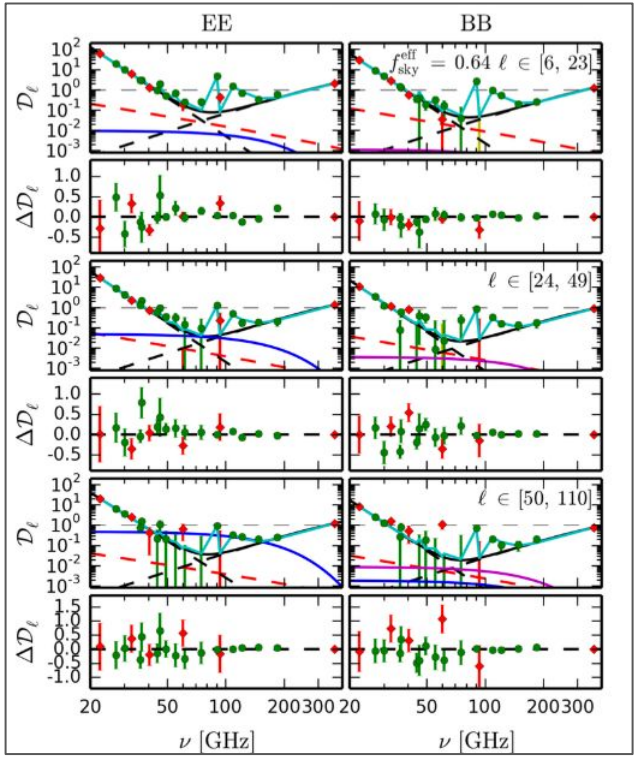


Planck 2015, X, XXV

Planck & WMAP Synchrotron: dust cross-correlation



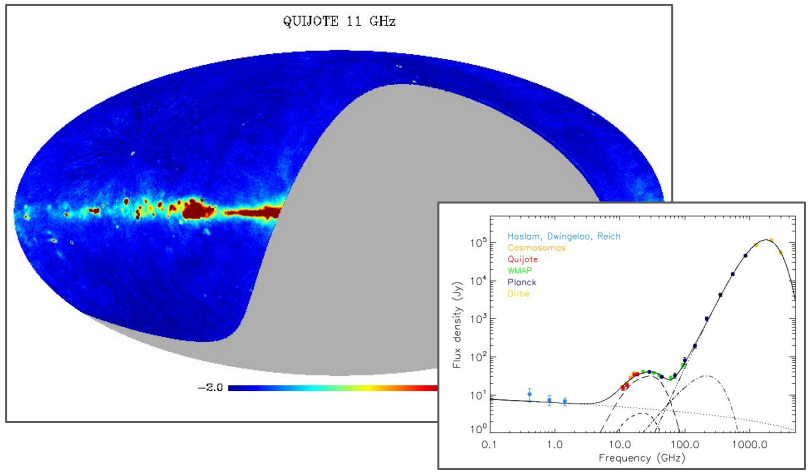


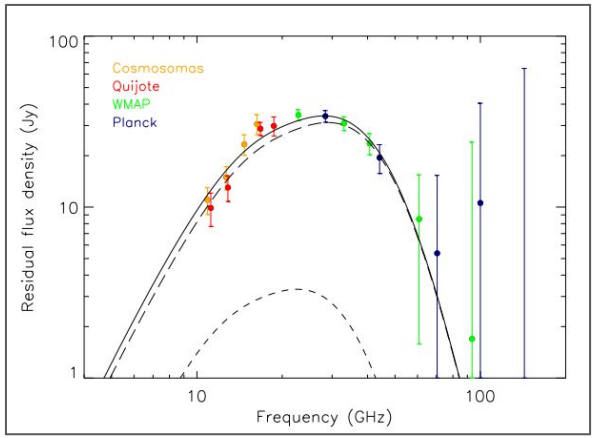


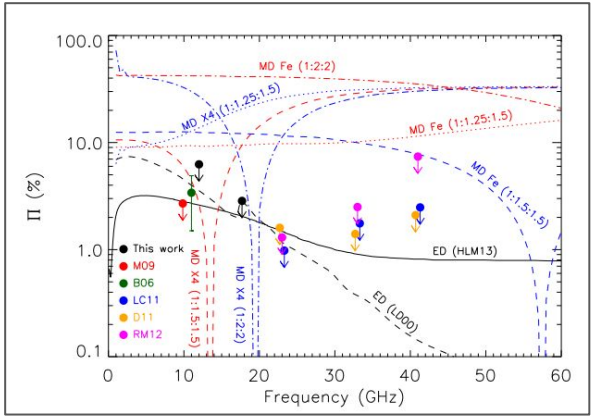
Choi & Page 2016,
Planck 2017, in preparation

QUIJOTE @ Tenerife

	MFI				TGI	FGI
Frequency [GHz]	11.0	13.0	17.0	19.0	31.0	41.0
Bandwidth [GHz]	2.0	2.0	2.0	2.0	10.0	12.0
Number of horns	2	2	2	2	31	31
Channels per horn	4	4	4	4	4	4
Tsys [K]	25.0	25.0	25.0	25.0	35.0	45.0
Beam FWHM [deg]	0.92	0.92	0.60	0.60	0.37	0.28
NET [μK s^1/2]	280	280	280	280	50	57
Sensitivity per beam [Jy s^1/2]	0.30	0.42	0.31	0.38	0.06	0.08



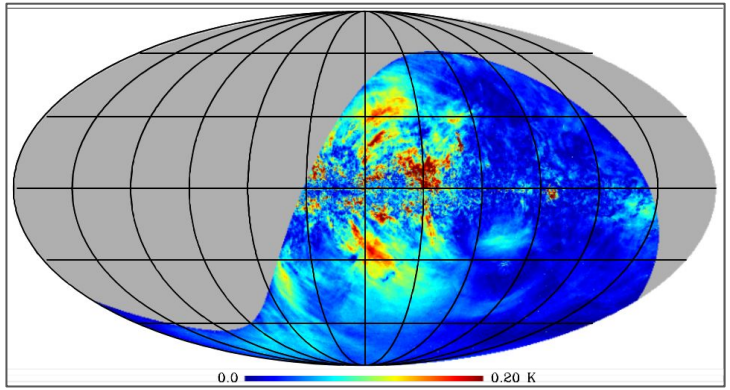




Genova-Santos et al. 2015
iac.es/proyecto/cmb/pages/en/quijote-cmb-experiment
Radioforegrounds.eu
See Flavien's talk

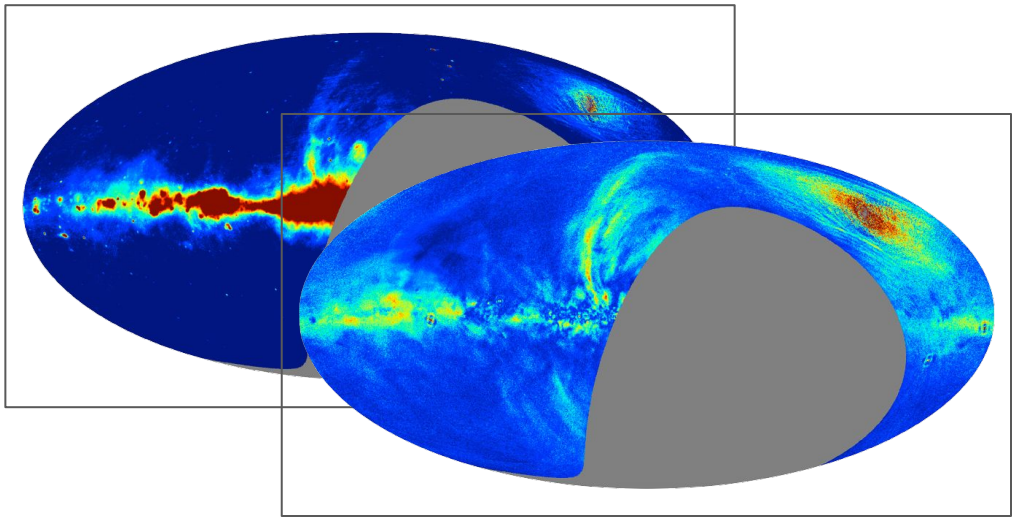
Radio Surveys: S-PASS, C-BASS

Sky-coverage:	All-sky
Angular resolution:	0.73 deg (43.8 arcmin)
Sensitivity:	<0.1 mK/beam r.m.s.
Stokes coverage:	I, Q and U
Tsys:	<20 K, including sky
Frequency/bandwidth:	1 GHz bandwidth, centered on 5.0GHz
Northern site:	OVRO, California, latitude 37.2 deg., 6.1m dish
Southern site:	meerKAT Karoo site, South Africa, latitude -30.7deg., 7.6m dish



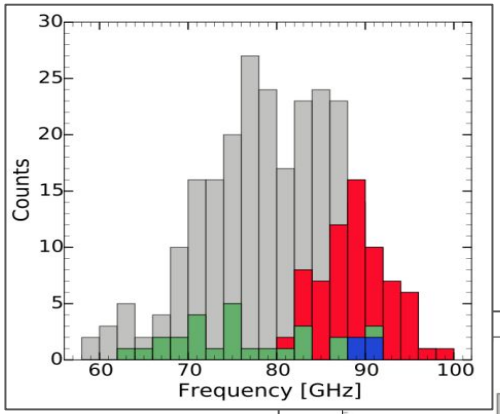
- Dec < 0º (unshaded area);
- Parkes: 2.3 GHz ;
- 224 MHz BW (100+ ch);
- FWHM = 9';
- s_{beam} < 1.0 mK;

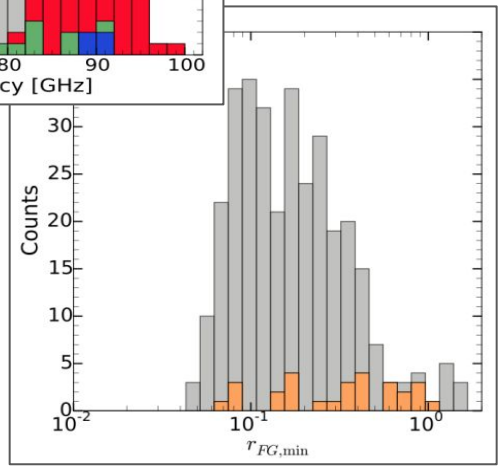
- Analysis for
  - publication of maps,
  - CMB contamination
- are ongoing,
  - Carretti et al., in preparation
  - Krachmalnicoff et al., in preparation (next talk)

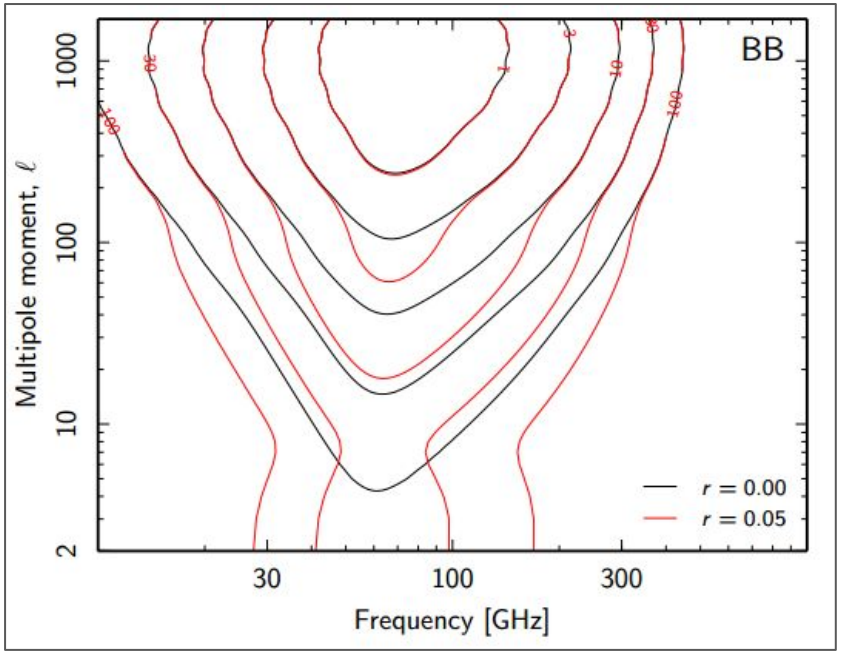


Data analysis in progress, see Jones talk
astro.caltech.edu/cbass

Contamination to CMB B-modes





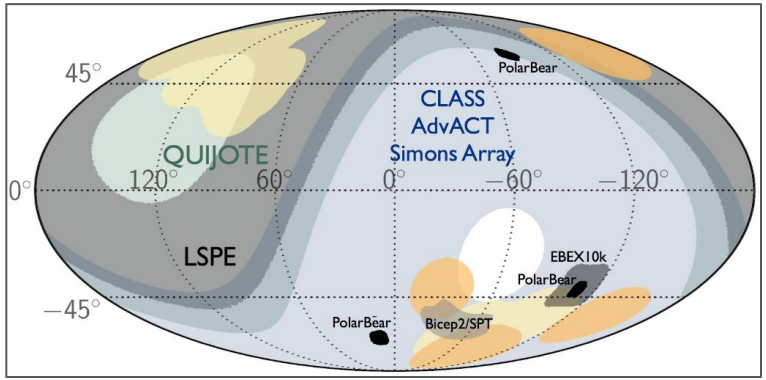


$$f(\ell,\nu) = [C_\ell^{\rm fg}(\nu)/C_\ell^{\rm CMB}]^{1/2}$$

K16, Planck 2015, X

Observations till 2020

- Southern Hemisphere
  - Simlations ingesting current analyses
  - Measurements by CLASS, Simons Array, Simons Observatory
- Northern hemisphere
  - QUIJOTE polarized synchrotron maps analyzed within RadioForegrounds
  - LSPE-STRIP being deployed in Tenerife
  - Combination from Satellite and Ground measurements

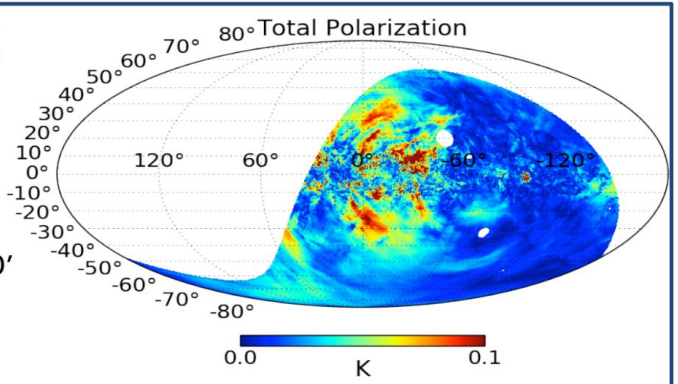


Observations till 2020: southern hemisphere

SPASS survey

Carretti et al. 2013
Carretti et al. in prep

Frequency: 2.3 GHz
Angular resolution: 10′
Sky coverage: ~50%
S/N: >3 everywhere

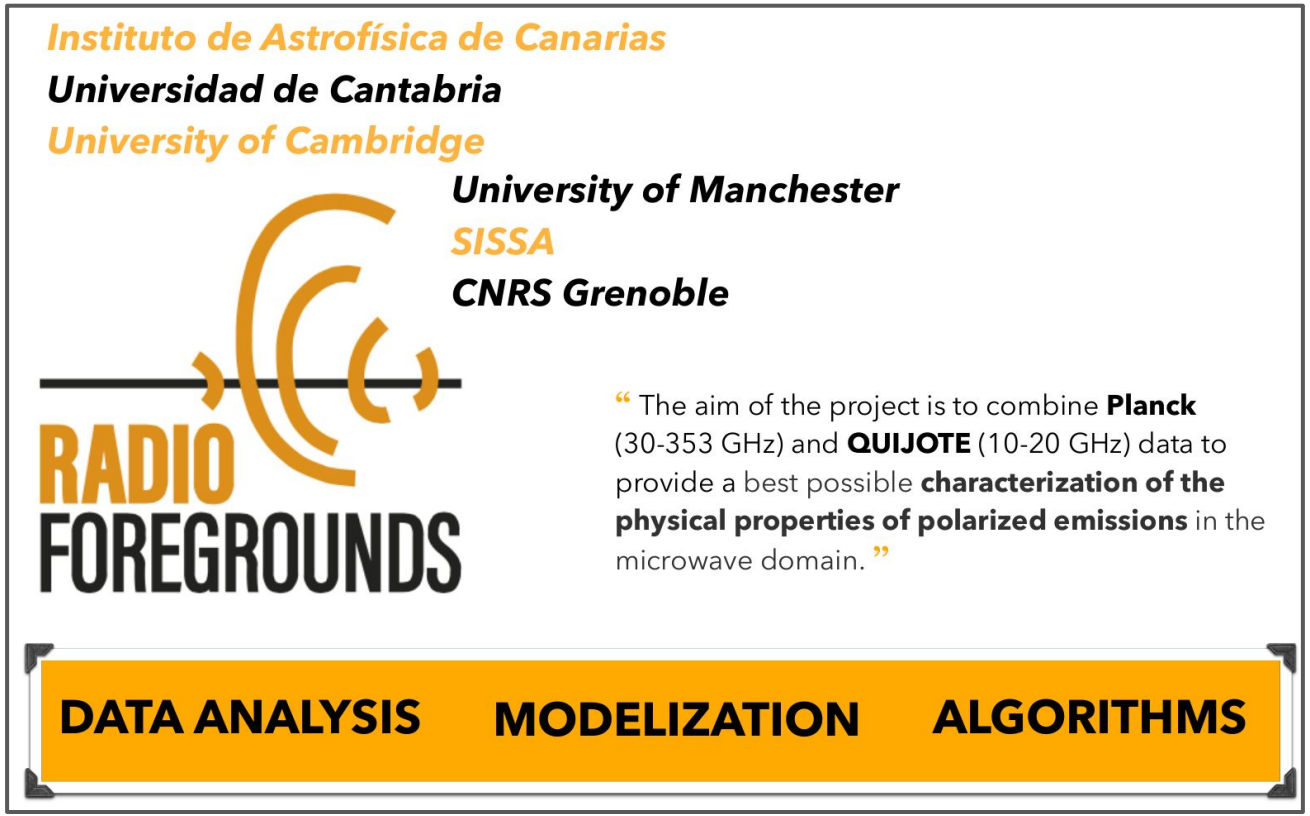


Diffuse Synchrotron emission as CMB contaminant:
(Krachmalnicoff et al. in prep)

- Angular power spectra at different Galactic latitudes up to ell~500
- Contamination to CMB B-modes in small sky regions at high Galactic latitude
- Correlation with other data (WMAP-Planck): SED, spectral index variation, correlation with dust emission

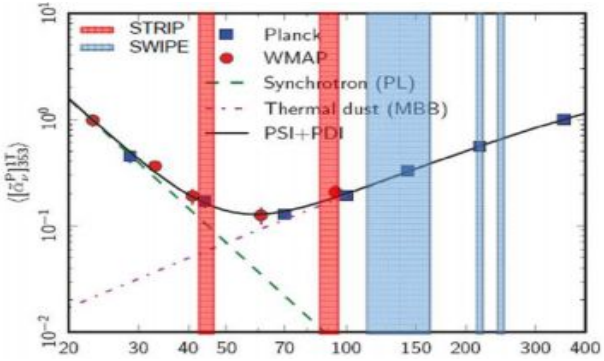
See Krachmalnocoff talk next

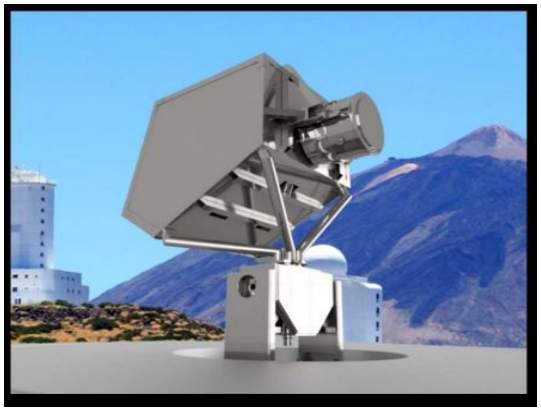
Observations till 2020: northern hemisphere

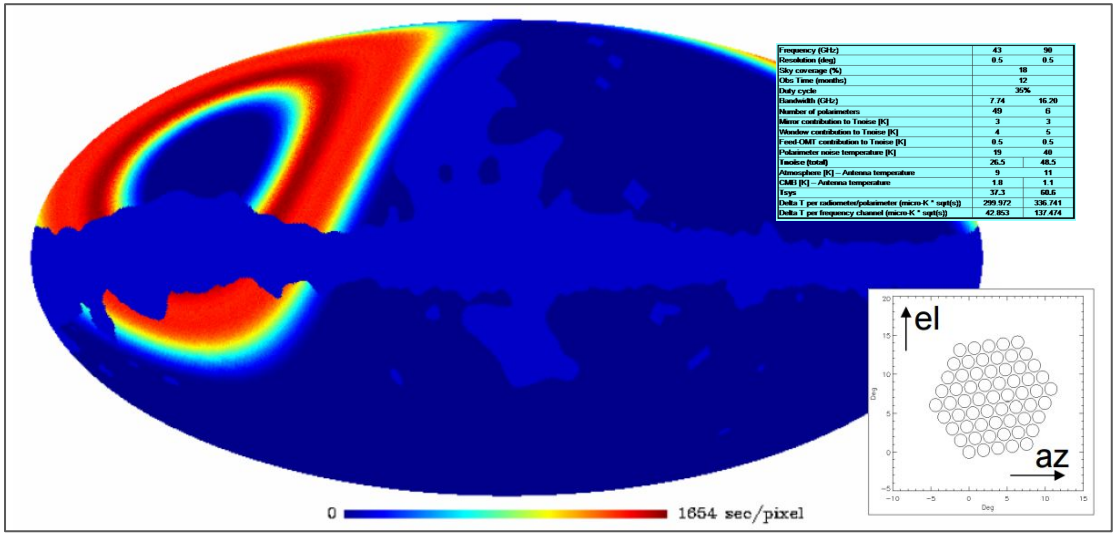


radioforegrounds.eu

LSPE-STRIP

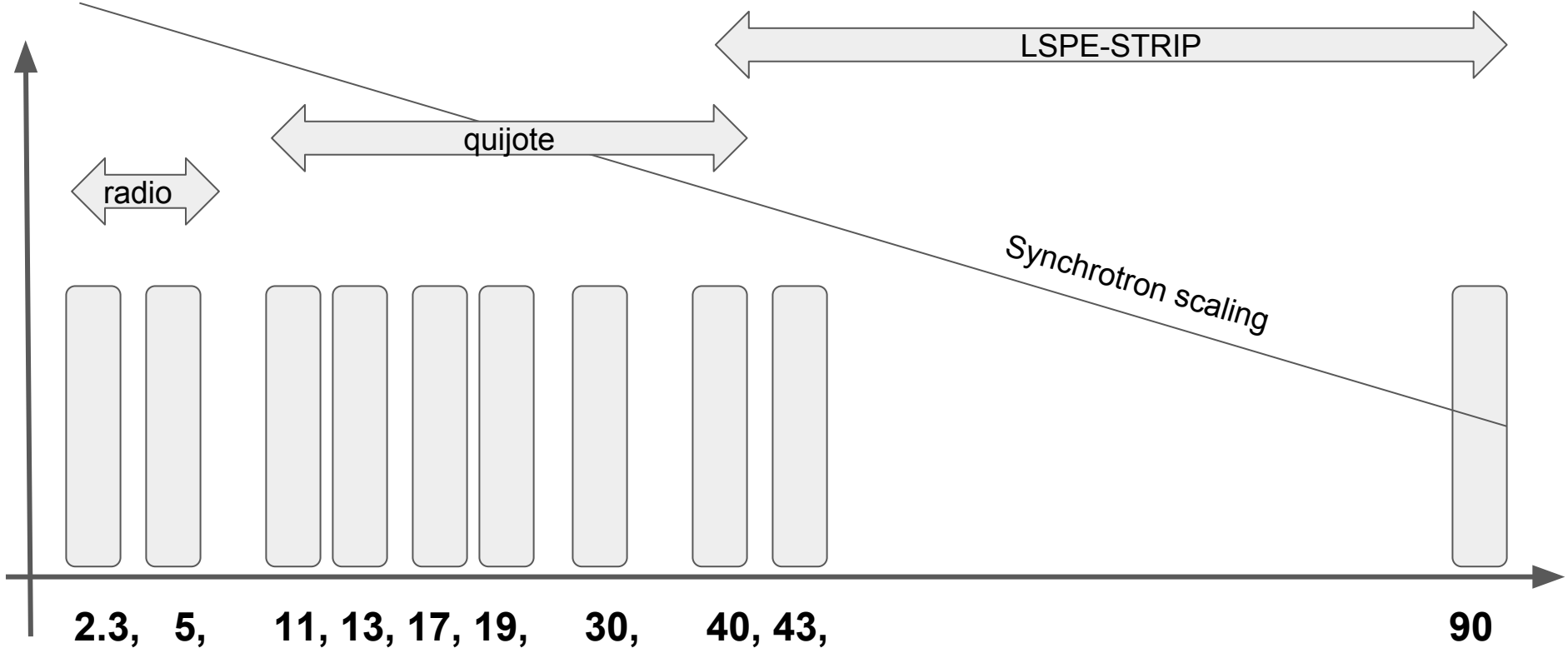






Now deploying in Tenerife
cosmo.fisica.unimi.it/research/lspe

Northern hemisphere: frequency bands



Conclusions

- The B-modes from Synchrotron are poorly known on degree and sub-degree scales
- SED in polarization is unknown
- De-correlation is unknown
- Polarization fraction of non-synchrotron components is unknown
- Correlation with dust polarization is known to be macroscopic on large angular scales
- On the degree scale, the observed B-modes from Synchrotron is comparable to dust at:
  - 0.05<rFG<0.1
  - 60<frequency<90
- Given this, 2 synchortron monitoring bands, with S/N>1 till 10 arcminute resolution are a minimum requirement for B-mode experiments
- Obervations in the Radio surveys in the southern hemisphere are being analyzed, several other observations (LSPE-STRIP, QUIJOTE) being analyzed/taking data soon in the southern hemisphere

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