# The dust polarization statistics at high Galactic latitudes



#### Jonathan Aumont ON BEHALF OF THE PLANCK COLLABORATION Planck 2014, Ferrara Tuesday, December 2<sup>nd</sup> 2014

- \* Study statistically the polarized emission from interstellar dust, in the formalism used to study the CMB, with the angular power spectra
- \*Draw some general properties that can be used for the cosmological analysis or for component separation
- \*Quantify the contamination of CMB measurements by polarized dust
- \*Give constraints for Galactic magnetic field and Galactic dust models

#### General methodology



Q and U maps at 353 GHz

**XPOL** pseudo-*C*<sub>l</sub> estimator based on **XSPECT** [Tristram et al. 2005]

Corrects for incomplete sky coverage, pixel and beam window functions



Angular power spectra  $C_{\ell}^{EE}$  and  $C_{\ell}^{BB}$ 

Spectra are computed from the two noise-independent Detector Set maps

 $C_{\ell}(\nu \times \nu) \equiv C_{\ell}(D_{\nu}^{1} \times D_{\nu}^{2})$ 

The CMB *C*<sub>l</sub><sup>EE</sup> best fit model is removed [Planck Collaboration XIV 2014]

- ★ Dust polarized angular power spectra on large fractions of the sky
- ★Statistics of the dust angular power spectra on small patches at high Galactic latitudes
- Implications for the BICEP2 experiment

## Large sky fraction regions

Masks: built from the smoothed (10 degrees) dust intensity map at 857 GHz



+ CO + radio point sources mask + apodization (5 degrees)

[Planck Intermediate XXX 2014, arXiv 1409.5738]

#### Results

- ★ First detection of the dust polarized angular power spectra at ℓ>10
- Even on 30% of the sky, the dust polarized emission dominates the CMB, at all scales
- 1. Shape of the spectra?
- 2. Variation of their amplitudes with respect to the mask?3. BB/EE ratio?
- 4. Amplitudes at other frequencies?

[Planck Intermediate XXX 2014, arXiv 1409.5738]





★ The spectra are compatible with power-laws with a -2.42 slope ★ No significant difference between EE and BB Amplitude as a function of the mask



\* There is an empirical relation between the amplitude and the mean

dust intensity on the considered region

[Planck Intermediate XXX 2014, arXiv 1409.5738]



\* The dust polarized emission produces twice as much *EE* than *BB* \* The existing dust models give  $BB/EE \sim 1$ 





★ The spectra amplitudes follow the frequency dependence of the dust polarization for both *EE* and *BB* 

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## Statistics on 400 deg<sup>2</sup>

- ★ Extrapolation of the *BB* amplitudes at 150 GHz
- \* Amplitudes expressed in units of  $r_d$  (*e.g.*  $r_d = 0.2$  means that the dust has the same level as the CMB r = 0.2 à  $\ell = 80$ )



- \* The cleanest regions of the sky have  $r_d \sim 0.01 \pm 0.06$
- ★ In no region the dust polarization can be neglected if one wants to measure the CMB primordial *B*-modes

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### Measurement of the dust in the BICEP2 field

★ Computation of the BB spectrum at 353 GHz in the BICEP2 region
★ Extrapolation to 150 GHz



- $\star$  4.5  $\sigma$  detection of the dust at 353 GHz
- $\star$  3.6 $\sigma$  prediction at 150 GHz
- \* Prediction of the dust level similar to the B-modes measured by BICEP2



 Measurement compatible with polarized dust emission through the Planck-HFI bands ★Planck allowed to measure for the first time the Galactic dust polarization angular power spectra

★We have shown that these spectra can be described by a simple empirical model

 $\star C_{\ell}$  have a power-law shape with a slope of -2.42

- \* Amplitudes are described by  $\langle I_{353} \rangle^{1.9}$
- **★***BB*/*EE* ~ 0.5
- \*Frequency dependence described by the modified black-body spectrum of [Planck Int. XII]

★These properties are statistically conserved on 1% of the sky

- \* There are no regions on the sky were the dust polarization B-modes could be neglected (even if some regions are cleaner the the BICEP2 field)
- ★ It is necessary to take into account the dust polarization in the BICEP2 data

- ★All the derived properties will be used as a benchmark for CMB polarization data analysis (likelihood, component separation, ...)
- ★We are currently working at the joint analysis of the Planck and BICEP2 data (MoU between the Planck and BICEP2 collaborations)
- \*This work is an input for a promising work on the modelization of the polarized dust emission. These models can for the first time rely on all sky data and will have to mimic the properties we have derived

#### Thank you

