

# FIRST DETECTION OF THE SUBMILLIMETER GALACTIC DUST EMISSION BY ARCHEOPS

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**Abstract.** We present the first determination of the Galactic polarized emission at 353 GHz by Archeops. The data were taken during the Arctic night of February 7, 2002 after the balloon-borne instrument was launched by CNES from the Swedish Esrange base near Kiruna. In addition to the 143 GHz and 217 GHz frequency bands dedicated to CMB studies, Archeops had one 545 GHz and six 353 GHz bolometers mounted in three polarization sensitive pairs that were used for Galactic foreground studies. We present maps of the I,Q,U Stokes parameters over 17 % of the sky and with a 13 arcmin resolution at 353 GHz (850 microns). They show a significant Galactic large scale polarized emission coherent on the longitude ranges [100, 120] and [180, 200] deg. with a degree of polarization at the level of 4–5 %, in agreement with expectations from starlight polarization measurements. Extrapolated to high Galactic latitude, these results indicate that interstellar dust polarized emission is the major foreground for PLANCK–HFI CMB polarization measurement.

## 1 Introduction

The power spectrum of the *temperature* anisotropies of the Cosmic Microwave Background (CMB) have now been measured over most of the relevant angular scales (10 arcmin to 90 deg). However, CMB *polarization* is only in its experimental infancy. Theoretical predictions are rather tight for the polarization effect coming from the last scattering surface. Accurate polarization measurements are not only useful for breaking some degeneracies between cosmological parameters but also for obtaining the gravitationnal wave background. For high frequency CMB measurements the most important foreground is certainly the emission from Galactic Interstellar Dust (ISD). Ground-based observations of submm ISD polarization are concentrated on high angular resolution (arcminute scale) of star formation regions. *Indirect* evidence for large scale polarization come from the polarization of starlight in absorption ([4]). *Direct* submm measurements are therefore highly required both for Galactic studies of the large scale coherence of the magnetic field and in the field of CMB polarization, but are rather challenging as they require sensitivities comparable to those of CMB studies.

Archeops is an experiment designed to obtain a large sky coverage in a single balloon flight. First results on CMB anisotropies power spectrum are reported in ([2], [3]). Here, we present the first results on ISD polarization measurements with Archeops detailed in [1]. Its large sky coverage strategy is optimized for finding fairly strongly polarized sources without any bias on their location.

## 2 Results

Once the data are cleaned, they are filtered, calibrated and combined according to  $\mathbf{M} = \mathbf{A}\mathbf{S} + \mathbf{N}$ , where  $\mathbf{M}$  is the time ordered vector of the  $n_t \times n_{bol}$  measures with  $n_t$  measures of  $n_{bol}$  bolometers,  $\mathbf{S}$  the  $(3 n_{pix})$ -vector Stokes map of the sky,  $\mathbf{A}$  the pointing matrix encoding the pointing information and polarizer angles and  $\mathbf{N}$  the  $n_t \times n_{bol}$  noise vector. Then they are inverted using  $\mathbf{S} = (\mathbf{A}^T \mathbf{N}^{-1} \mathbf{A})^{-1} \mathbf{A}^T \mathbf{N}^{-1} \mathbf{M}$  to produce maps of  $I$ ,  $Q$ , and  $U$ . We choose a pixel size of 27.5 arcmin, corresponding to HEALpix ([5]) resolution parameter  $n_{side} = 128$ . In the analysis that follows we use the measured dispersion as a measure of the noise. Pixels that have less than 100 detector samples, which correspond to 0.11 sec mission integration time and a  $1\sigma$   $I$  noise level of  $143 \mu\text{K}_{RJ}$  are blanked. For display purposes the maps shown in the figure are smoothed with a 1 deg beam.

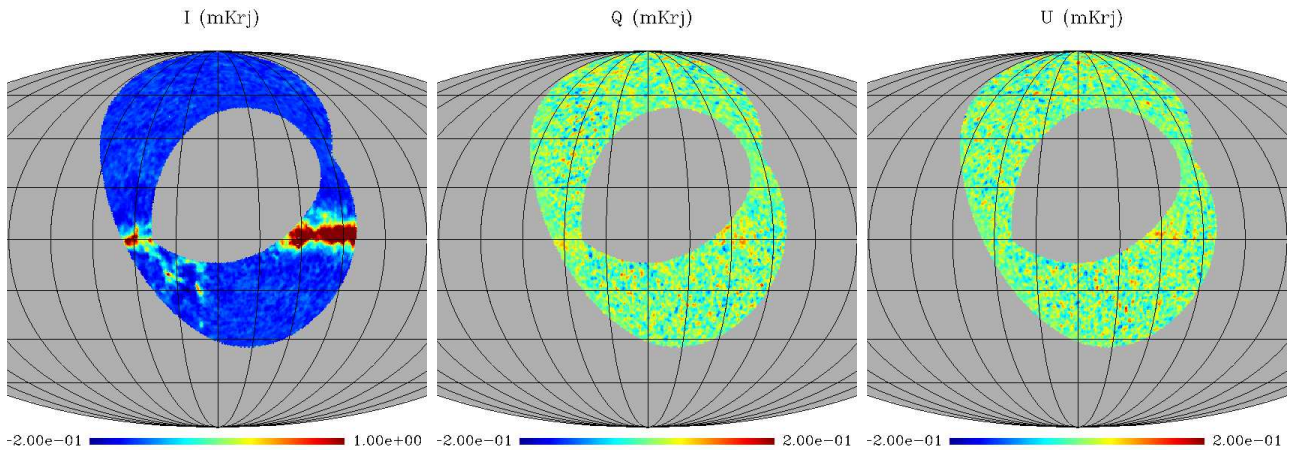


Figure 1: Archeops  $I$ ,  $Q$  and  $U$  maps at 353 GHz in  $\text{mK}_{\text{RJ}}$  smoothed with a 1 degree Gaussian beam centered at 30 deg from the Galactic anti-center.

The instantaneous mission  $I$  sensitivity is found to be about  $48 \mu\text{K}_{\text{RJ}}.\text{sec}^{1/2}$ . On average, the  $1 \sigma$  noise per pixel of 27 arcmin ( $n_{\text{side}} = 128$ ) is found to be  $82 \mu\text{K}_{\text{RJ}}$  in intensity and  $105 \mu\text{K}_{\text{RJ}}$  in  $Q$  and  $U$ . A statistically significant polarization signal is detected in various locations on the Galactic plane.

Archeops provides the first large coverage maps of Galactic submm emission with 13 arcmin resolution and polarimetric capabilities at 353 GHz. We find that the diffuse emission of the Galactic plane in the observed longitude range is polarized at the 4-5 % level except in the vicinity of the Cygnus region. Its orientation is mostly perpendicular to the Galactic plane and orthogonal, as expected, to the orientation of starlight polarized extinction. Some regions in the Galactic plane (Gem OB1, Casiopeia) show an even stronger degree of polarization in the range 10–20 %. This suggests a powerful grain alignment mechanism throughout the interstellar medium. Our findings are compatible with models where a strong coherent magnetic field coplanar to the Galactic plane follows the spiral arms, as observed in external Galaxies.

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## References

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