POLARBEAR constraints on cosmic birefringence and primordial magnetic fields

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Abstract

We constrain anisotropic cosmic birefringence using four-point correlations of even-parity E-mode and odd-parity B-mode polarization in the cosmic microwave background measurements made by the POLARization of the Background Radiation (POLARBEAR) experiment in its first season of observations. We find that the anisotropic cosmic birefringence signal from any parity-violating processes is consistent with zero. The Faraday rotation from anisotropic cosmic birefringence can be compared with the equivalent quantity generated by primordial magnetic fields if they existed. The POLARBEAR nondetection translates into a 95% confidence level (C.L.) upper limit of 93 nanogauss (nG) on the amplitude of an equivalent primordial magnetic field inclusive of systematic uncertainties. This four-point correlation constraint on Faraday rotation is about 15 times tighter than the upper limit of 1380 nG inferred from constraining the contribution of Faraday rotation to two-point correlations of B-modes measured by Planck in 2015. Metric perturbations sourced by primordial magnetic fields would also contribute to the B-mode power spectrum. Using the POLARBEAR measurements of the B-mode power spectrum (two-point correlation), we set a 95% C.L. upper limit of 3.9 nG on primordial magnetic fields assuming a flat prior on the field amplitude. This limit is comparable to what was found in the Planck 2015 two-point correlation analysis with both temperature and polarization. We perform a set of systematic error tests and find no evidence for contamination. This work marks the first time that anisotropic cosmic birefringence or primordial magnetic fields have been constrained from the ground at subdegree scales.