

# Fundamental physics in the cosmos: The early, the large and the dark Universe



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**Fundamental physics in the cosmos:  
The early, the large and the dark Universe**

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## Improved constraints on lepton asymmetry from the \\ cosmic microwave background

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The lepton asymmetry of the Universe is one of the most weakly constrained cosmological parameters. Whereas the baryon asymmetry is tightly constrained to be at the order  $\mathcal{O}(10^{-9})$ , the lepton asymmetry could be larger by many orders of magnitude.

A cosmic lepton asymmetry affects the primordial helium abundance and the expansion rate of the early Universe. Both of these effects have an impact on the anisotropies of the cosmic microwave background. We derive constraints on the neutrino chemical potentials from the Planck 2015 data, assuming equal lepton flavour asymmetries and negligible neutrino masses. Our constraints on the lepton asymmetry are significantly stronger than previous constraints from CMB data analysis and we argue that they are more robust than those from primordial light element abundances. The resulting constraints on the primordial helium and deuterium abundances are consistent with those from direct measurements.

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