

Cosmological implications of an Axion-Like Majoron

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Recent observations in Physical Cosmology have achieved a precision that not only allows for a better determination of model parameters, but also, the existence of cosmological tensions between current datasets motivates exploiting this precision to test for alternative theories that extend the particle content of the Standard Model. Theories beyond the Standard Model of particle physics generally predict the existence of scalar fields whose excitations manifest as axion-like particles (ALPs). One such field is the majoron, which is an eV-scale neutrinophilic pseudo-Goldstone boson that is created in the oscillations of photons to axions in the presence of a primordial magnetic field. As the Universe cools down to a temperature below the majoron mass, they decay transferring their energy to the neutrino sector. This axion-like majoron has three interesting consequences for Physical Cosmology 1) This missing energy in the conversion of photons to axions is not accounted for in the standard Λ CDM model, so the inferred cosmic expansion rate of the universe from Cosmic Microwave Background (CMB) measurements would be increased, potentially solving the Hubble tension (H_0). 2) The baryon-to-photon ratio would also be decreased before the time of photon-to-axion oscillation, increasing the abundance of primordial deuterium formed at Big Bang Nucleosynthesis (BBN) and better matching primordial deuterium observations. 3) The extra contribution to the Cosmic Neutrino Background causes a small-scale suppression on structure formation due to free-streaming of massive neutrinos, contributing to the S_8 tension, and enabling a possible degeneracy with the controversial interpretation of the cosmological neutrino mass signal from Large Scale Structure observations (LSS). Overall, the phenomenology of an axion-like majoron appearing at the end of BBN and decaying before recombination has the power to modify the interpretation of the observations of the major pillars of the Big Bang Theory, and is therefore a promising particle physics scenario with the potential for addressing the current Tensions in Cosmology.

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