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The Cosmological Tension of Ultralight Axion Dark Matter and its Solutions JACOB LEEDOM, University of California, Berkeley, JEFF DROR, University of California, Santa Cruz — A number of proposed and ongoing experiments search for axion dark matter with a mass nearing the limit set by small scale structure ($\mathcal{O}(10^{21}$ eV)). We consider the late universe cosmology of these models, showing that requiring the axion to have a matter-power spectrum that matches that of cold dark matter constrains the magnitude of the axion couplings to the visible sector. Comparing these limits to current and future experimental efforts, we find that many searches require axions with an abnormally large coupling to Standard Model fields, independently of how the axion was populated in the early universe. We survey mechanisms that can alleviate the bounds, namely, the introduction of large charges, various forms of kinetic mixing, a clockwork structure, and imposing a discrete symmetry. We provide an explicit model for each case and explore their phenomenology and viability to produce detectable ultralight axion dark matter.

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