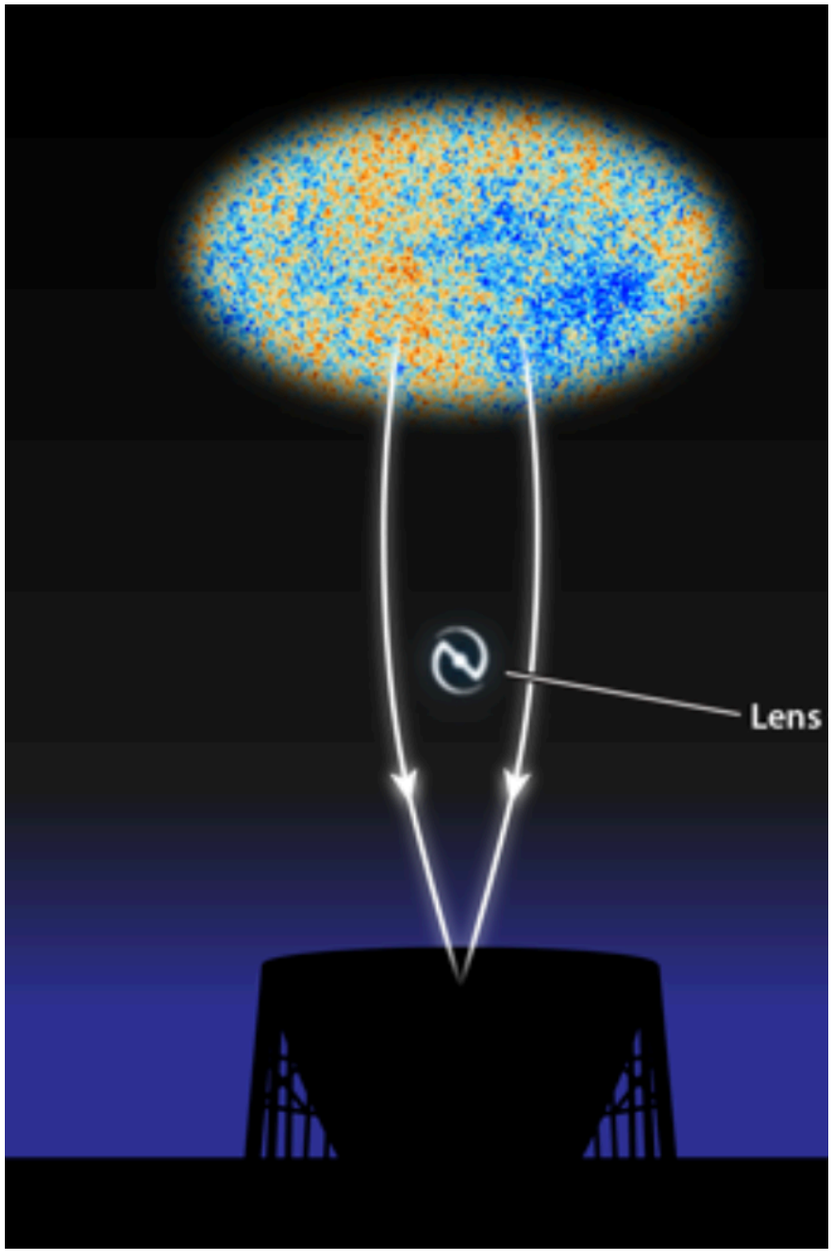
CMB-HD: Probing Dark Matter Particle Properties with Ultra-High-Resolution CMB Lensing

Neelima Sehgal
LSST DM KICP
August 6th, 2019



Ho Nam Nguyen, NS, Mathew Madhavacheril, PRD, 2019, (arXiv:1710.03747)

NS et al. 2019, Science White Paper for Astro2020 Decadal (arXiv:1903.03263)

NS et al. 2019, CMB-HD APC White Paper for Astro2020 Decadal (arXiv:1906.10134)

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Key Question: What do matter fluctuations look like on small-scales?

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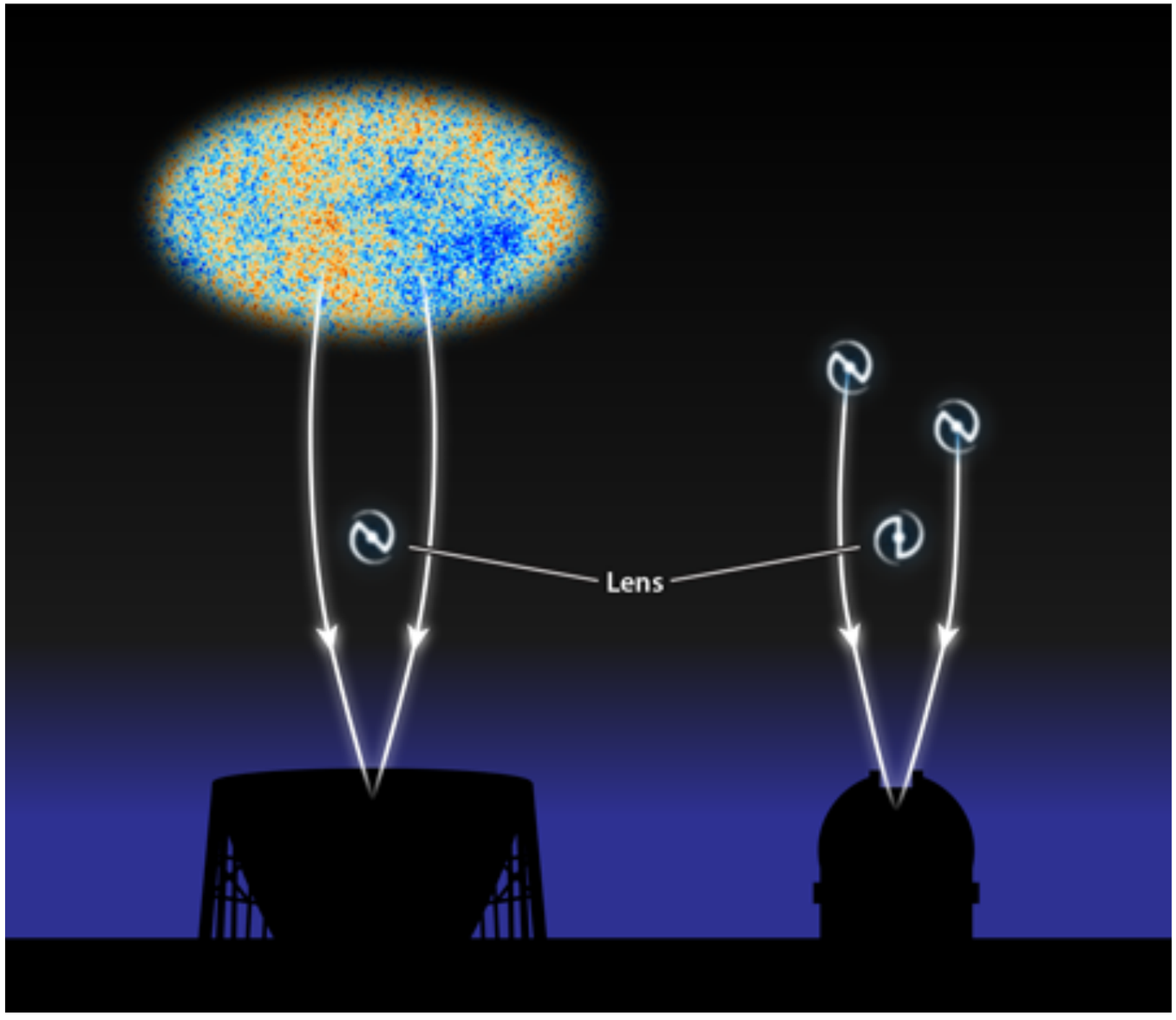
- Galaxy-galaxy strong lensing in optical and mm-wavelegths - need to disentangle complex structure of background source from substructure

Gravitational Lensing of the Cosmic Microwave Background



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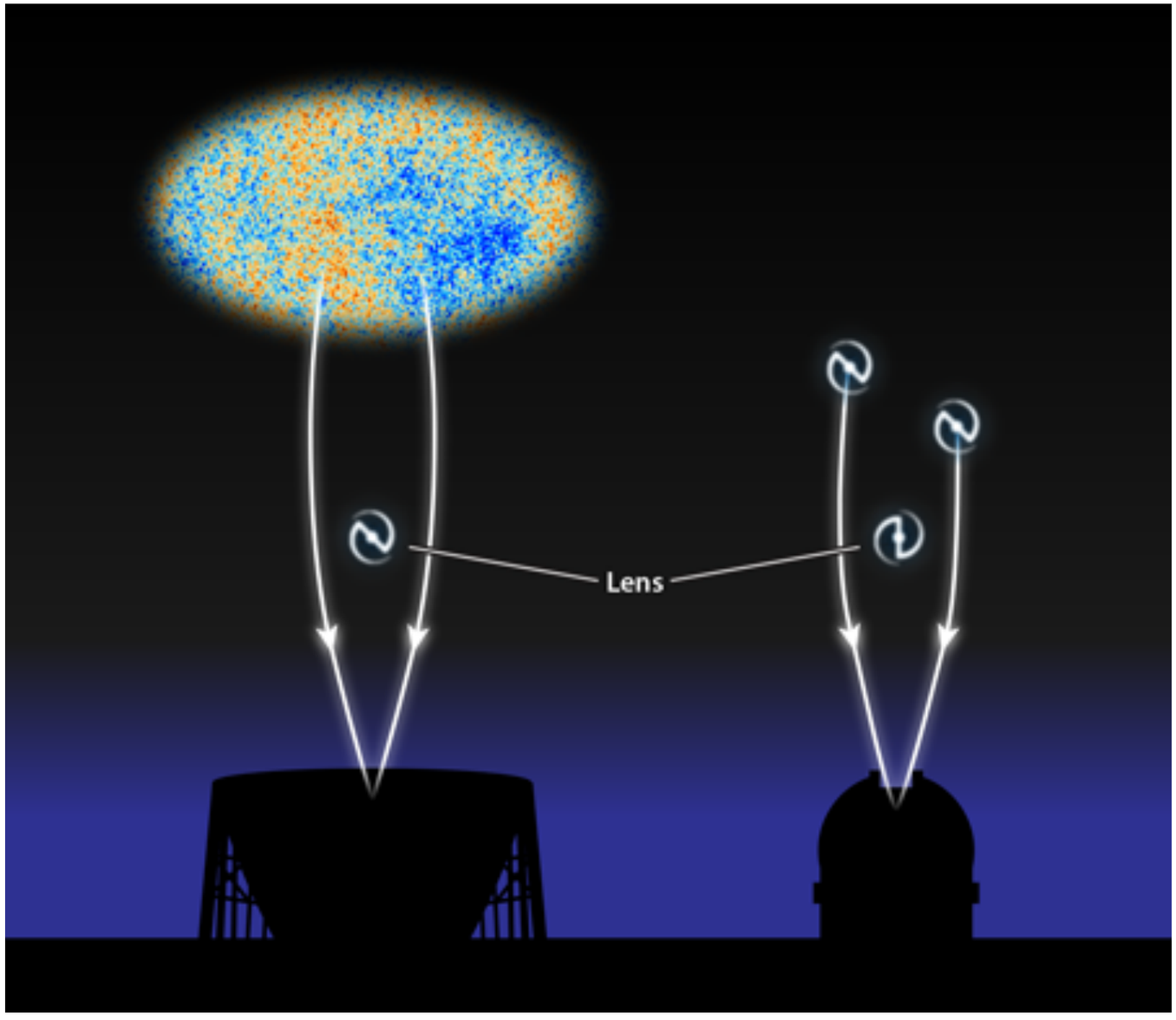

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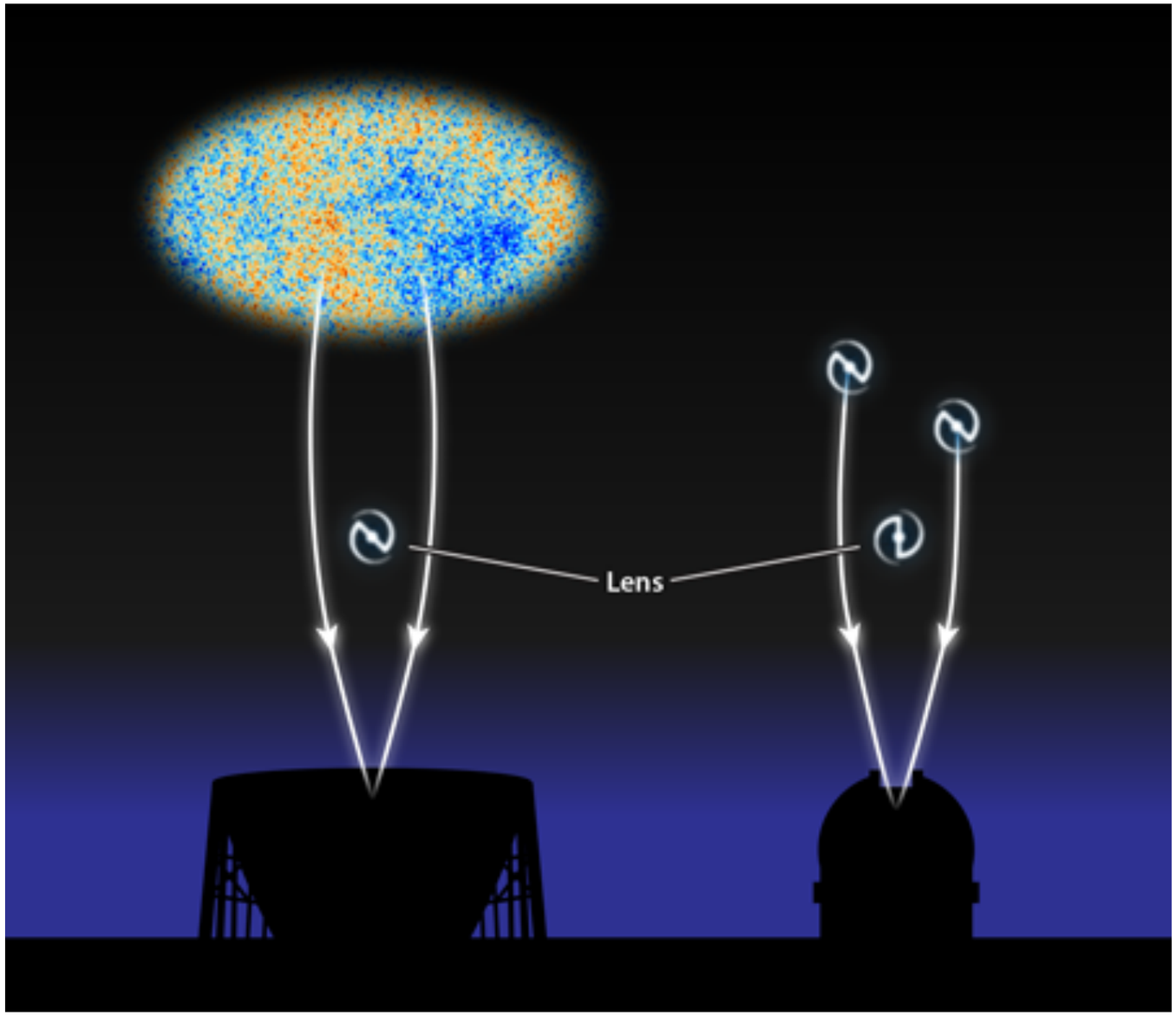

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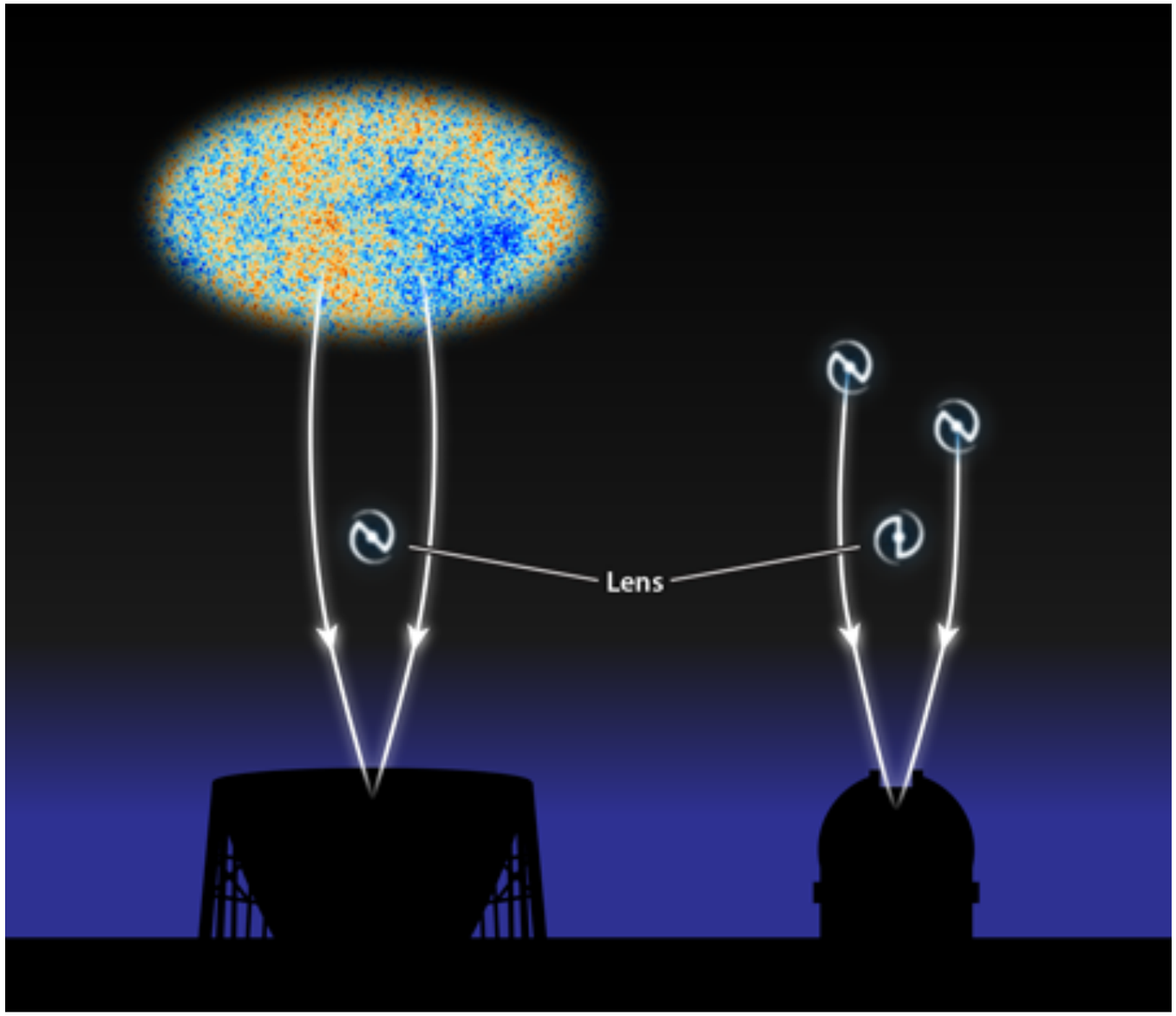

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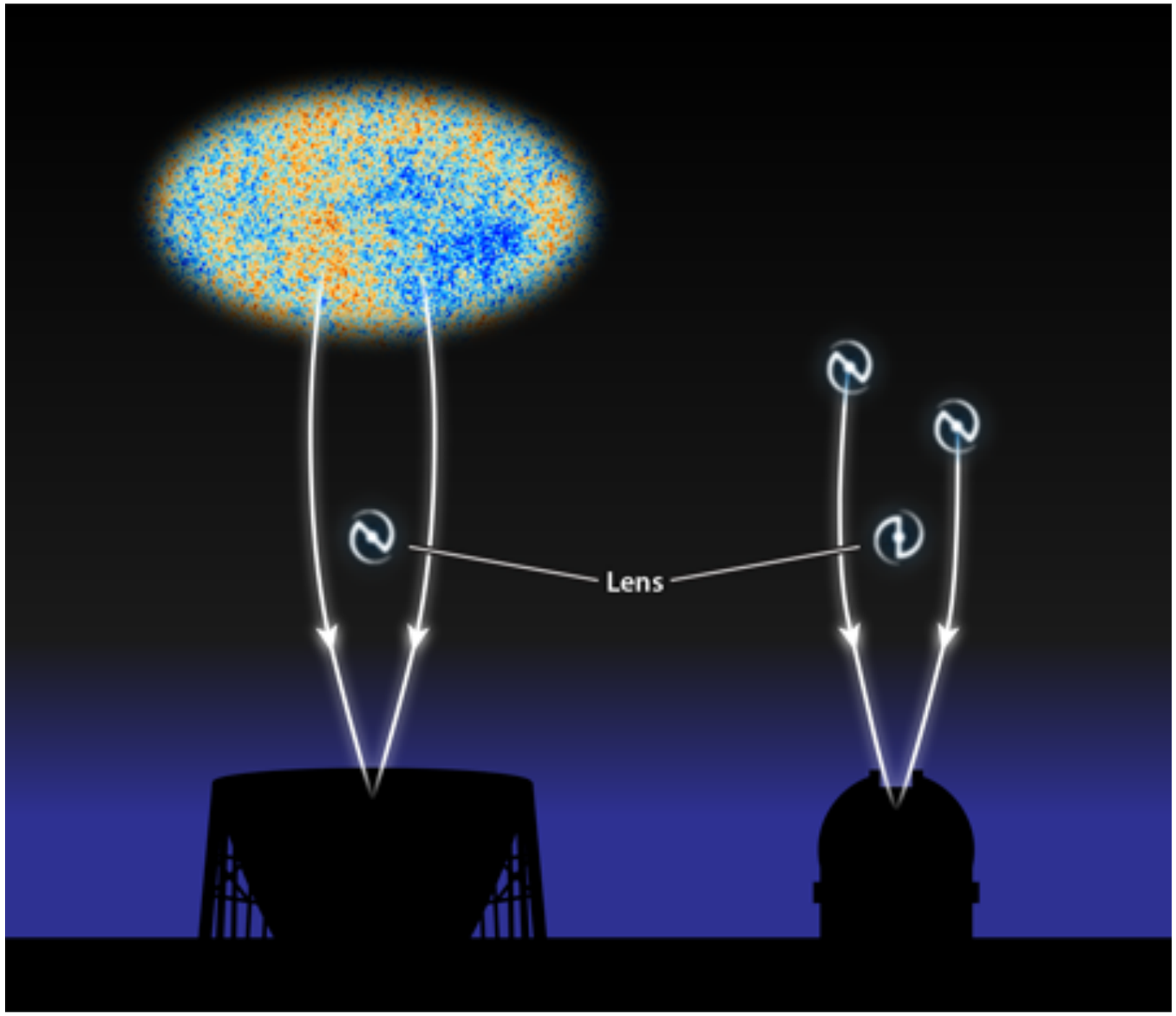

First Measurement of CMB Lensing on Halo Scales
Madhavacheril, NS, for the ACT Collaboration
PRL, 114, 2015

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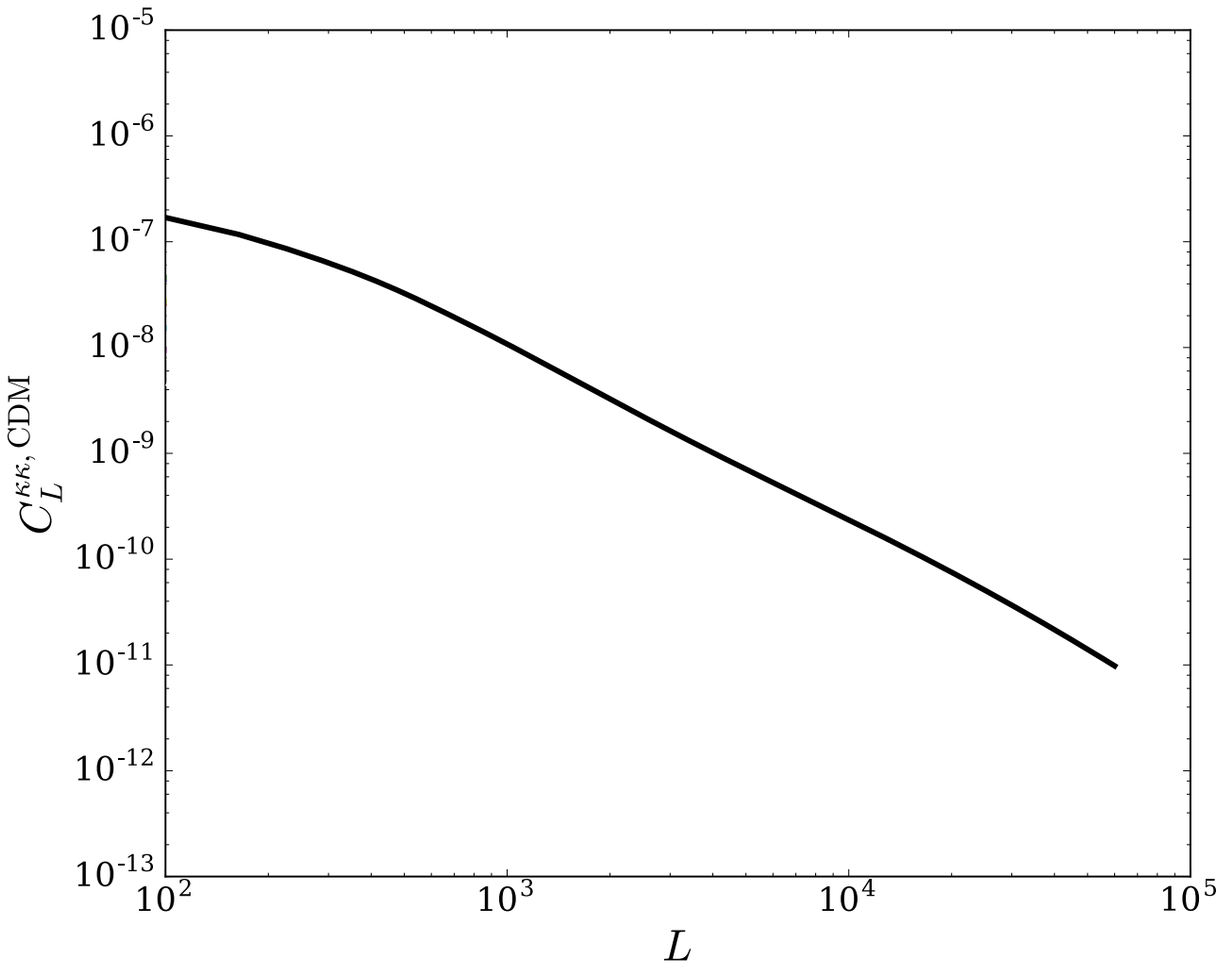
3. Properties of primordial CMB are well understood
4. Sensitive to structure at higher redshifts than other gravitational lensing probes; this makes it more sensitive to FDM/WDM-type models

CMB Lensing Power Spectrum



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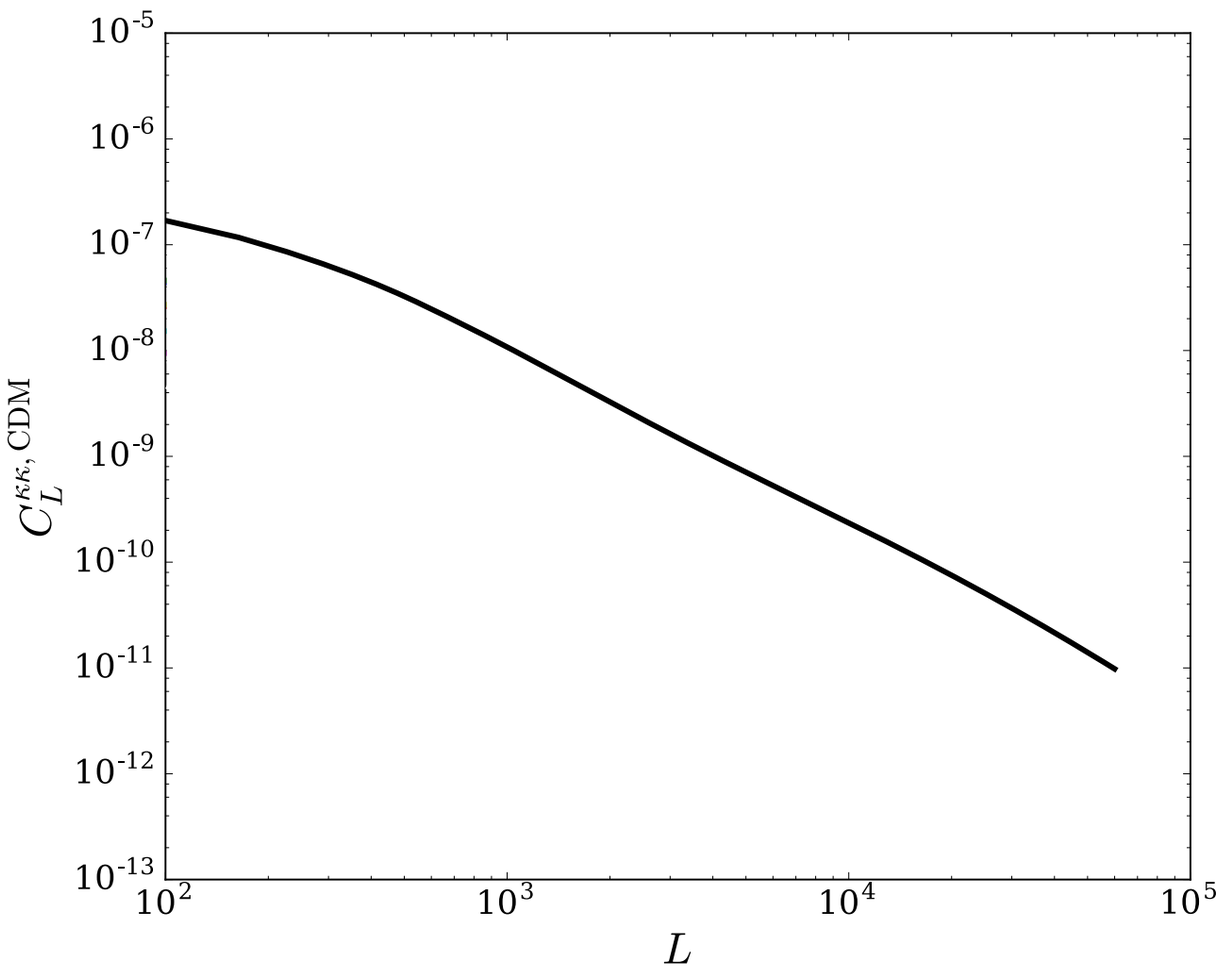

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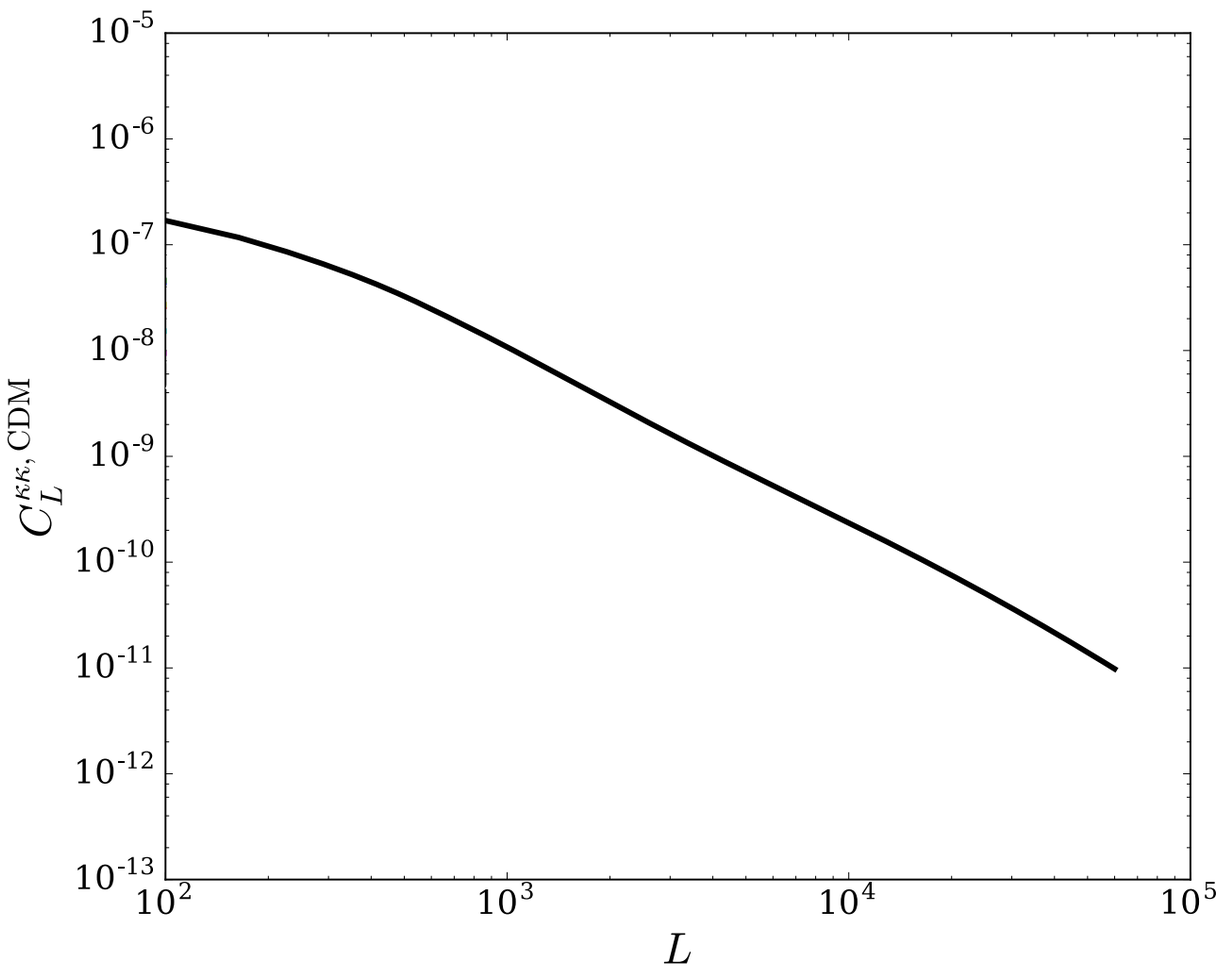

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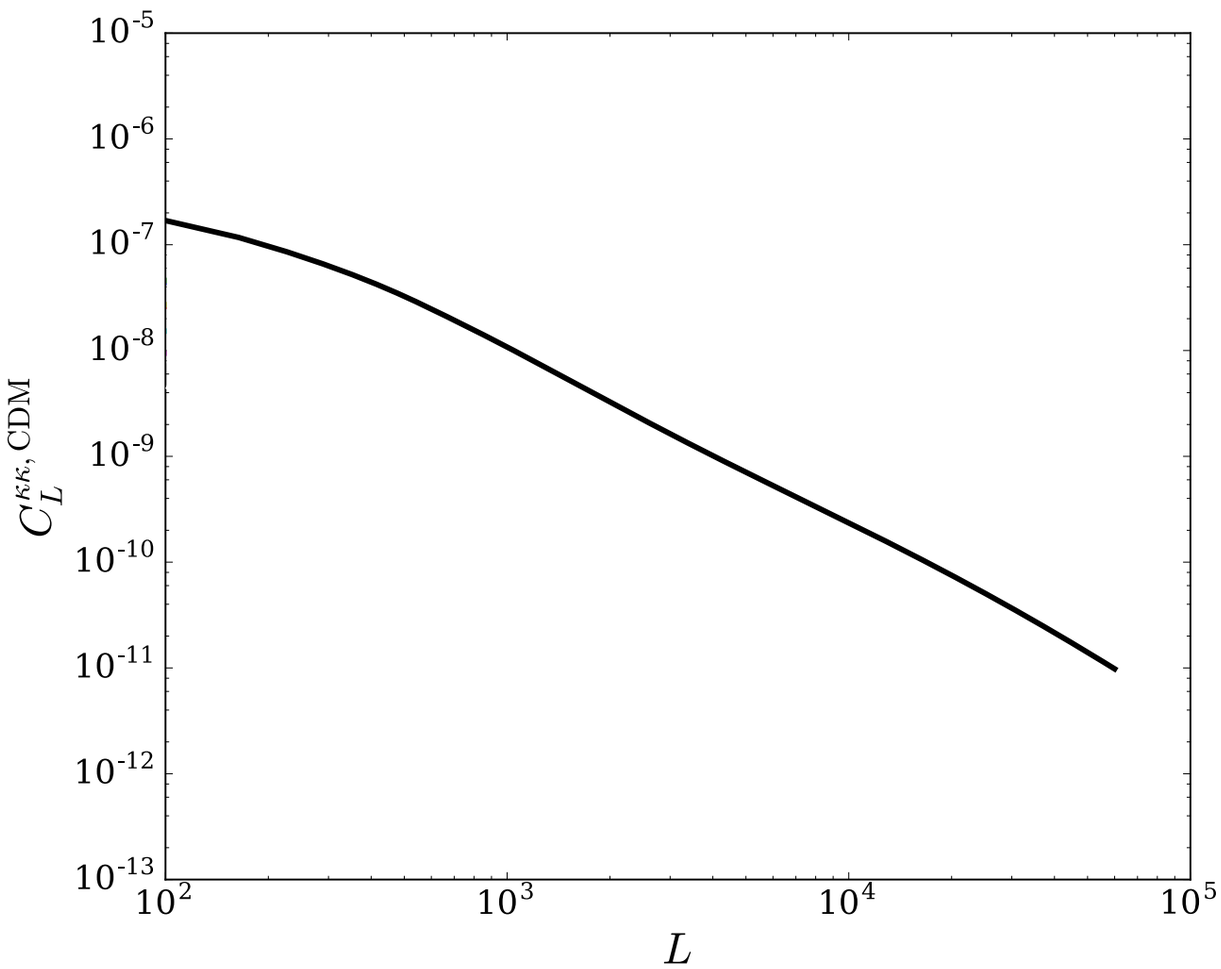

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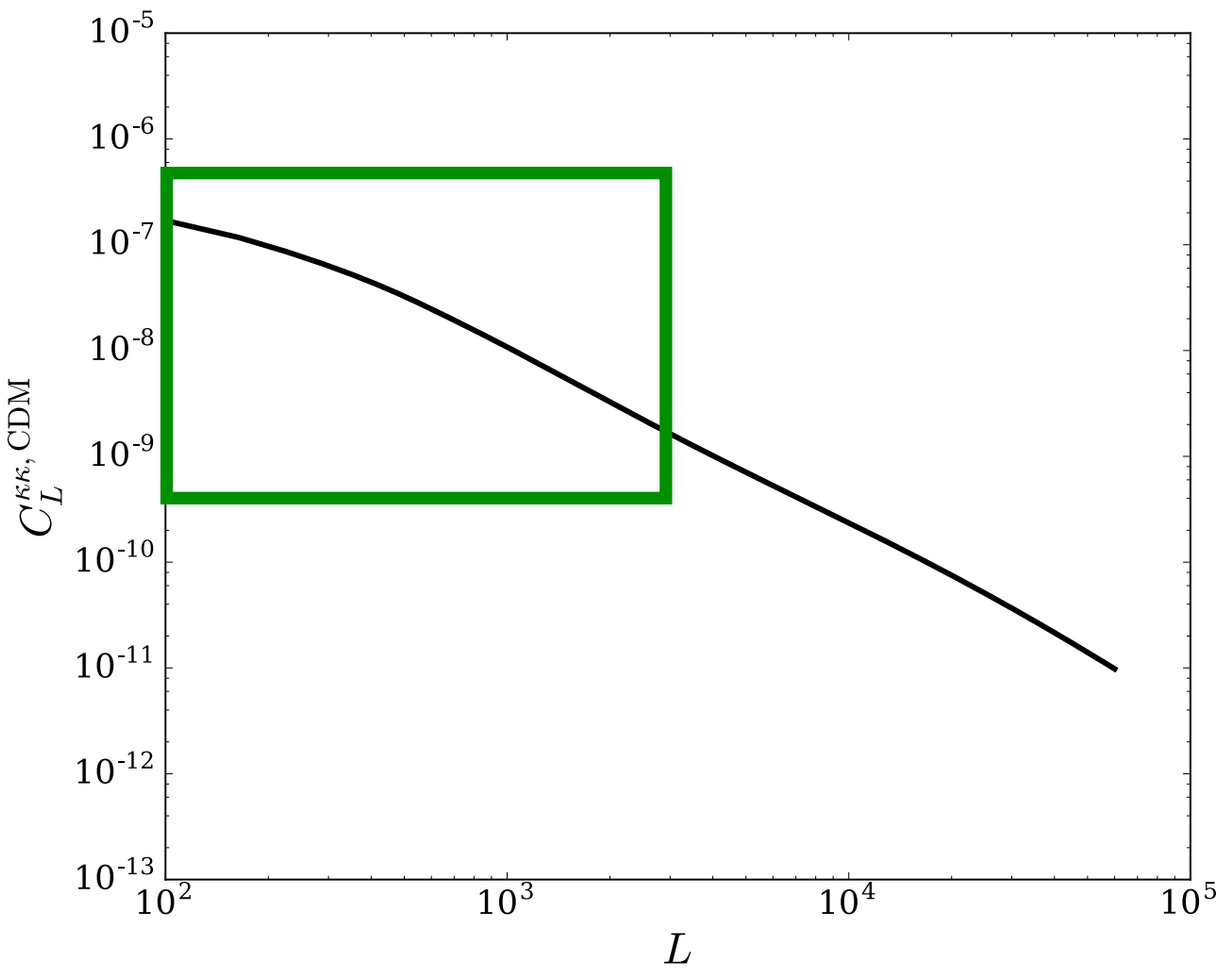

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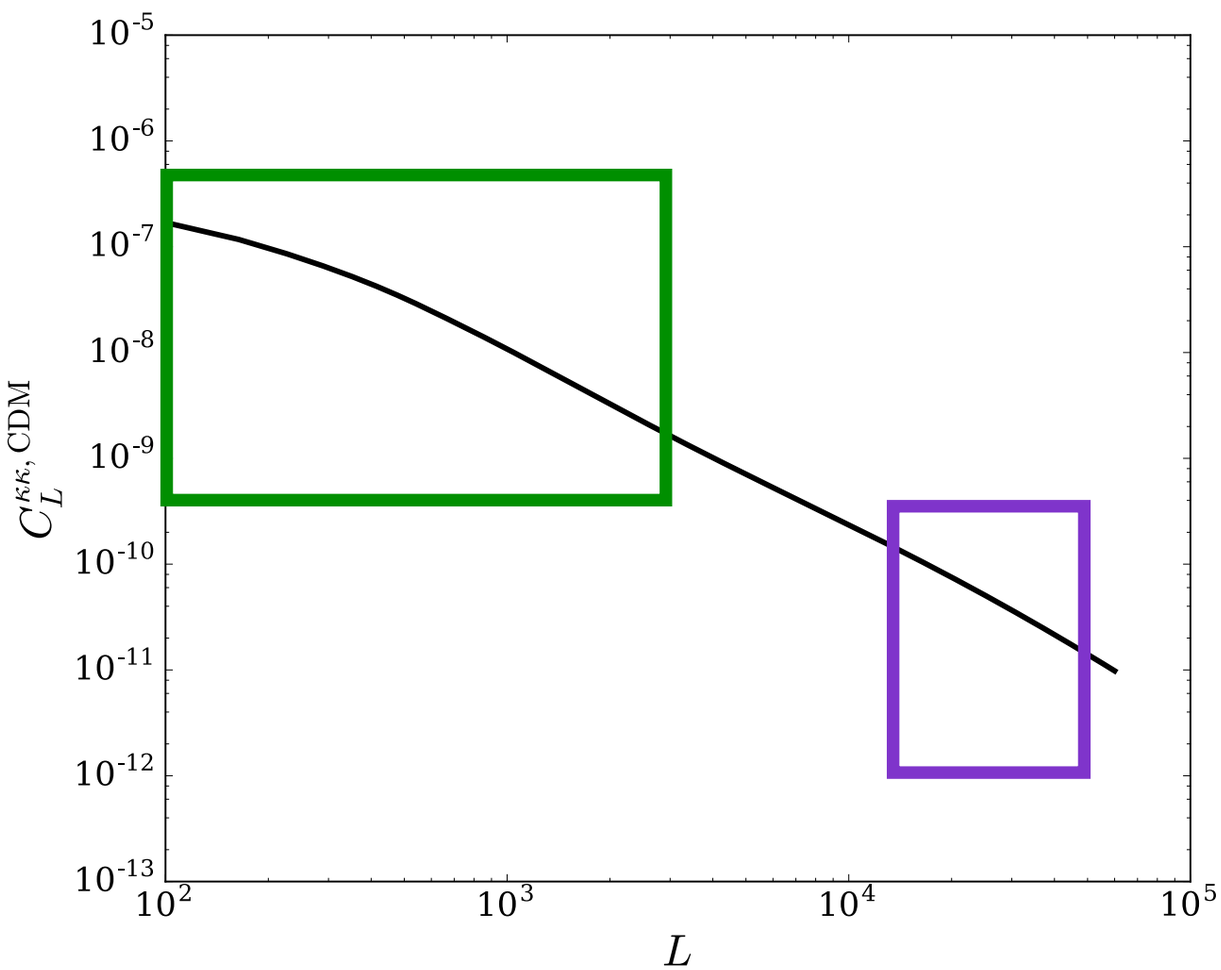

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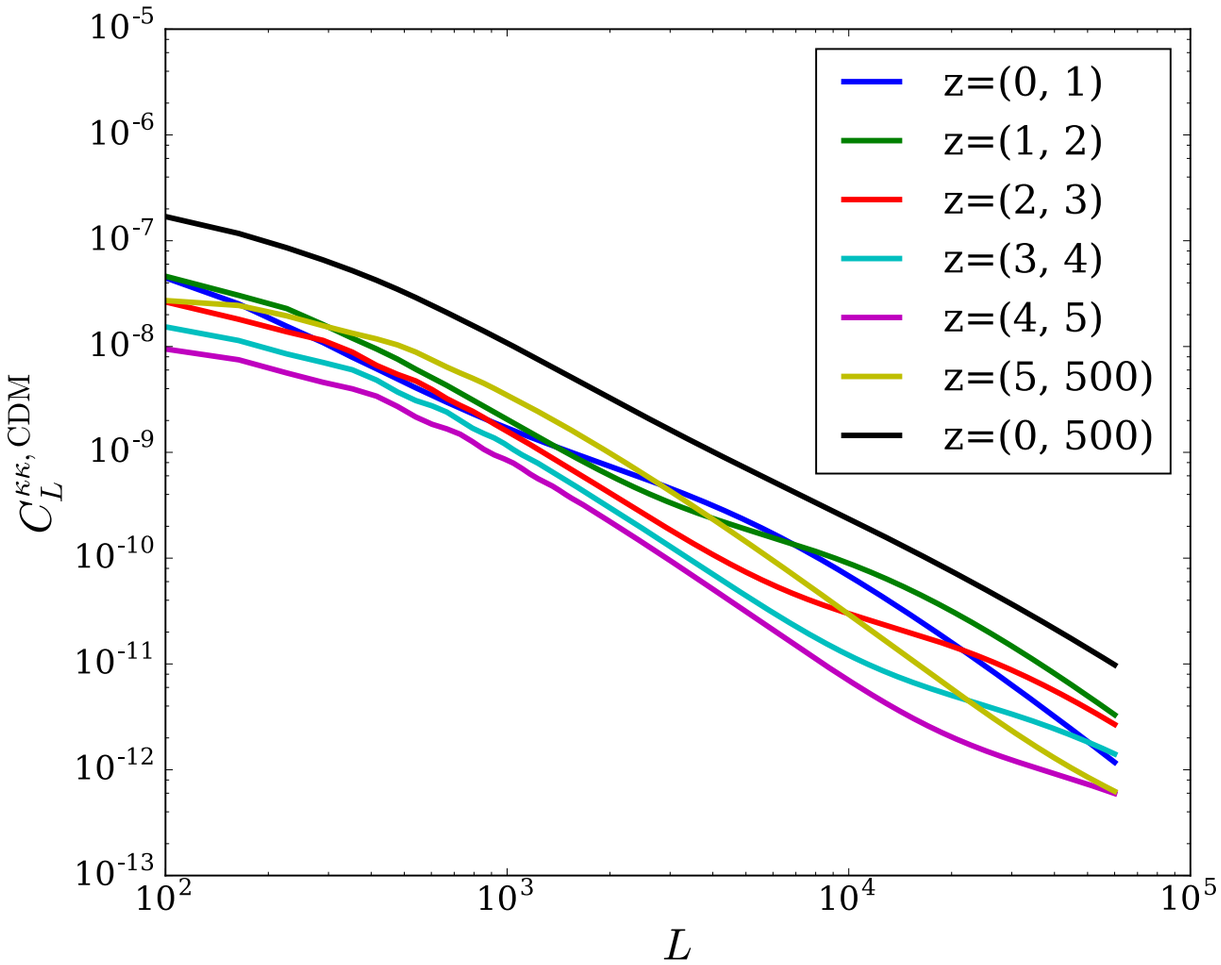

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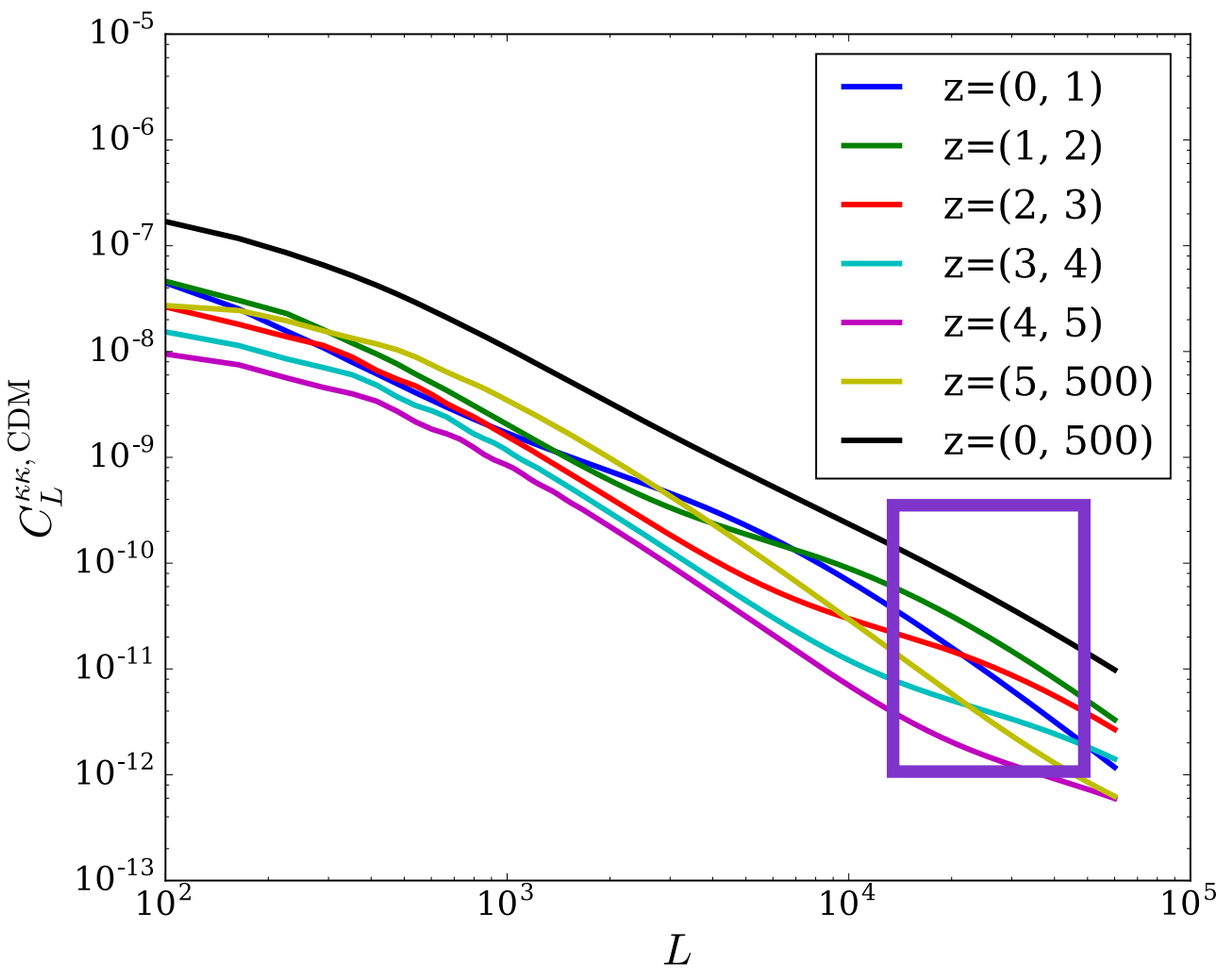

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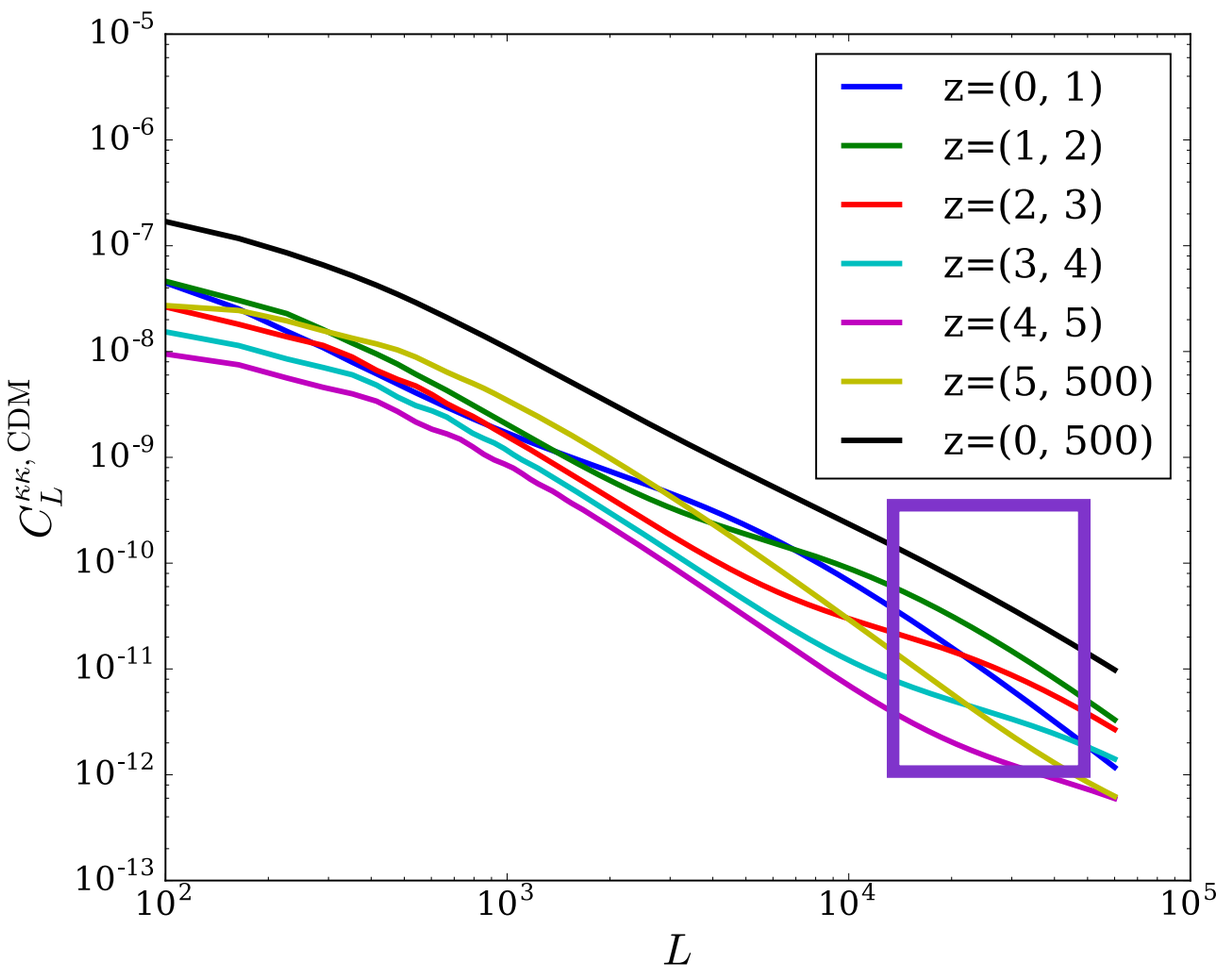

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Contrast between CDM and models that wash out small-scale structure is larger at higher redshifts

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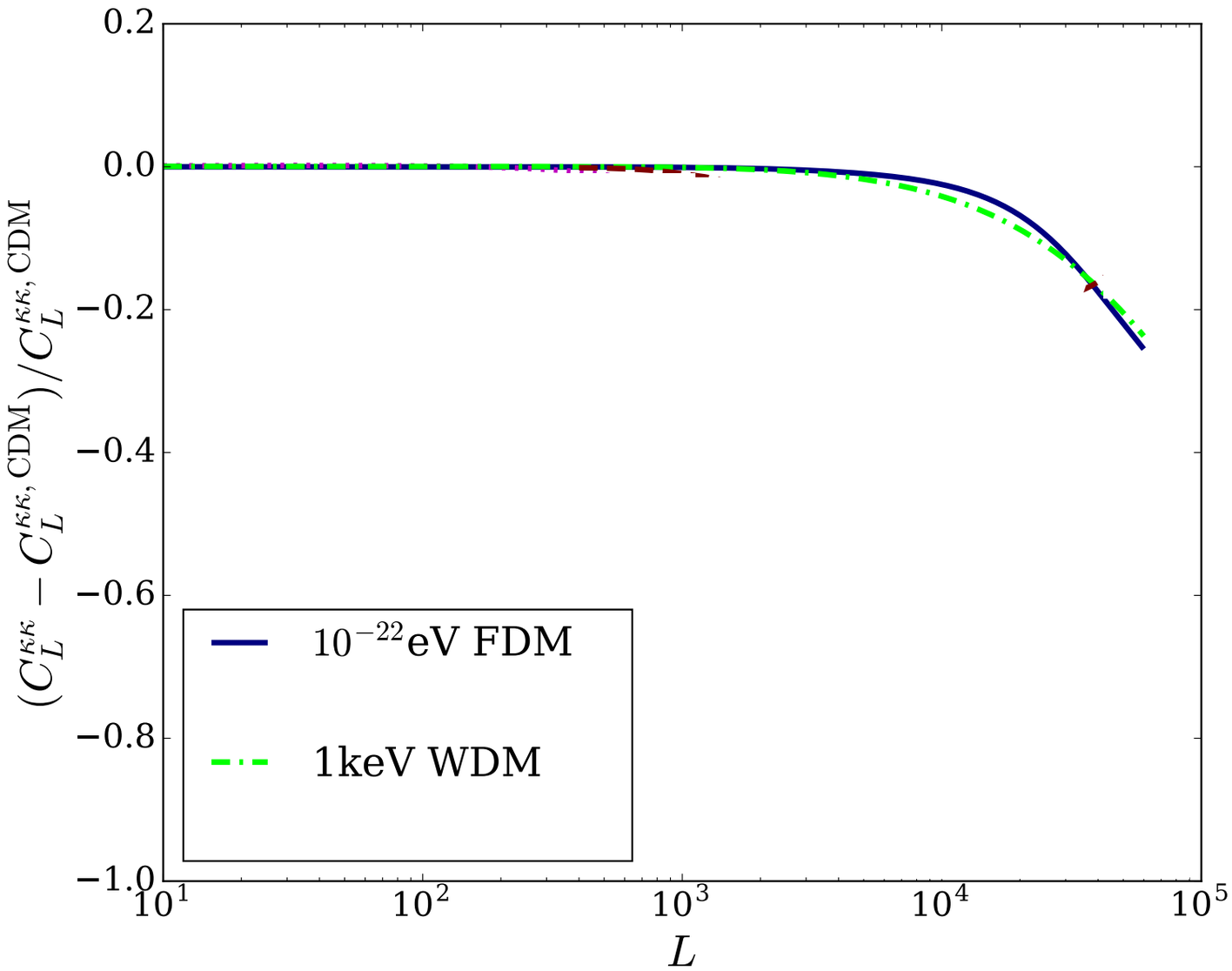
CMB Lensing Power Spectrum for CDM Versus FDM/WDM



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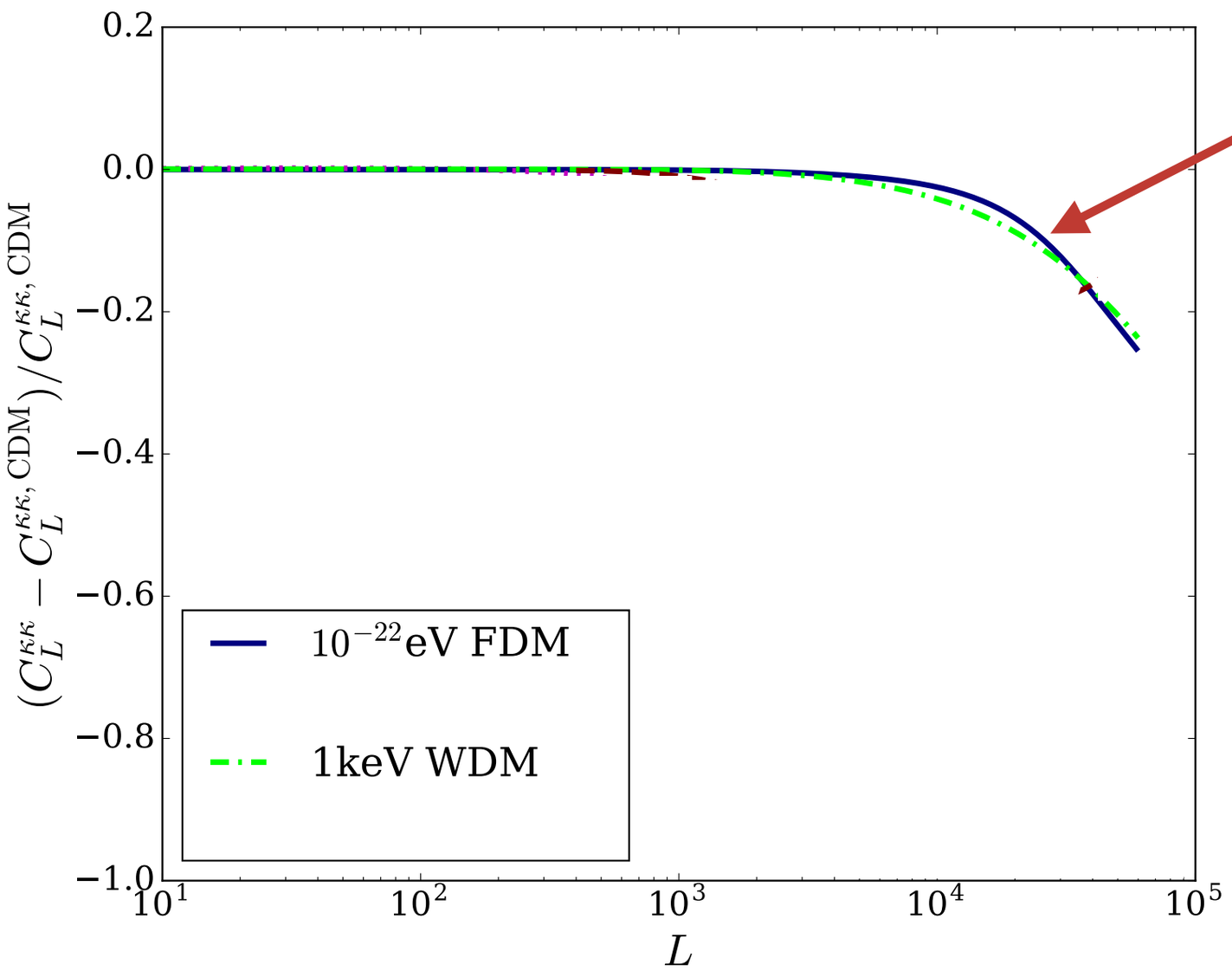

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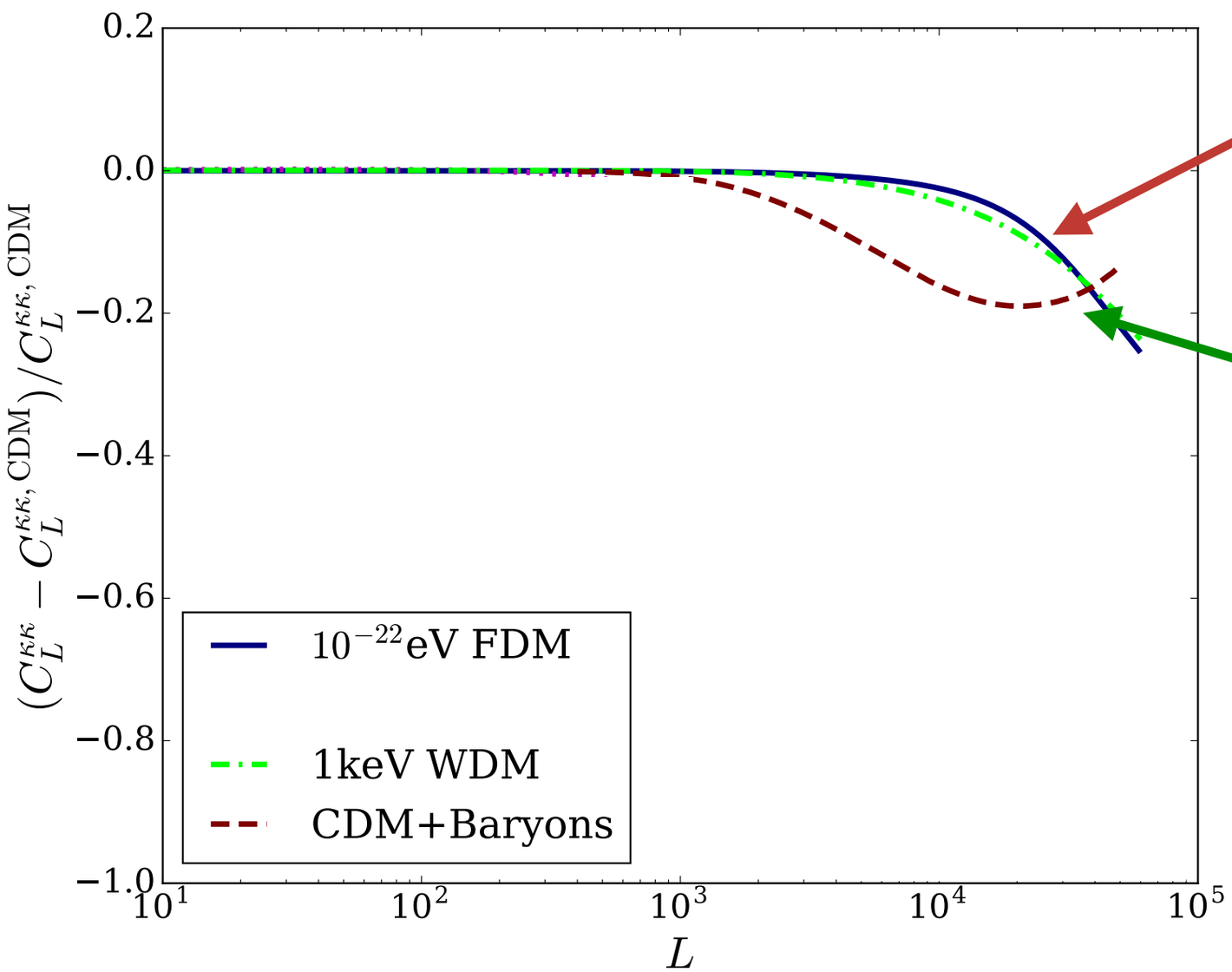

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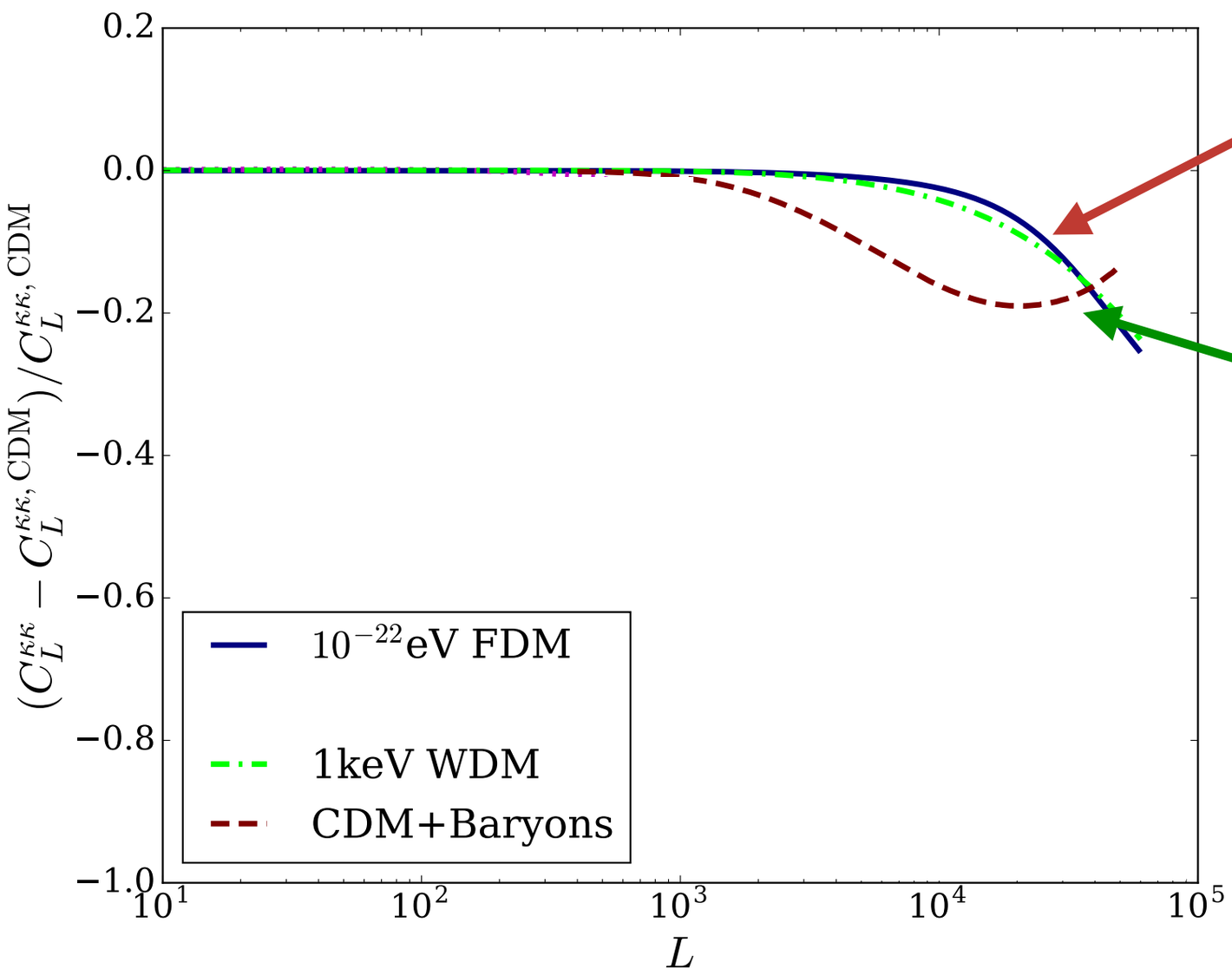

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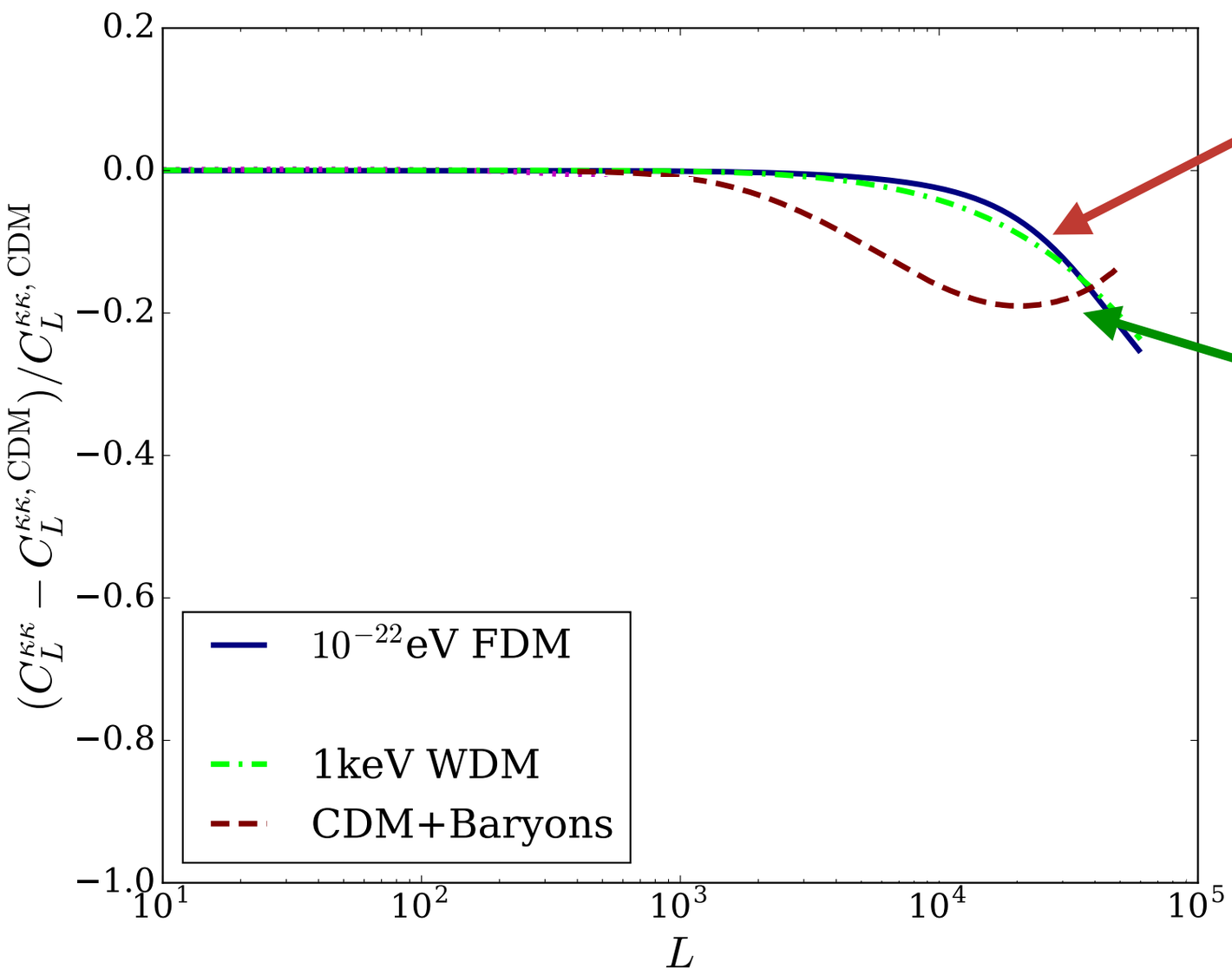

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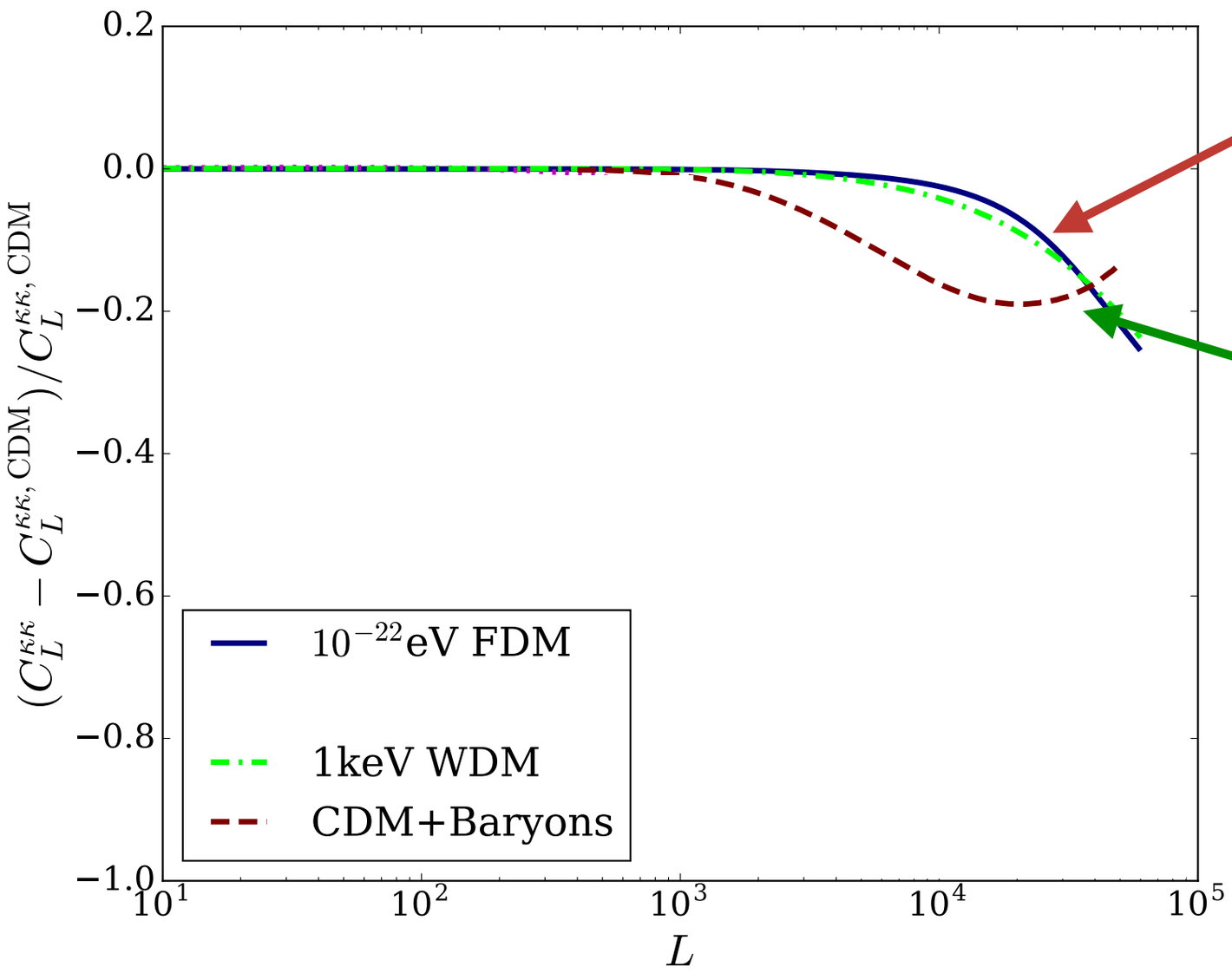

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2.) If see significant deviation, then can potentially use shape of curve to determine whether it is due to baryons or alternative to CDM

Dark Matter Constraints Not Degenerate with Neutrino Mass

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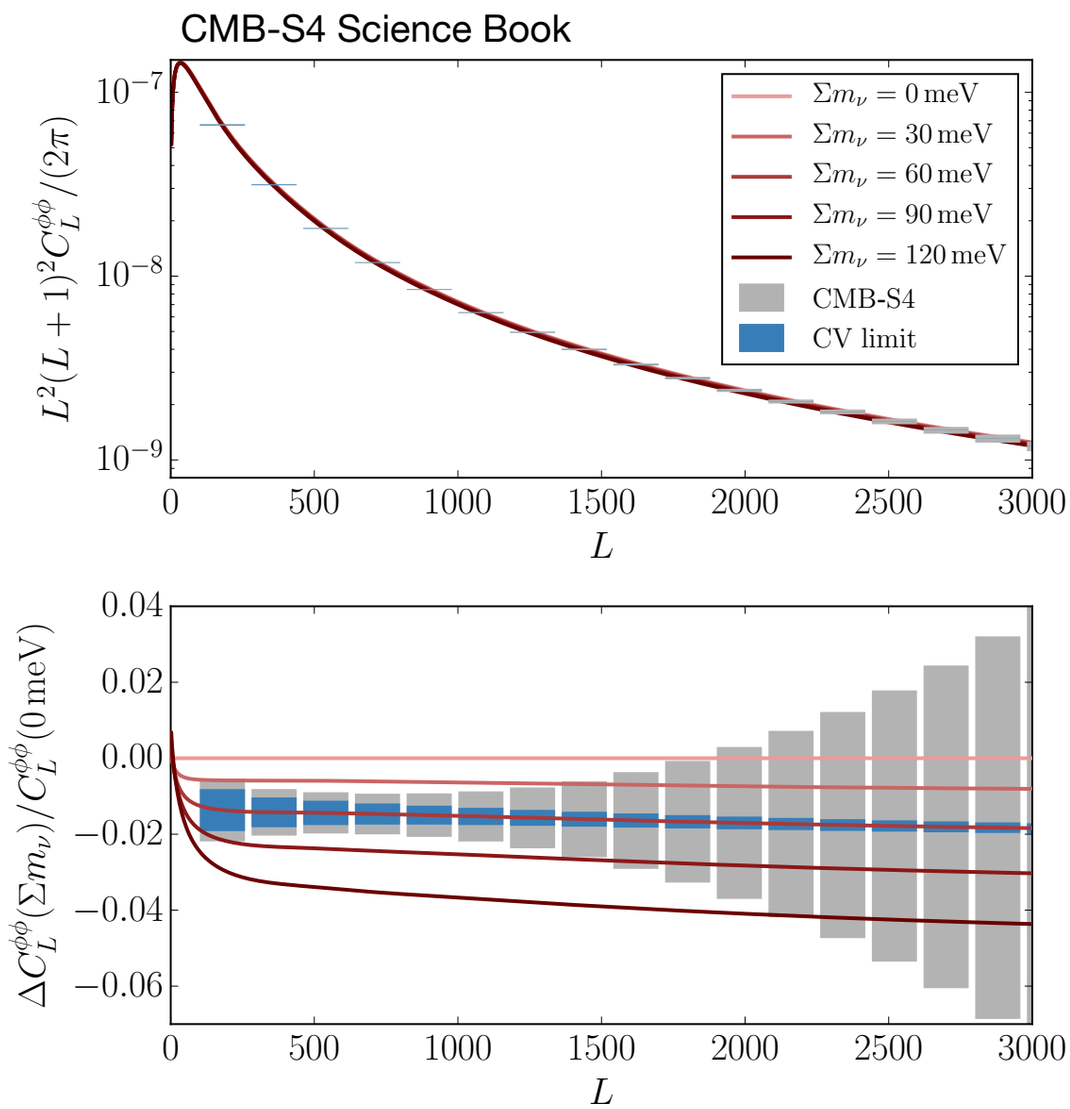

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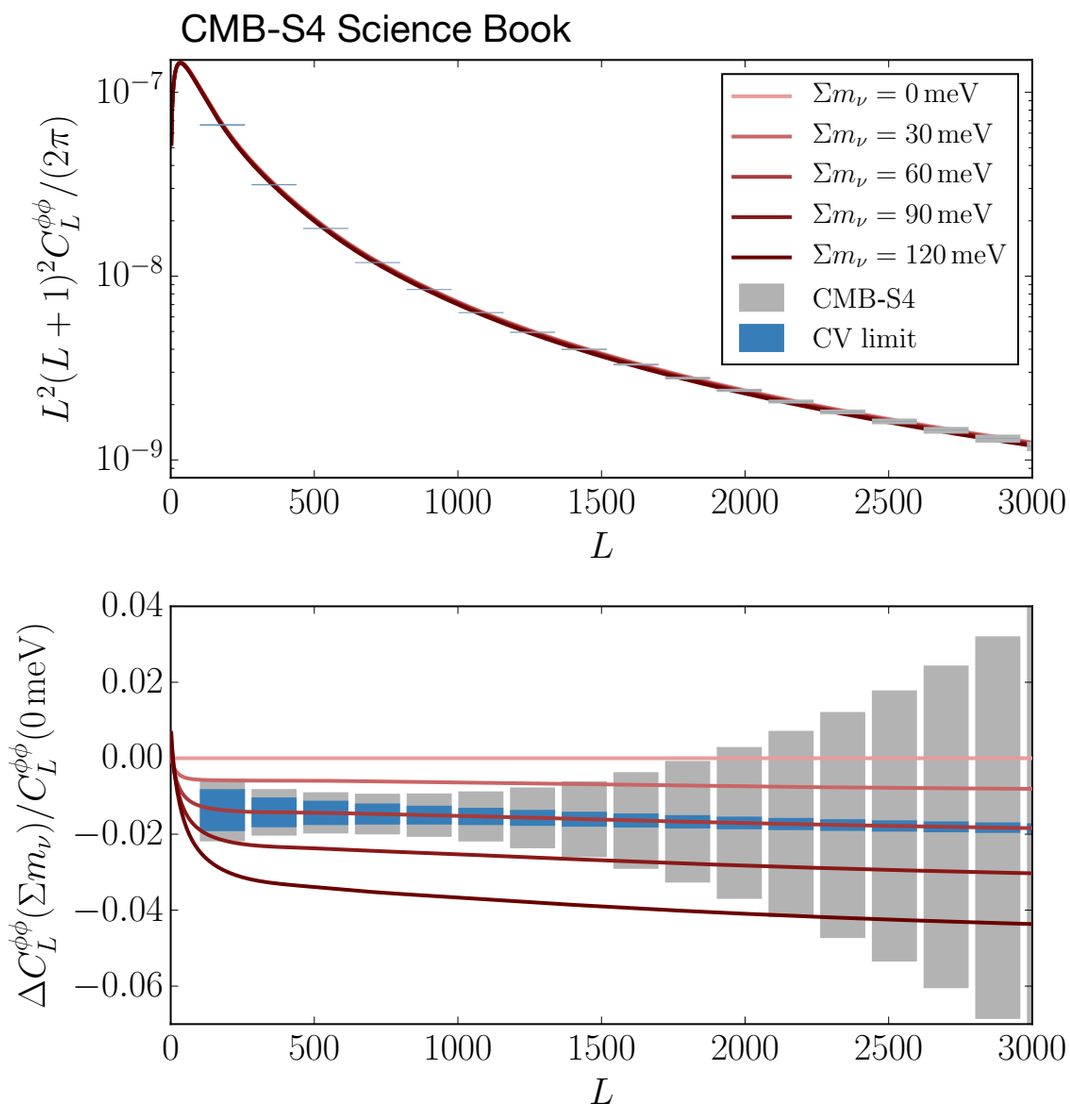

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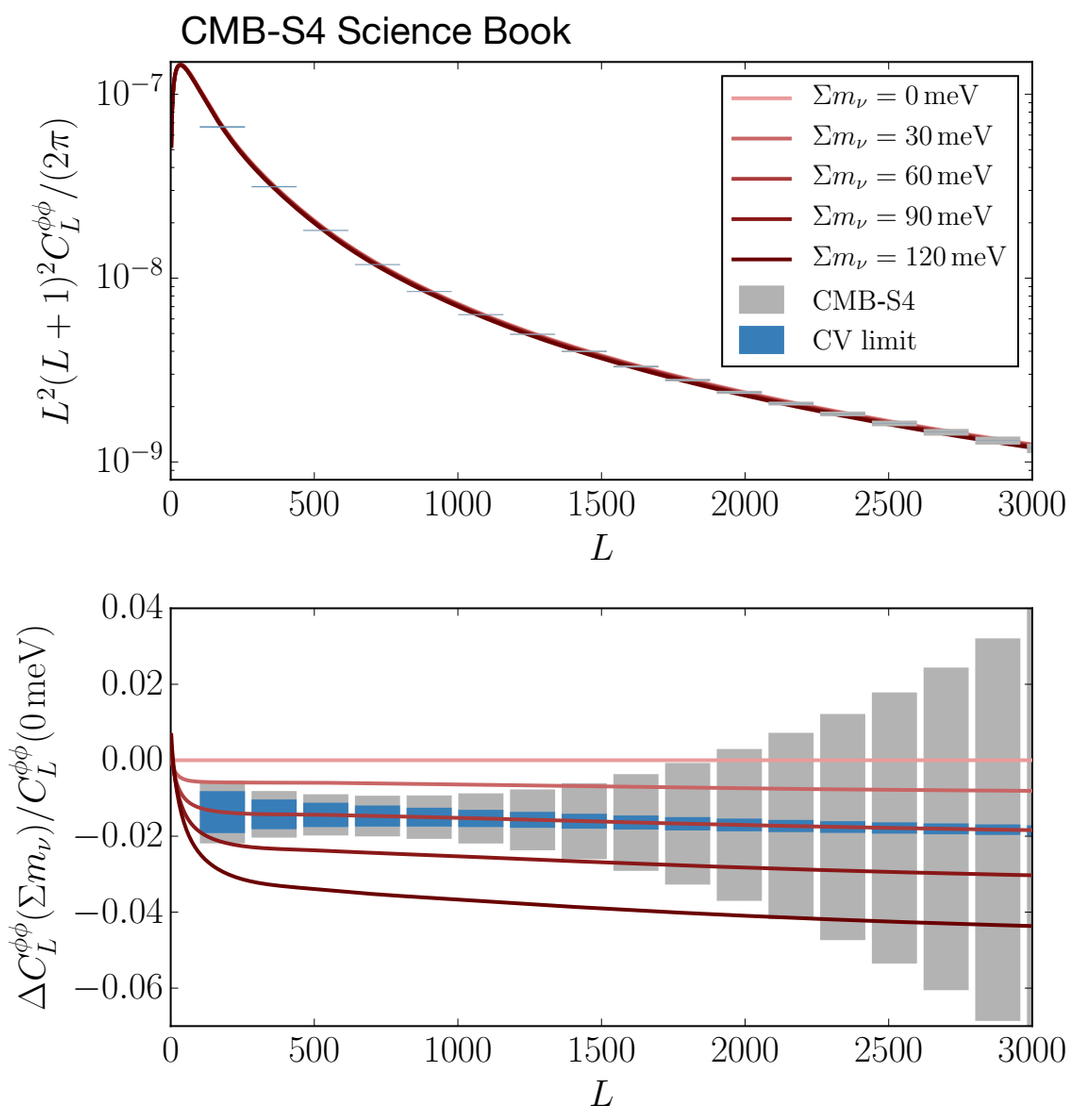

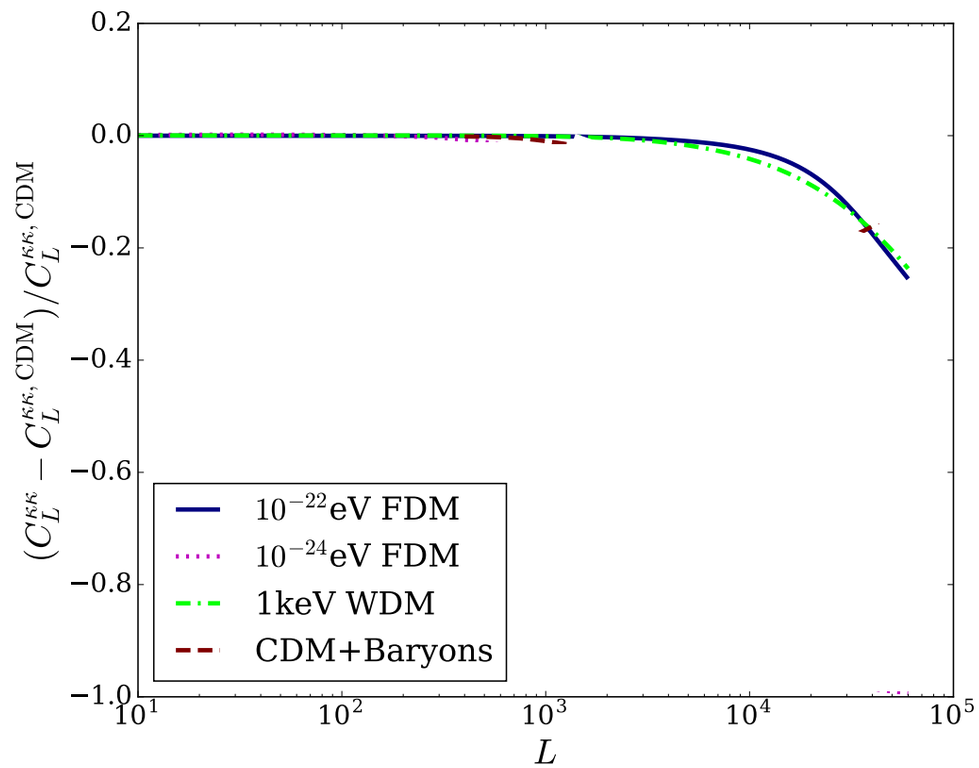

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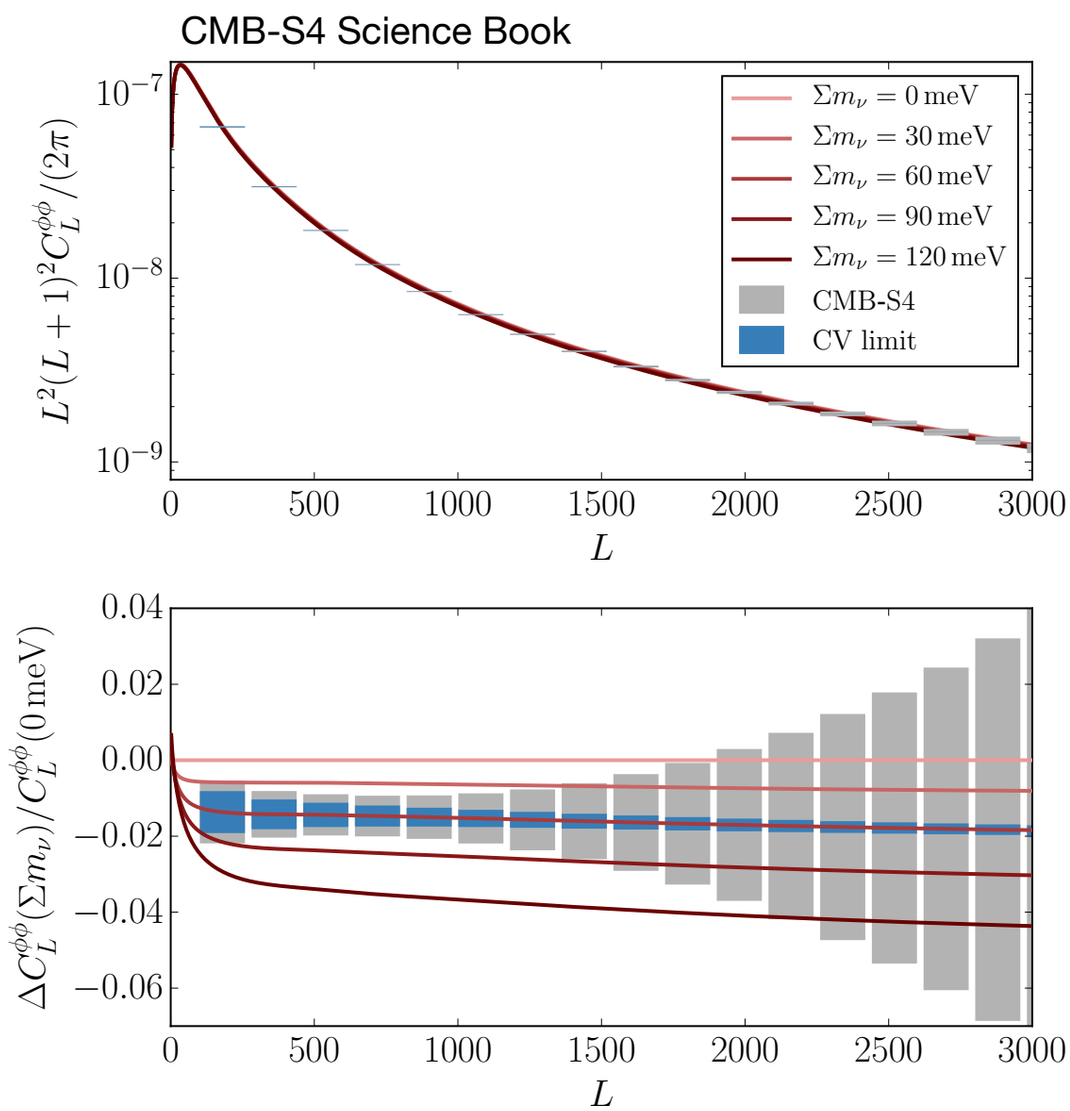

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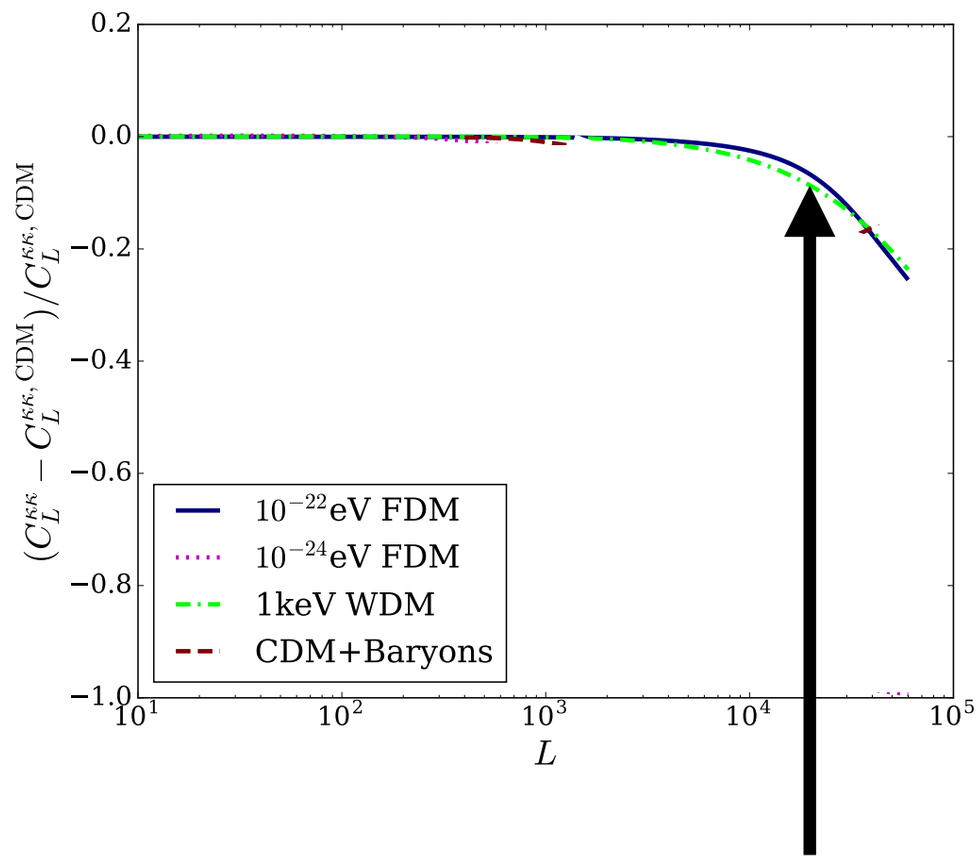

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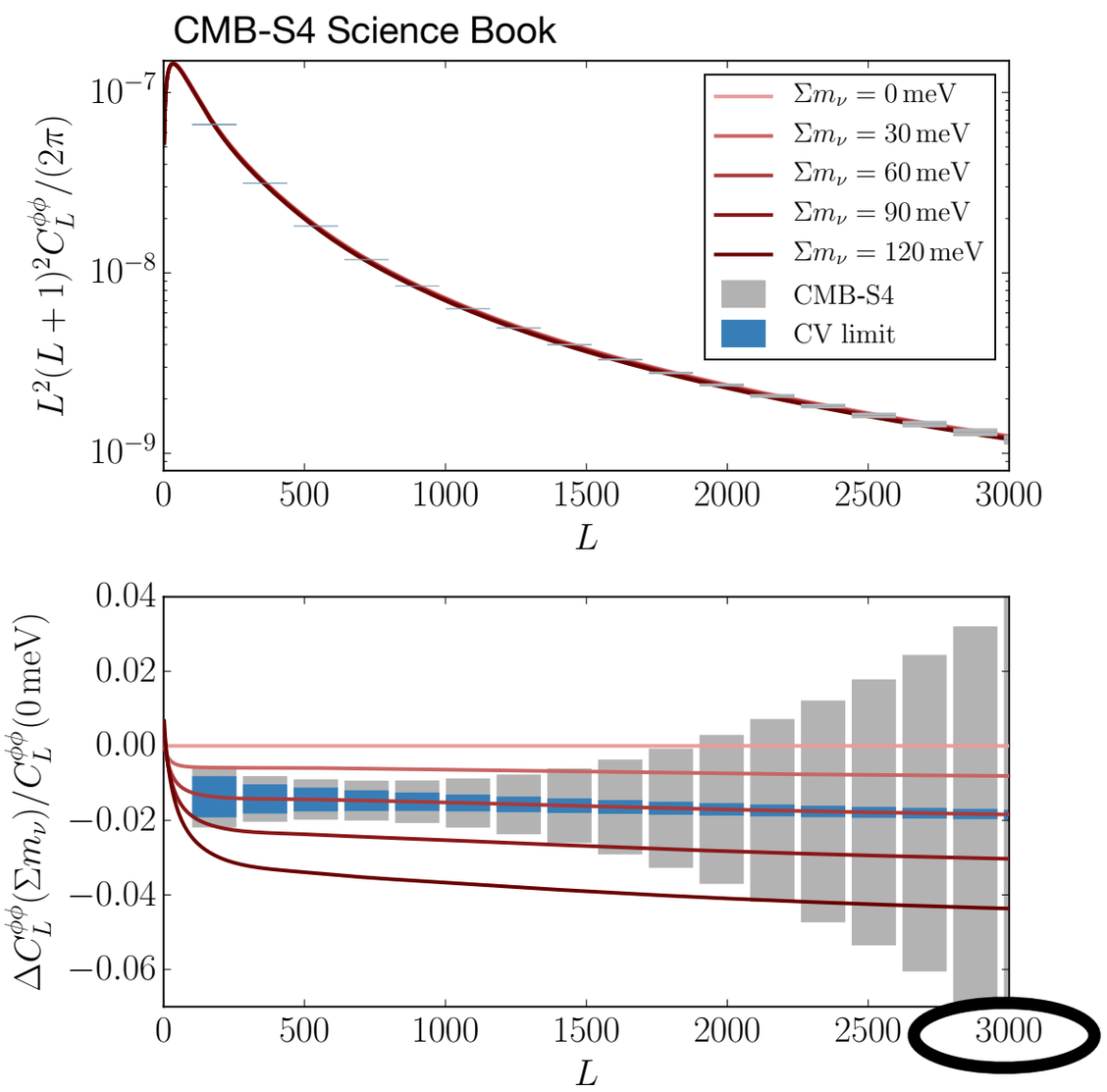

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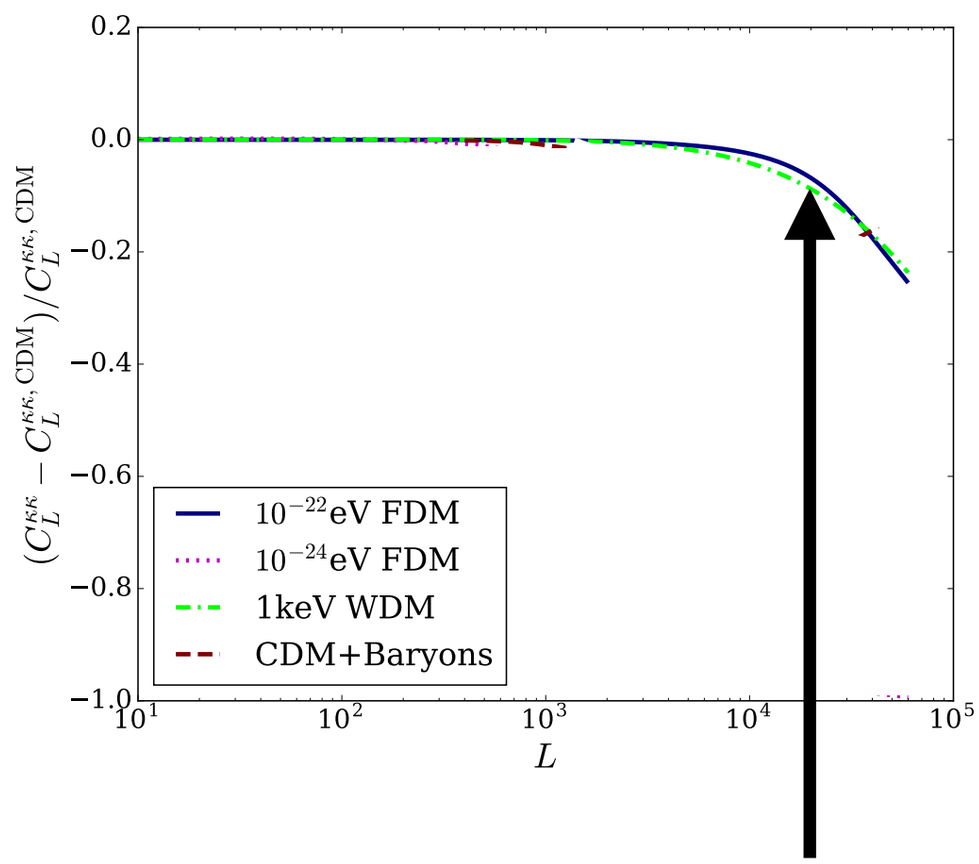

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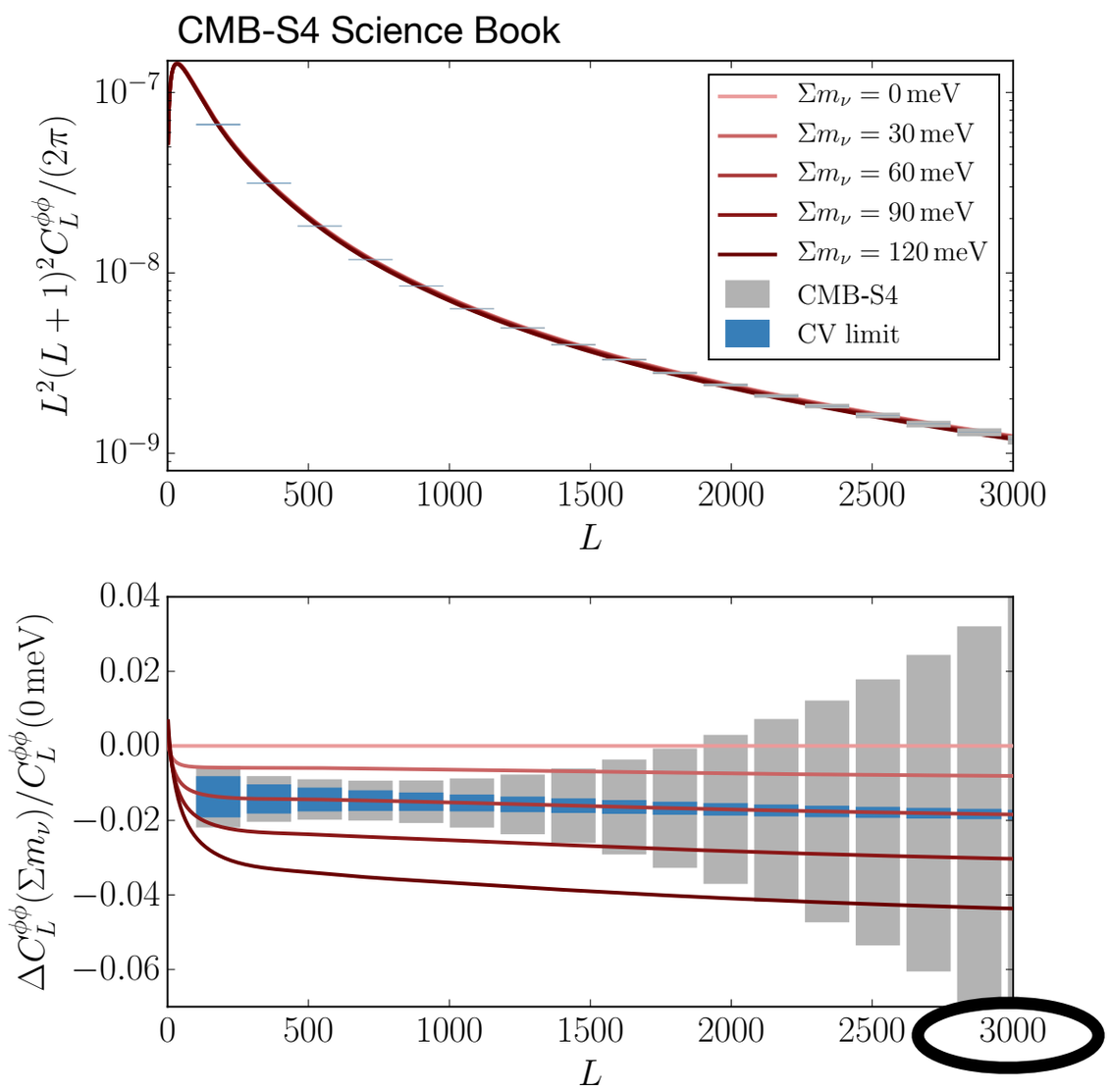

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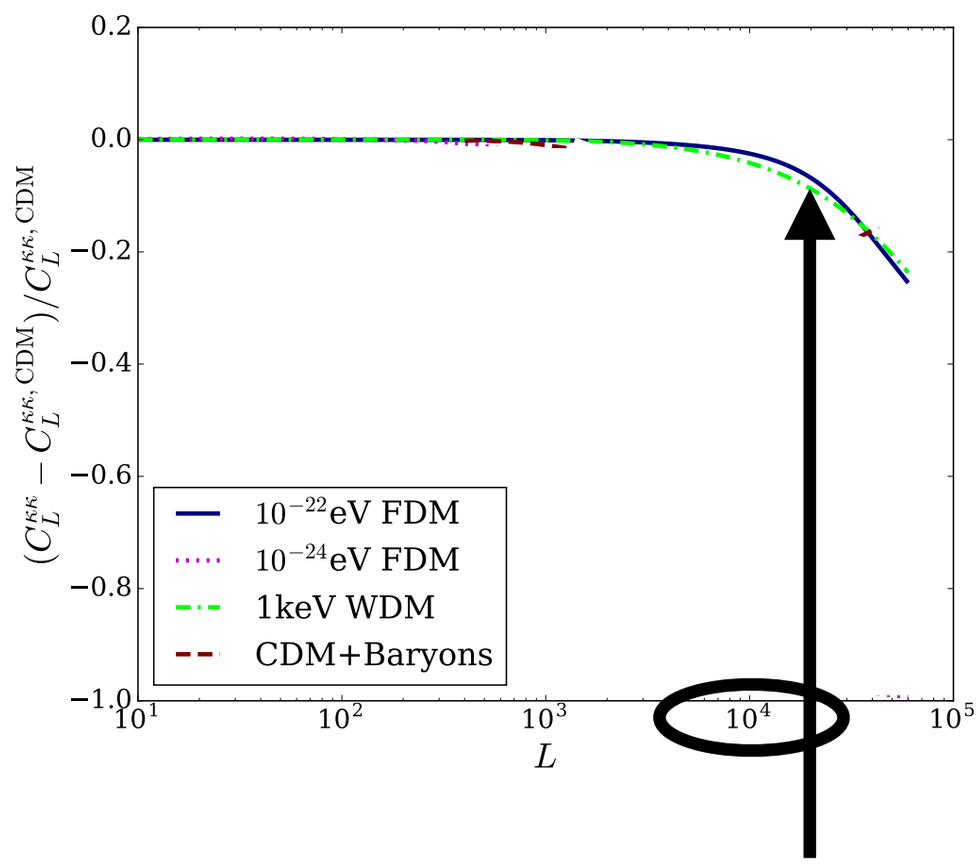

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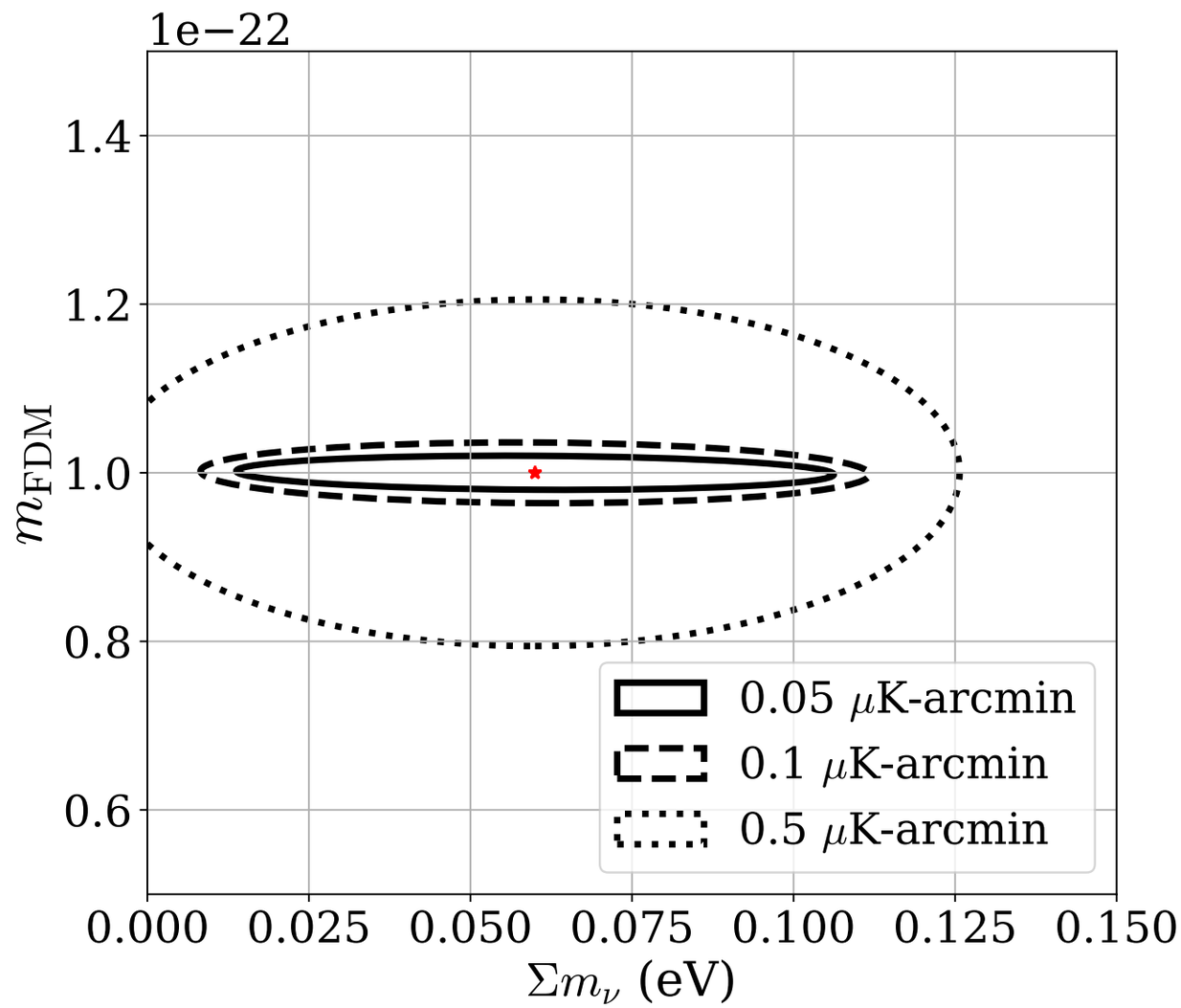
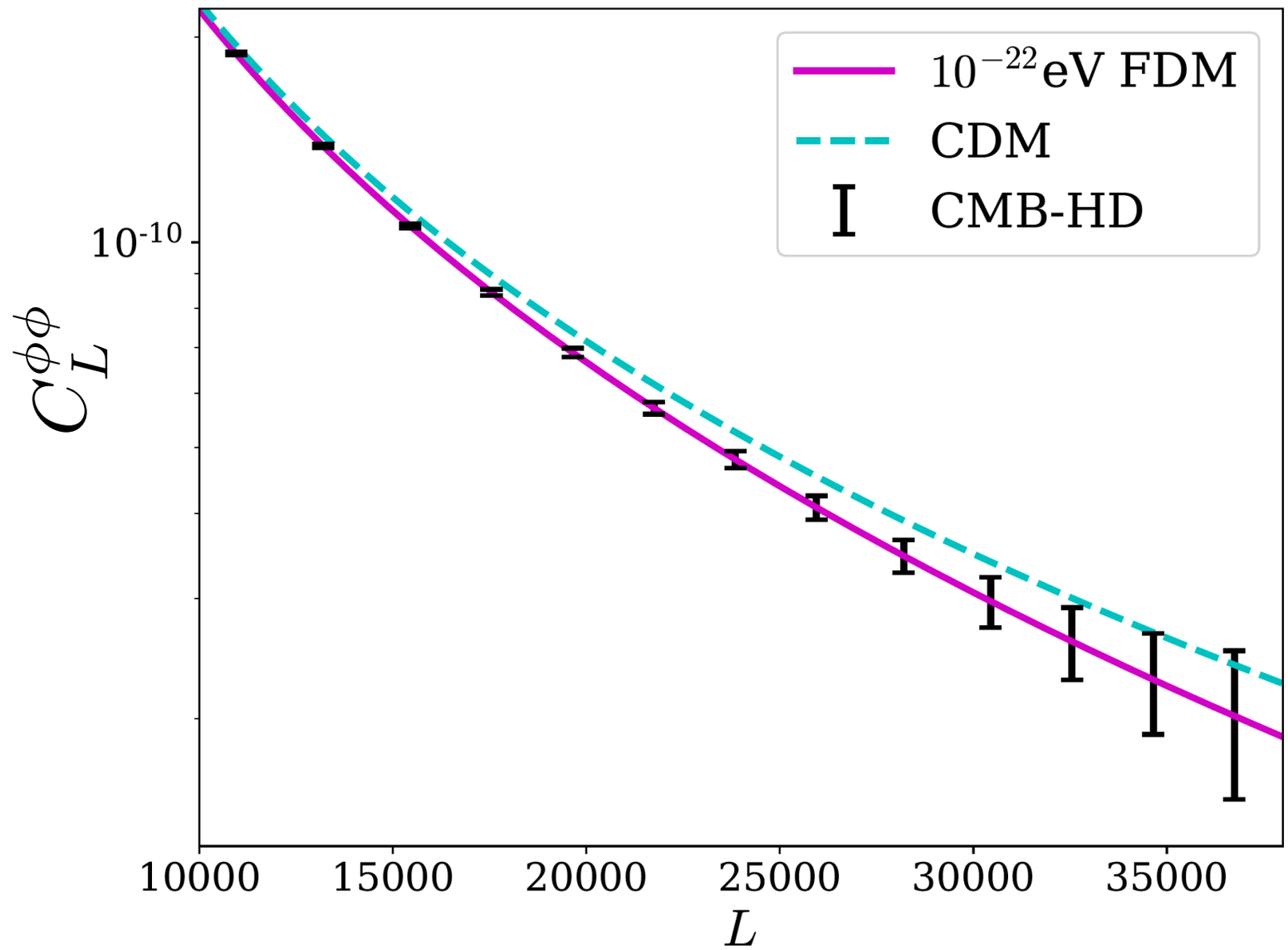


Ho Nam Nguyen, NS, Mathew Madhavacheril, 2019, PRD

Dark Matter Forecasts Using Ultra-Small-Scale CMB Lensing



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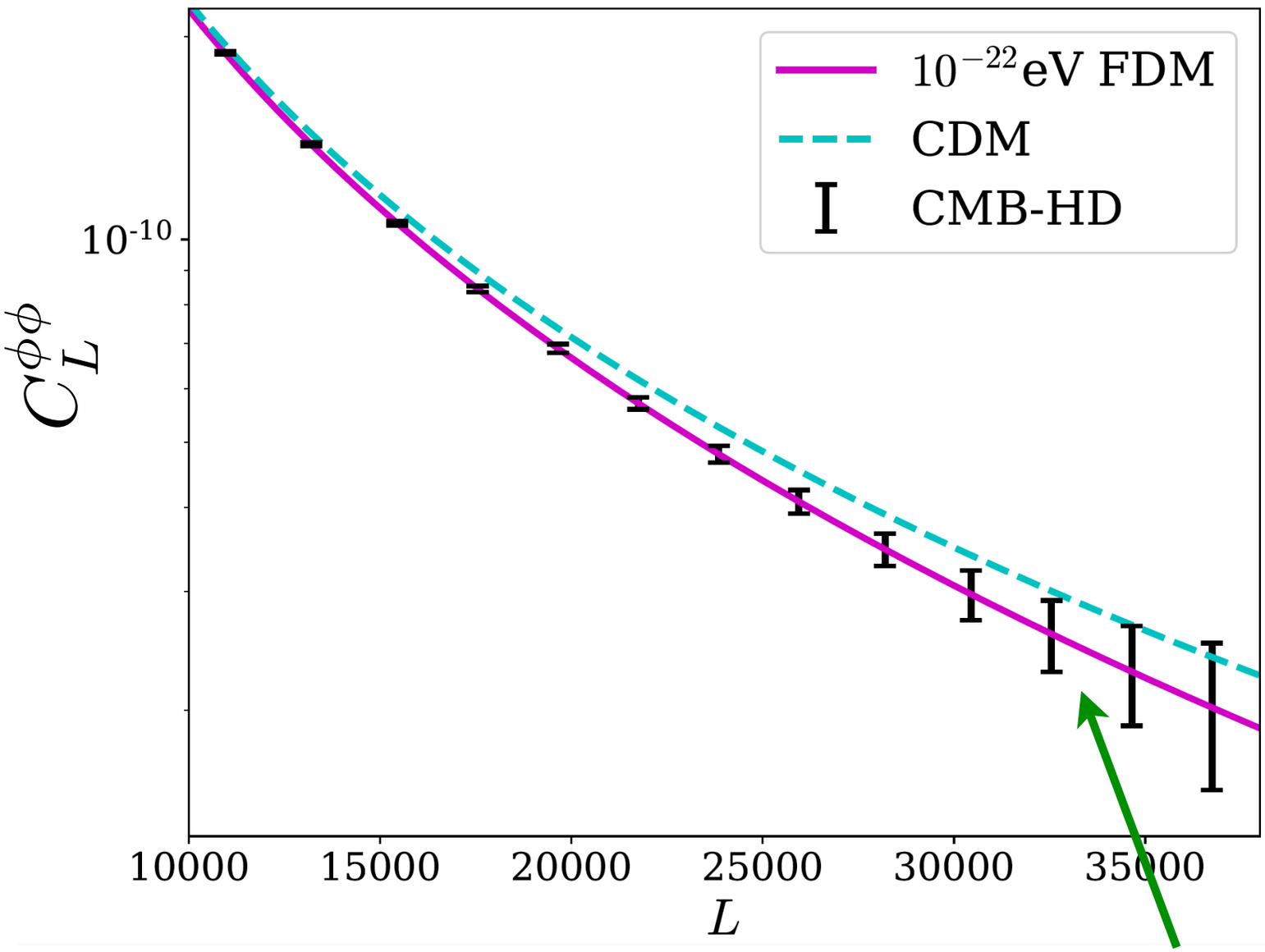

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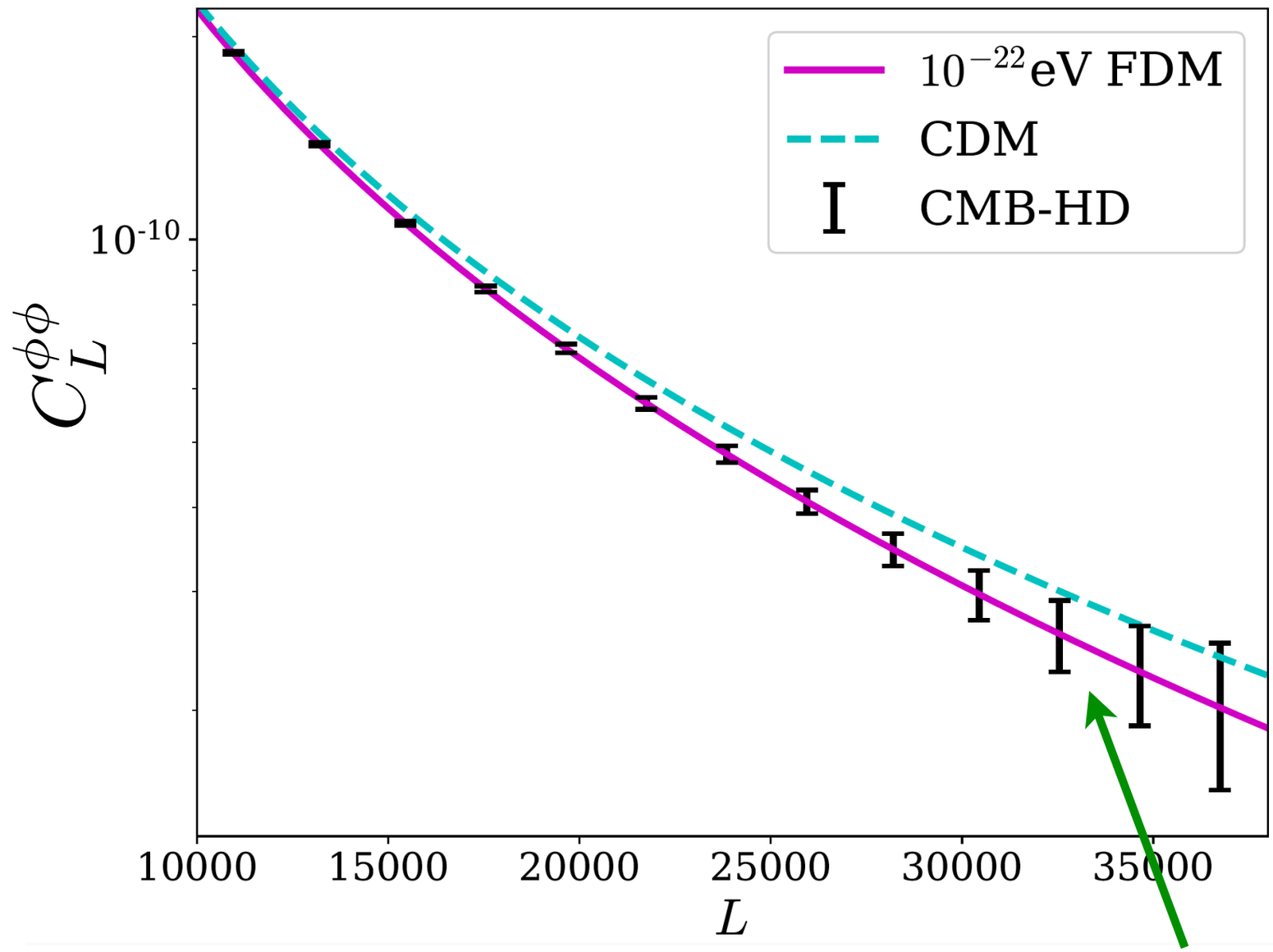

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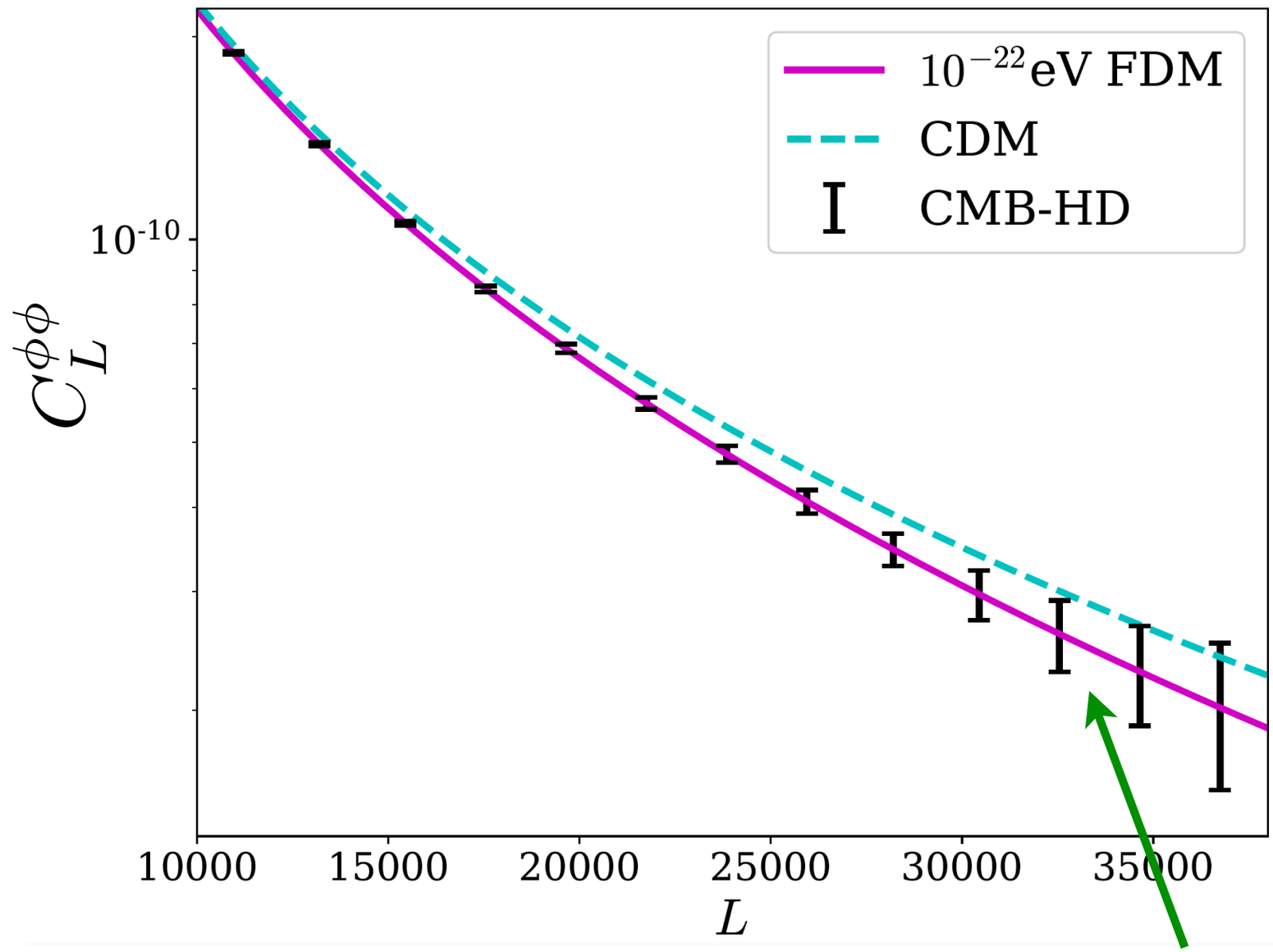

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CMB-HD is new proposed experiment

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Instrument Path

Two new 30-meter mm-wave telescopes in Atacama Desert
with total sensitivity 3 times deeper than CMB-S4 == CMB-HD

Motivation of CMB-HD

Rich Science from CMB-HD:

Dark Matter Properties from Small-Scale Matter Power Spectrum

Number of Relativistic Species

Delensing for Primordial Gravitational Waves

Neutrino Mass

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CMB-HD Probe of Light Particles

Table 1: Summary of CMB-HD key science goals in fundamental physics

Science	Parameter	Sensitivity
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New Light Species	$N_{\rm eff}$: Effective Number of Relativistic Species[b]	$\sigma(N_{\rm eff}) = 0.014$
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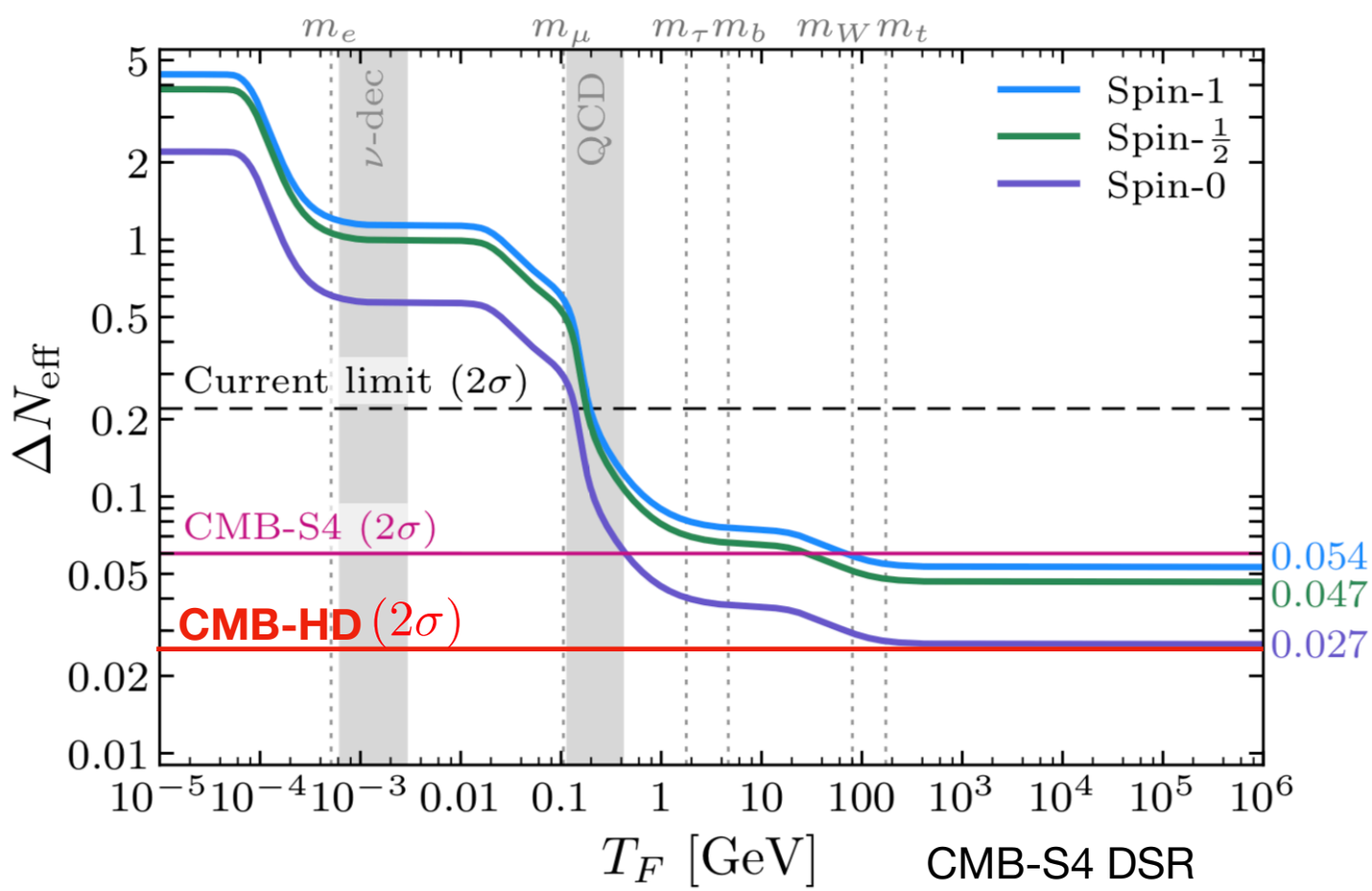

CMB-S4 DSR

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