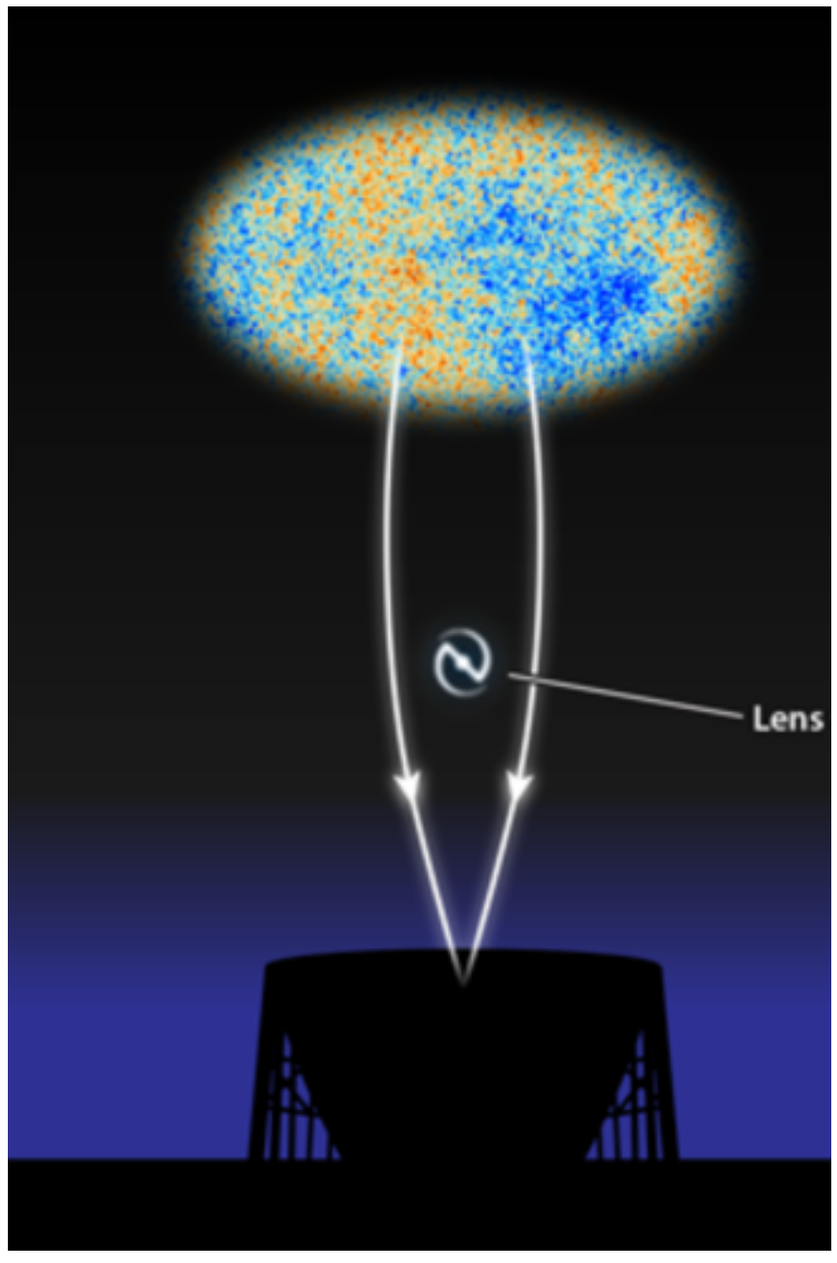
Measuring the Small-Scale Matter Power Spectrum with Ultra-High-Resolution CMB Lensing

Neelima Sehgal

Conference on Shedding Light on the Dark Universe with Extremely Large Telescopes

July 4th, 2018



Ho Nam Nguyen, NS, Mathew Madhavacheril, 2017, arXiv:1710.03747

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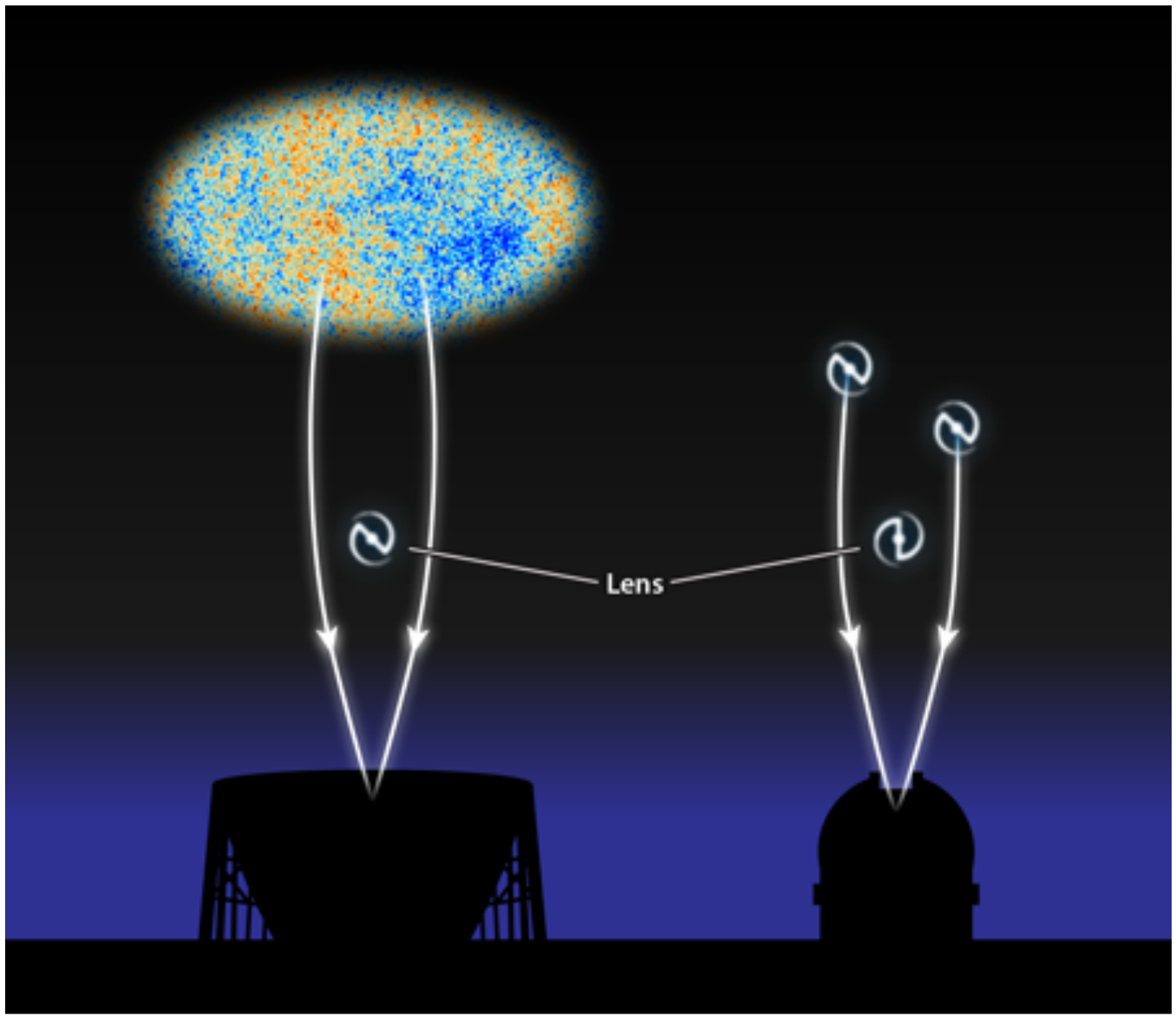
A technique that relies on lensing avoids complications of baryonic tracers.

Gravitational Lensing of the Cosmic Microwave Background (CMB)



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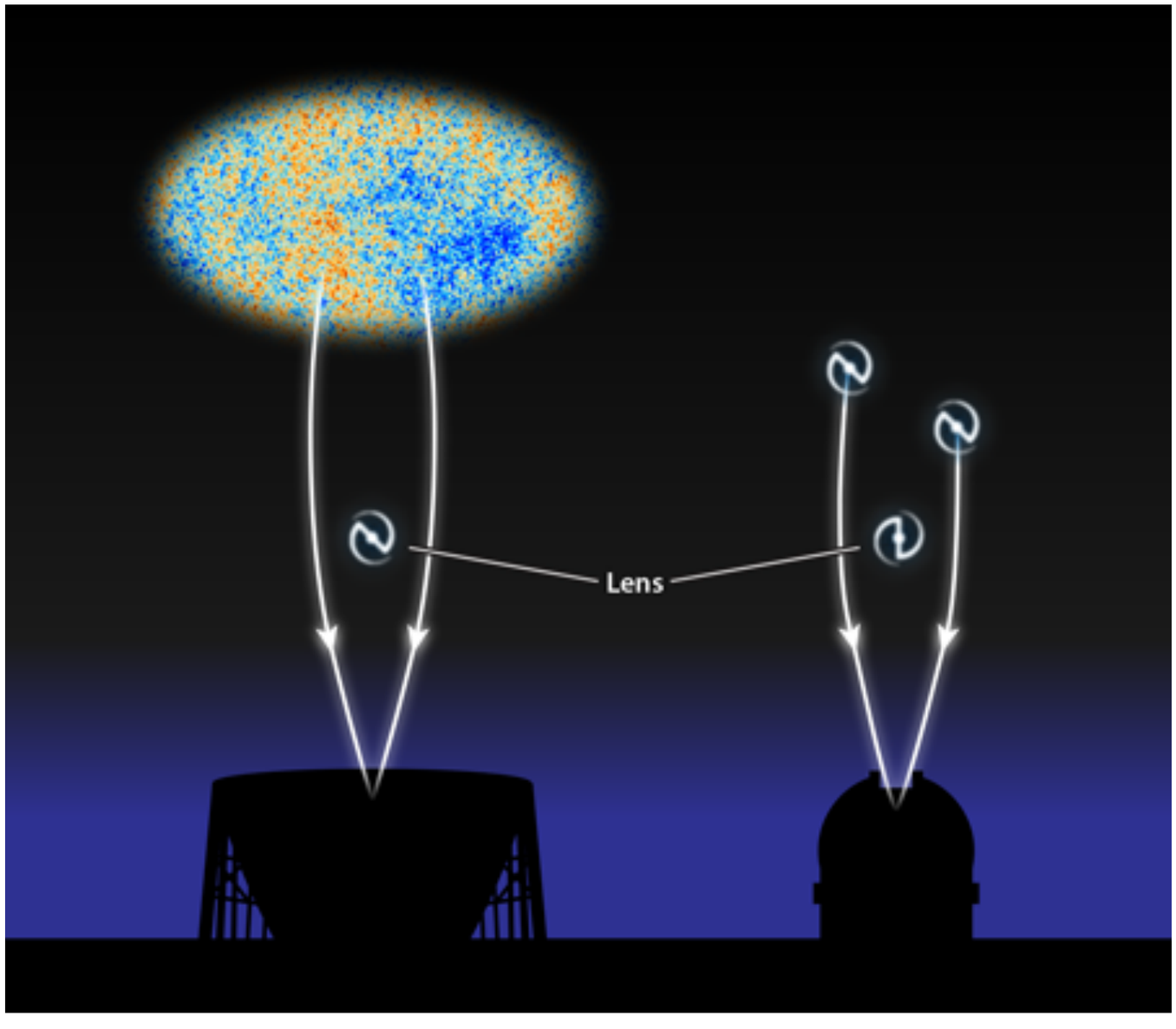

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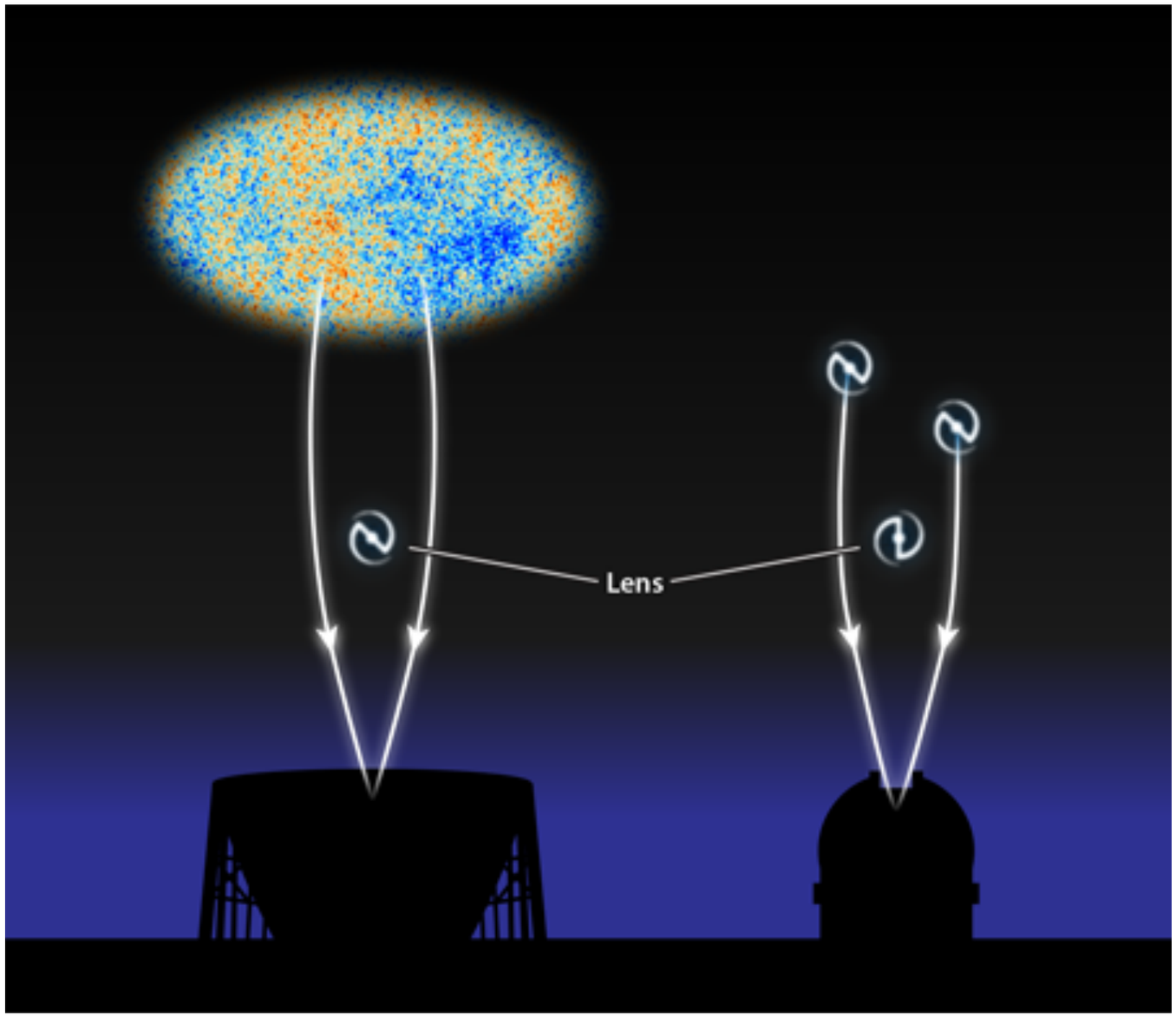

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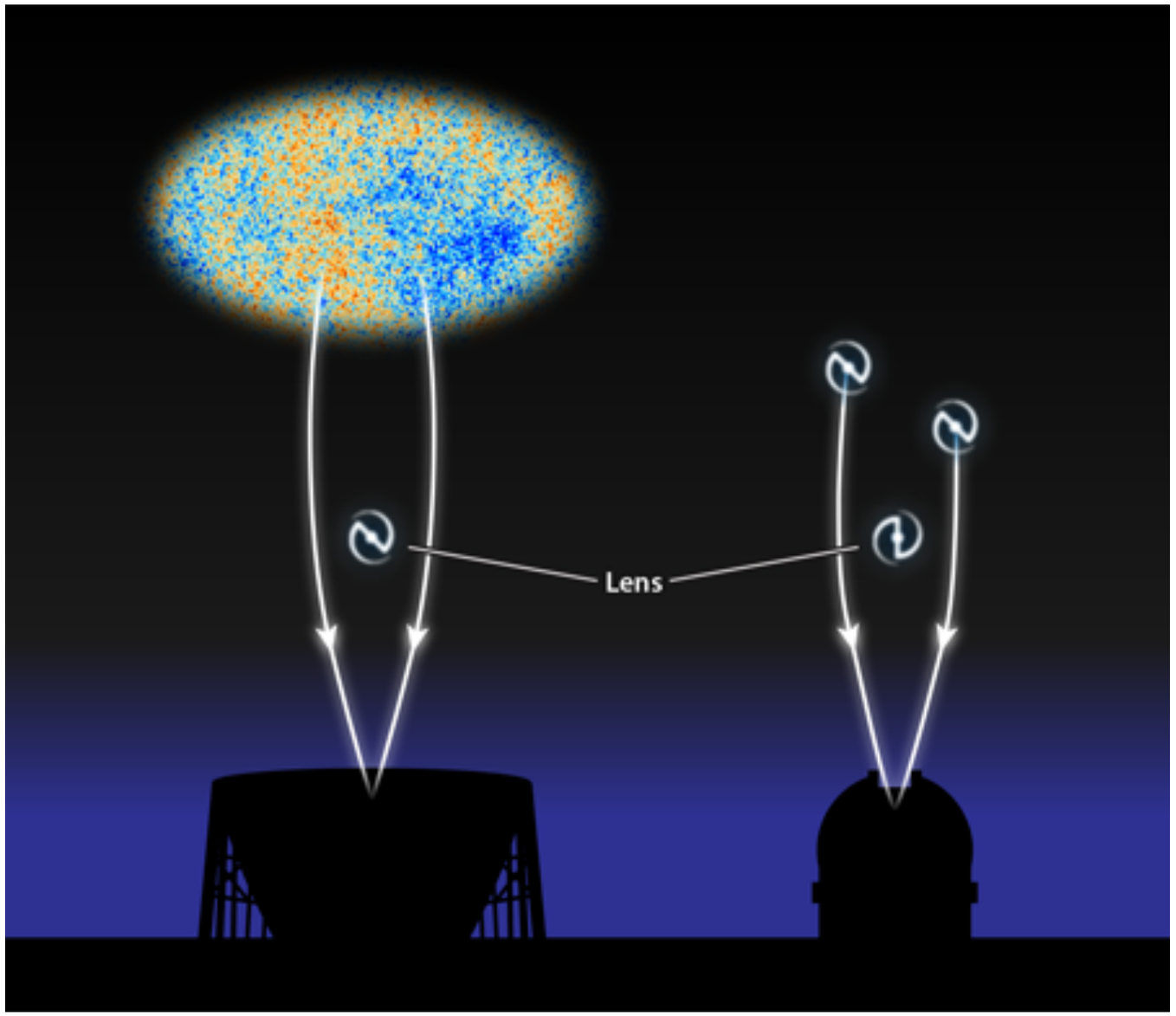

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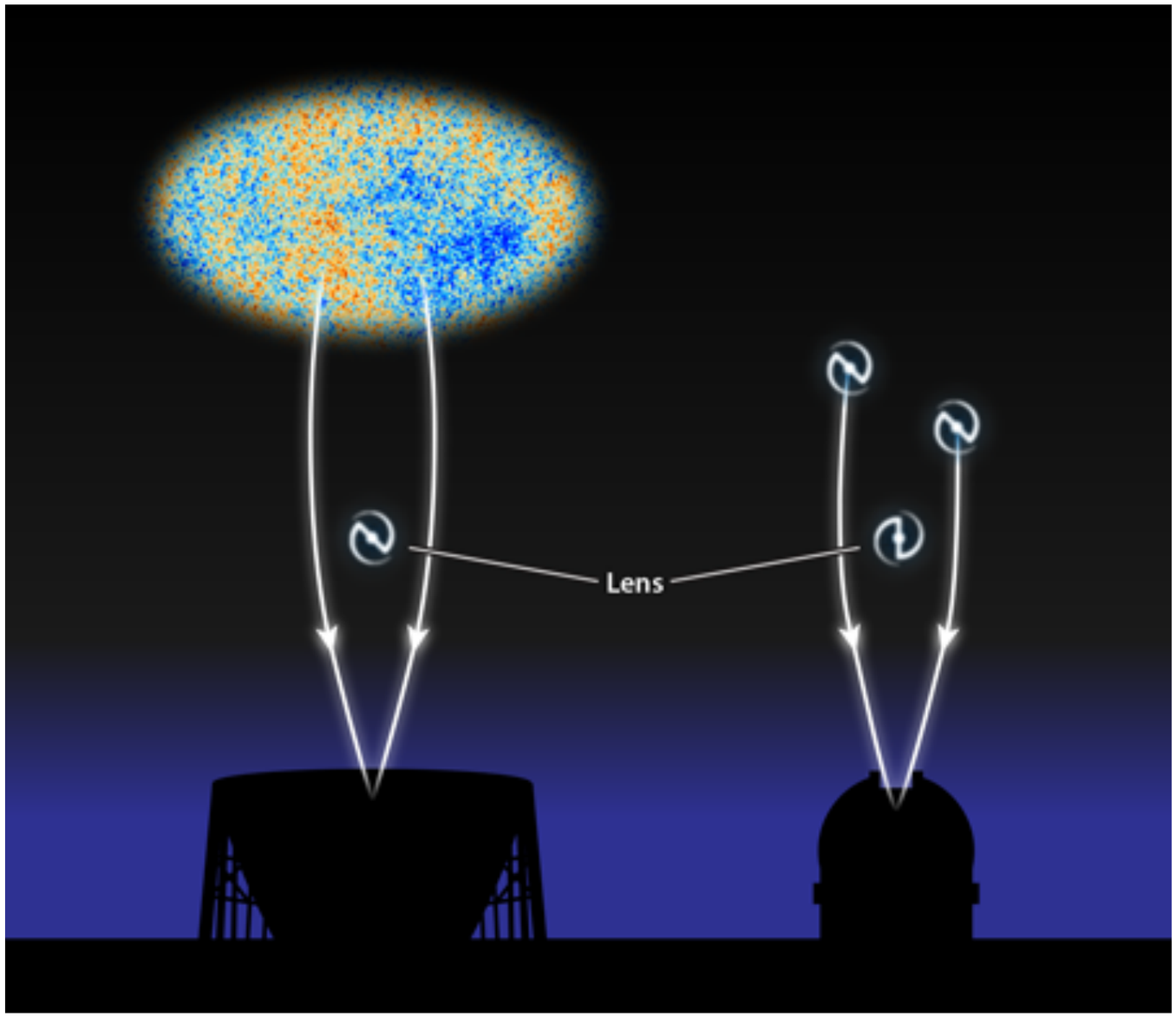

First Measurement of CMB Lensing on Halo Scales
Madhavacheril, NS, for the ACT Collaboration
PRL, 114, 2015

Advantage of CMB Lensing to Probe Small-Scale Structure

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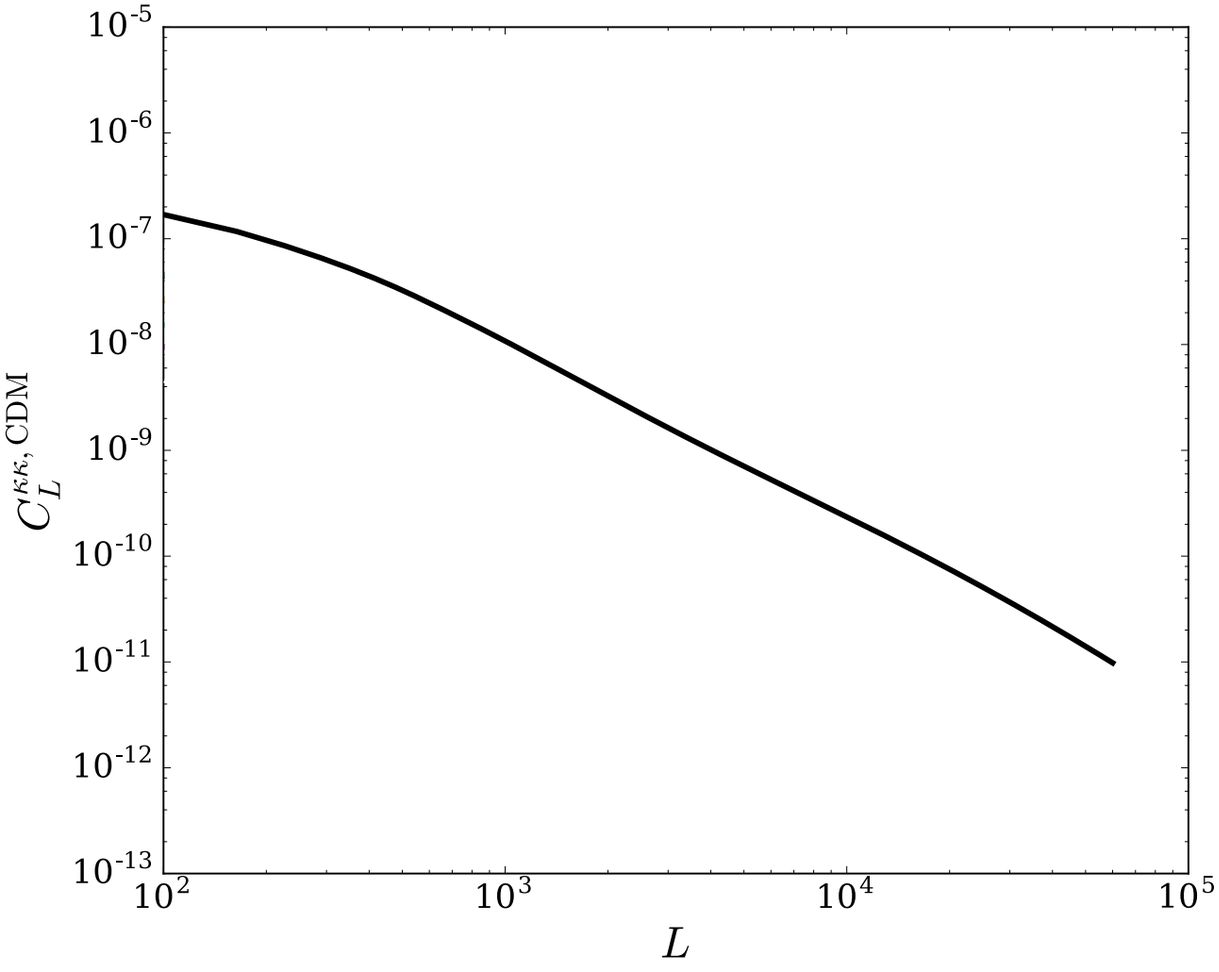
3. Properties of primordial CMB are well understood

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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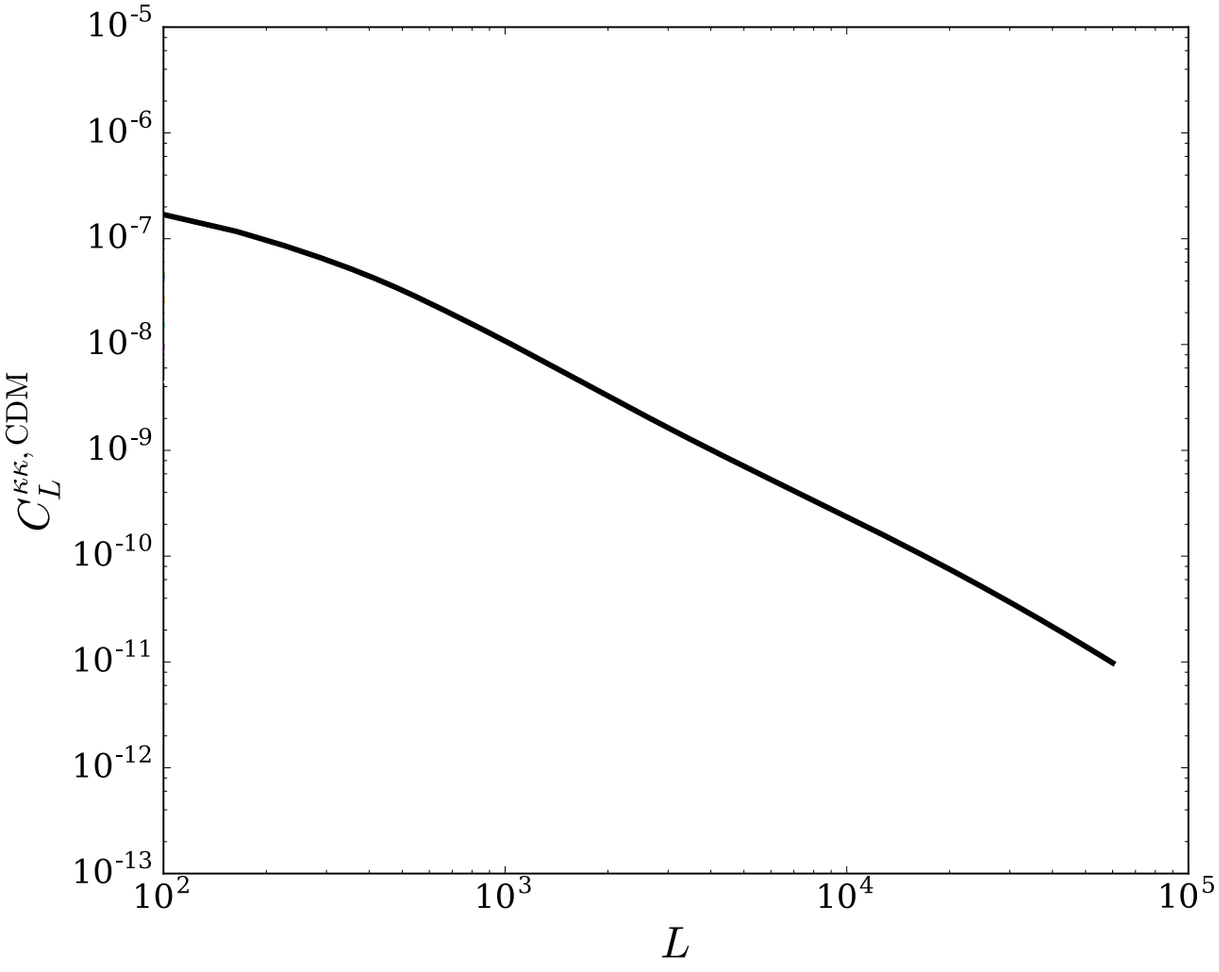

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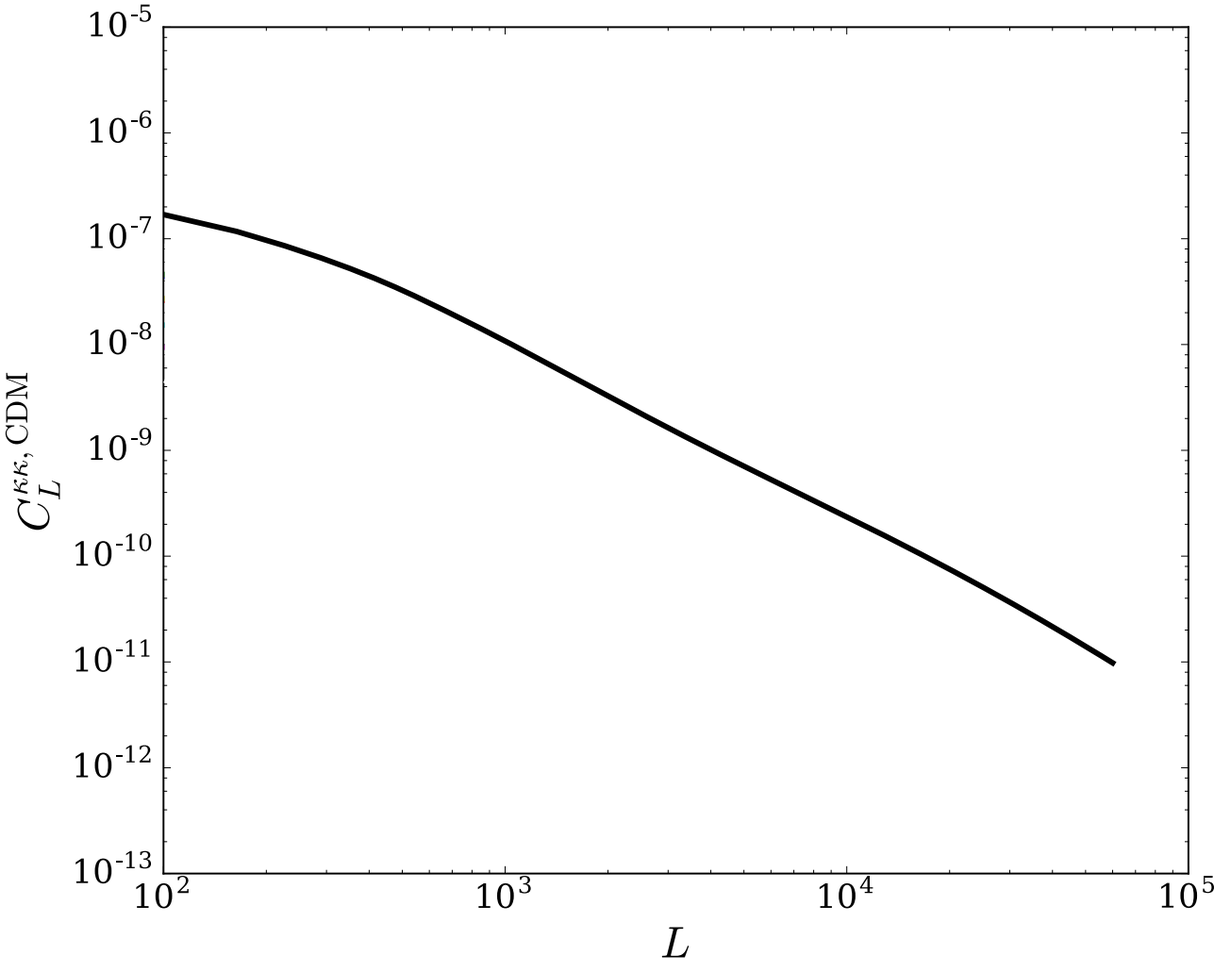

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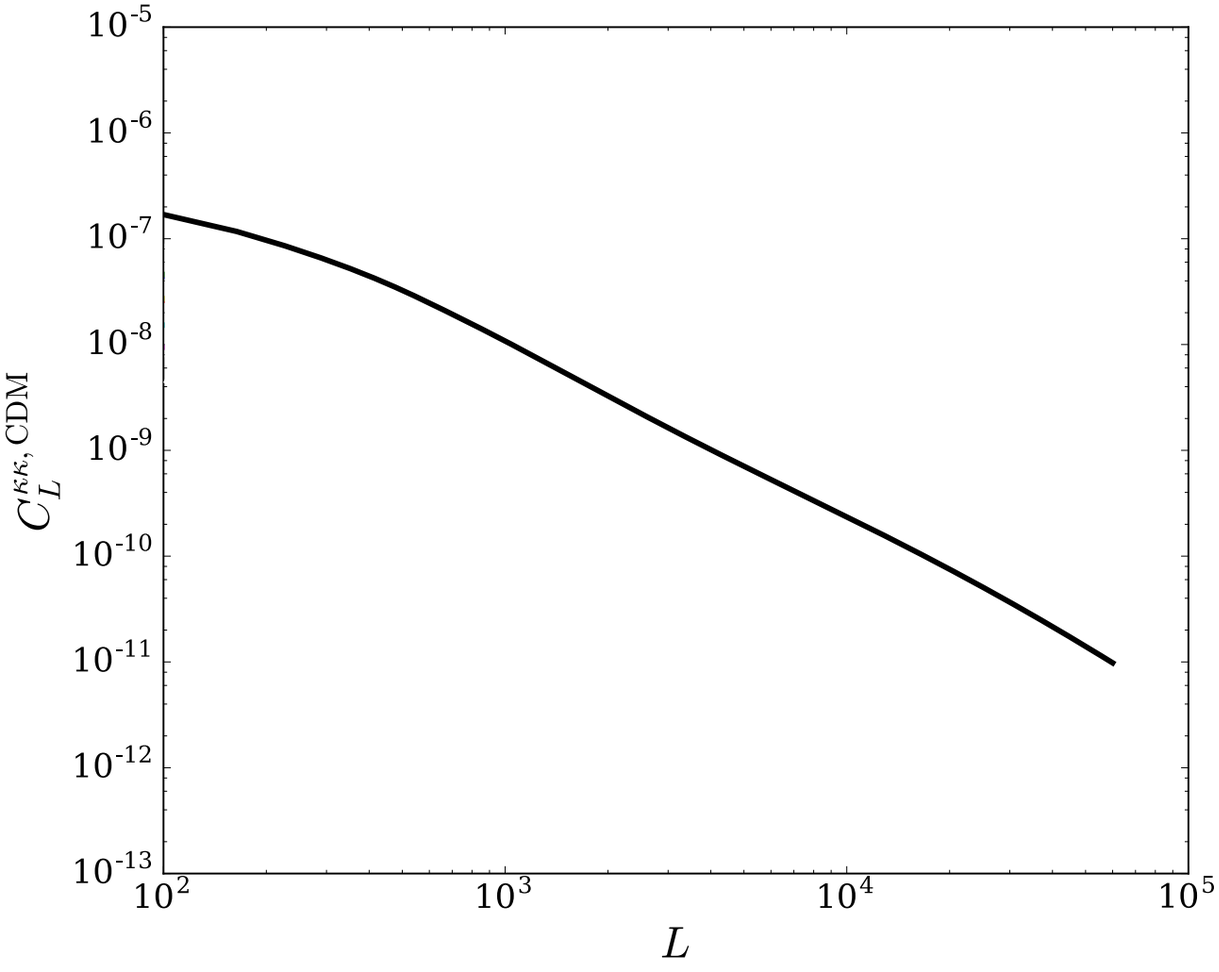

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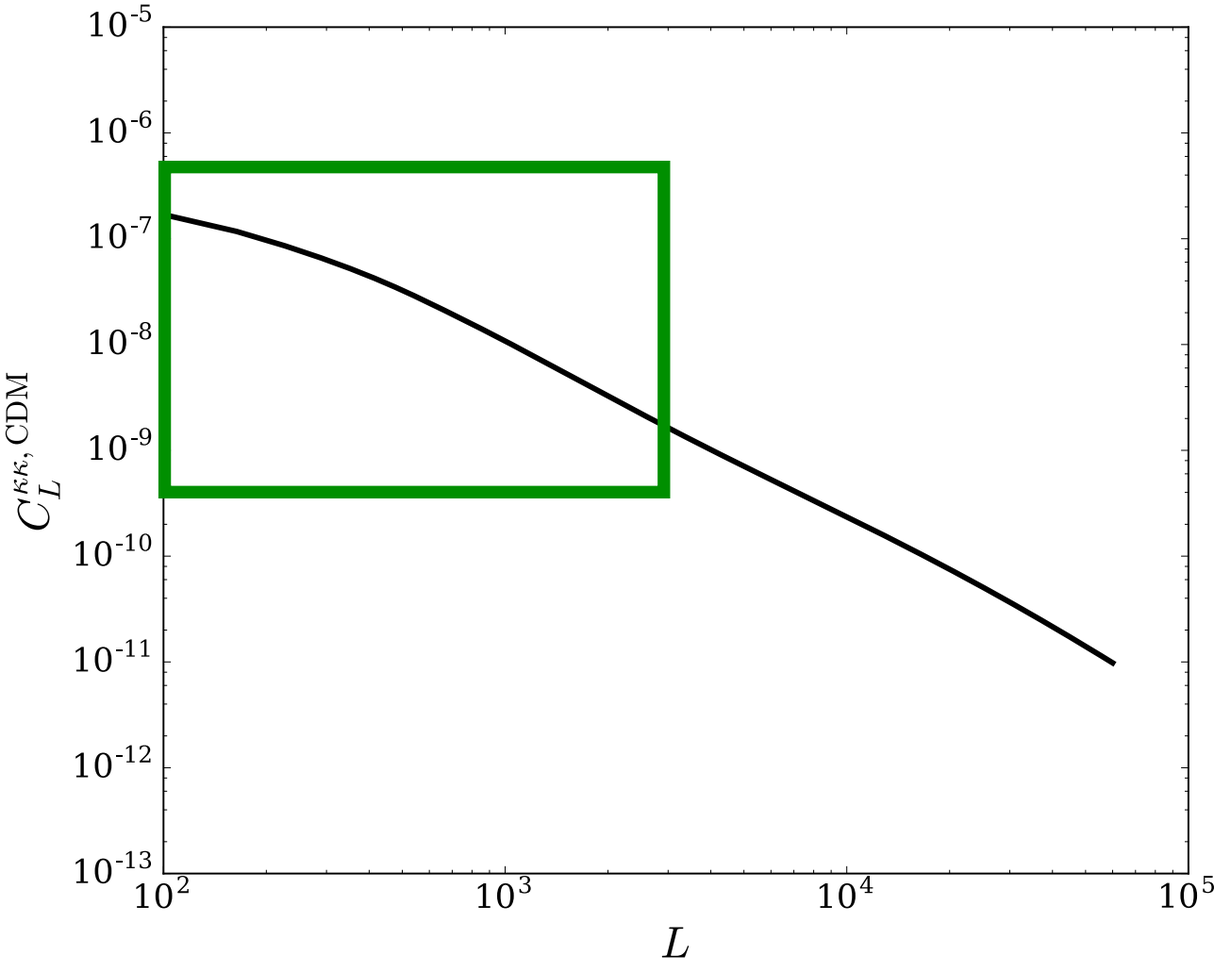

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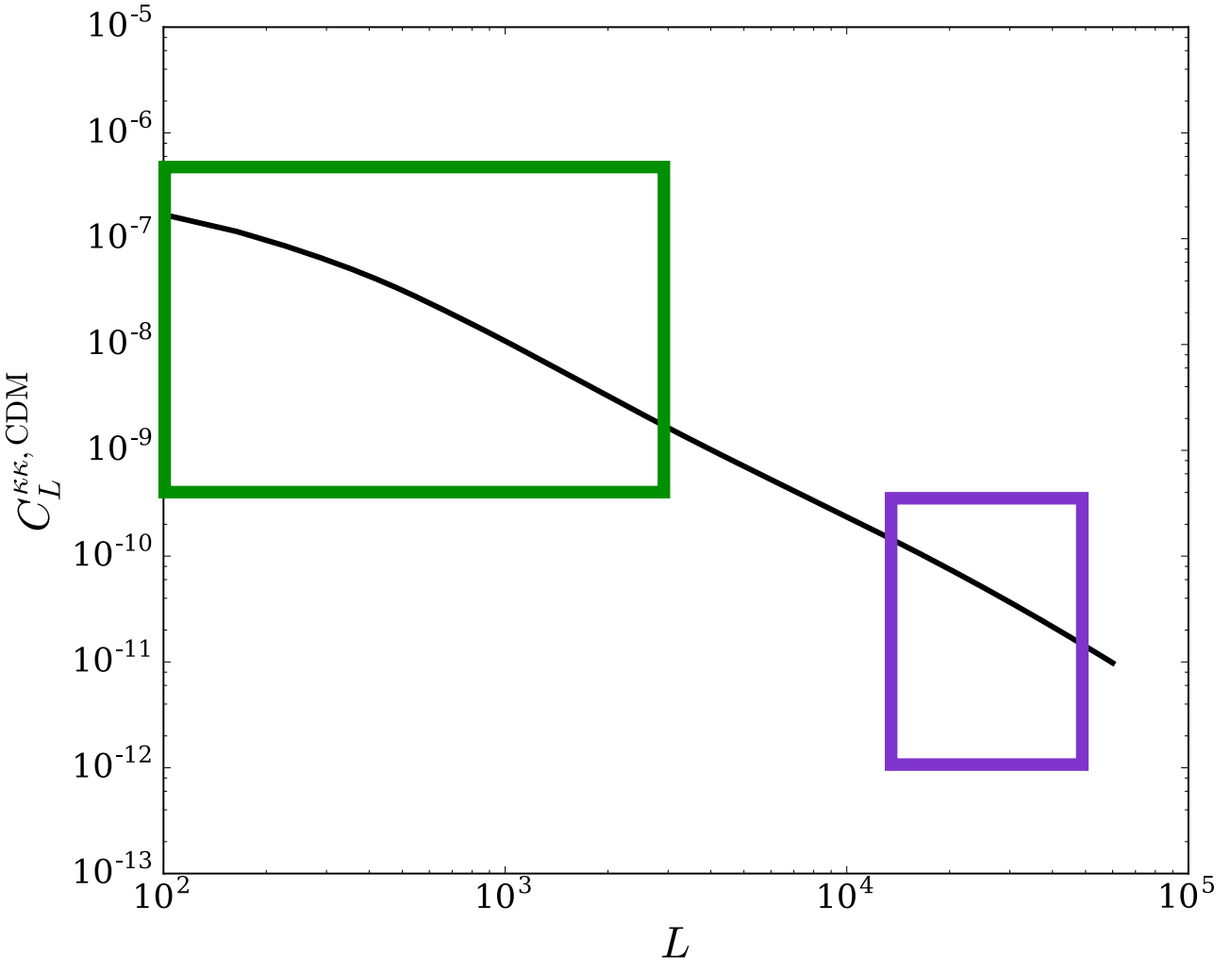

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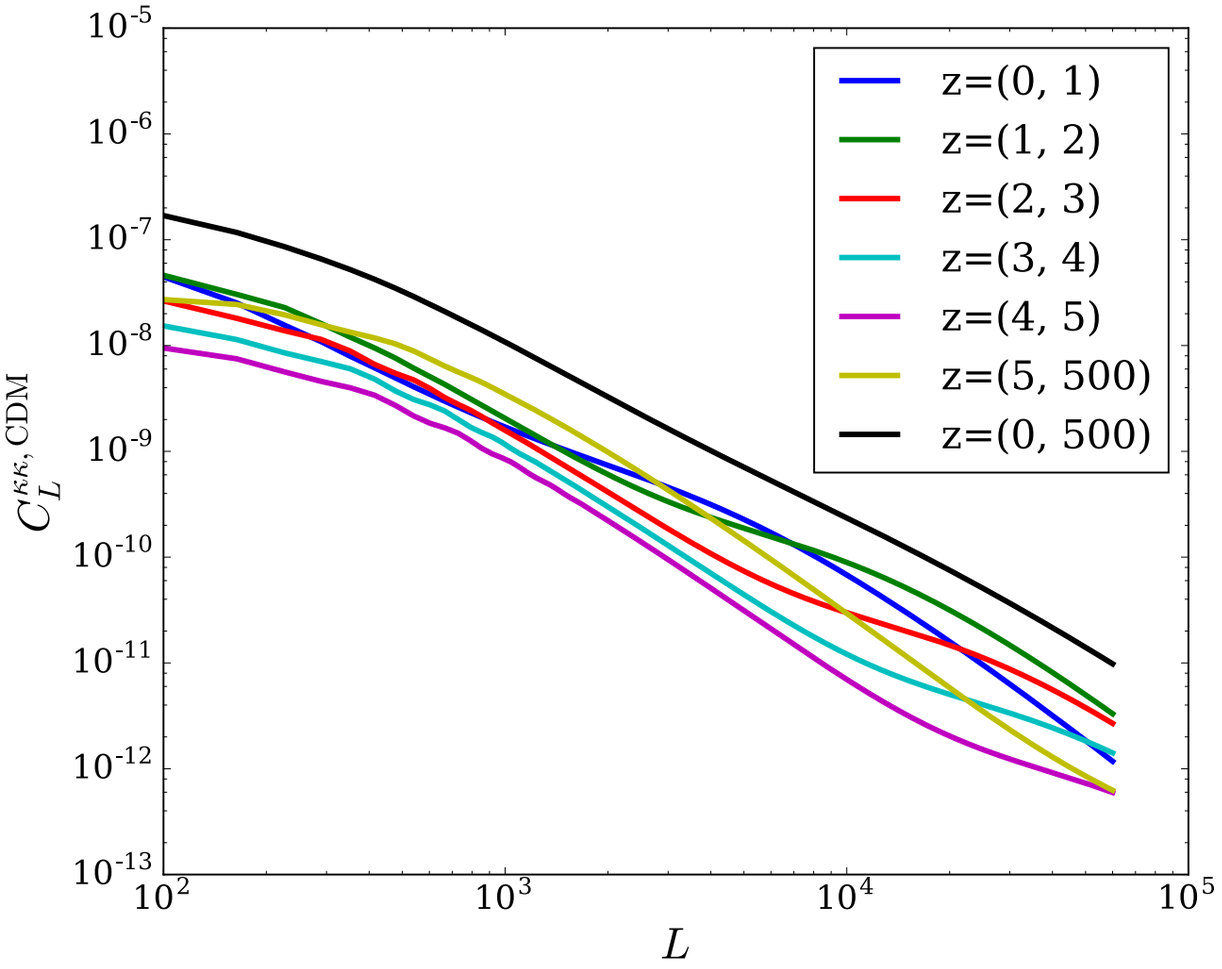

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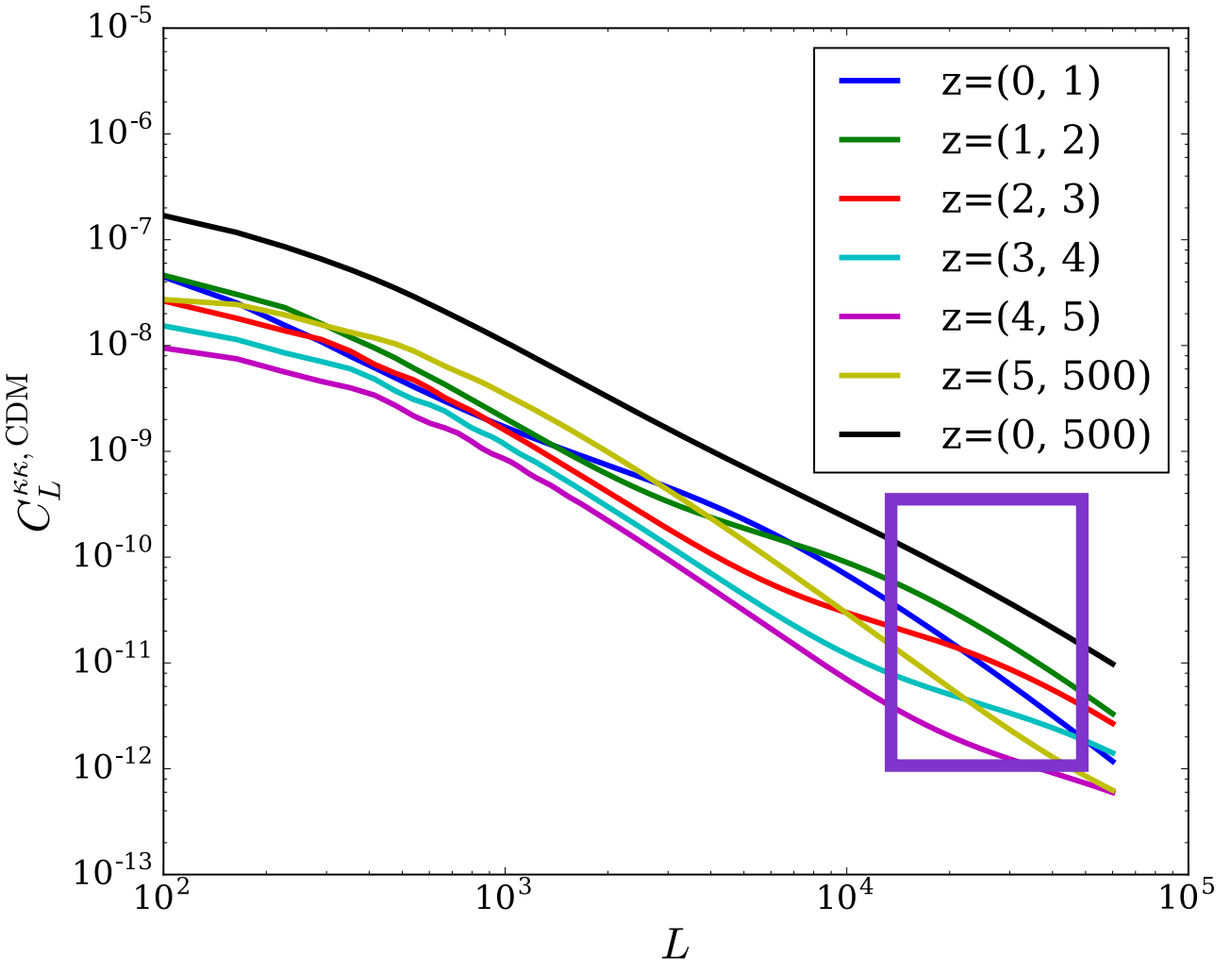

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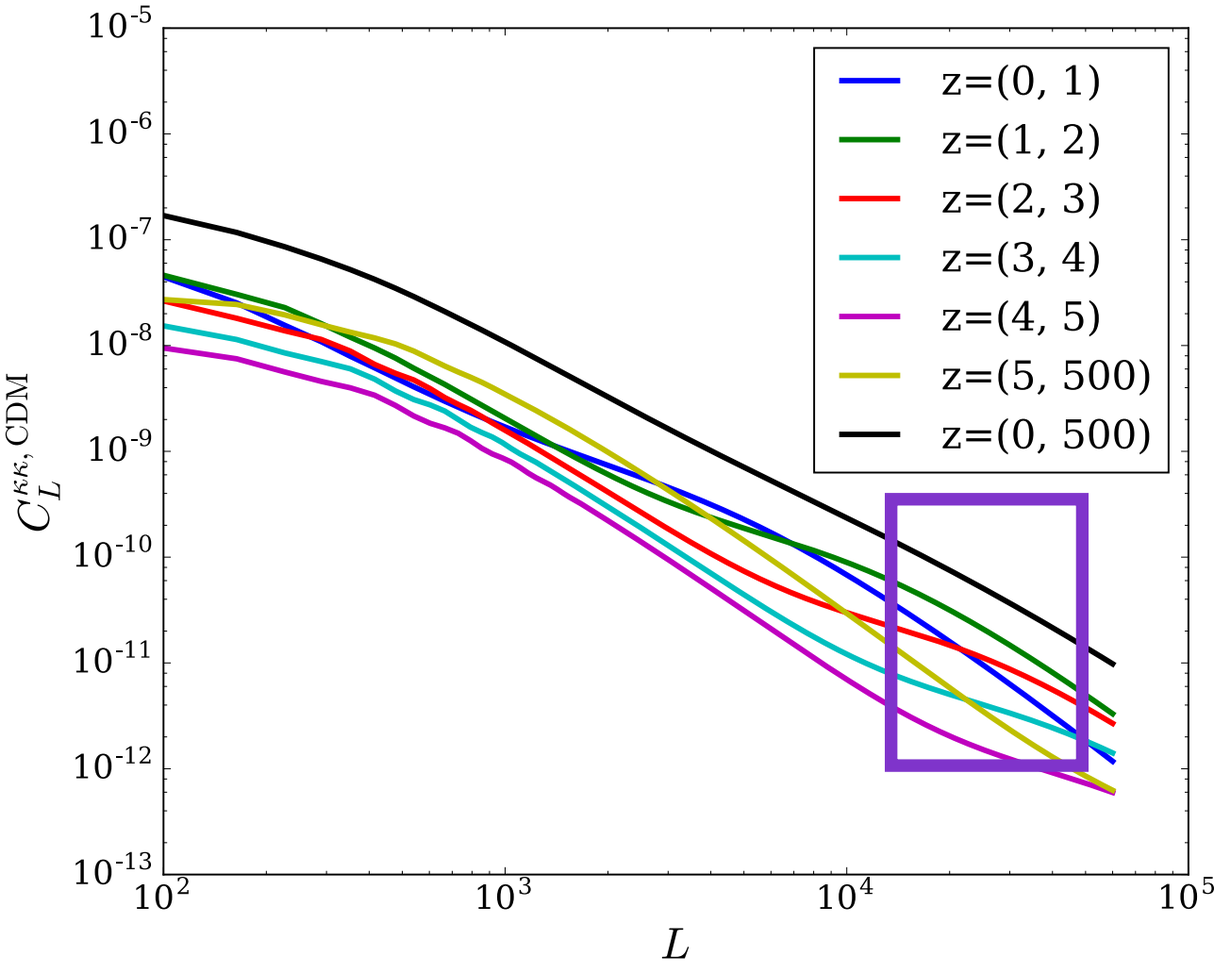

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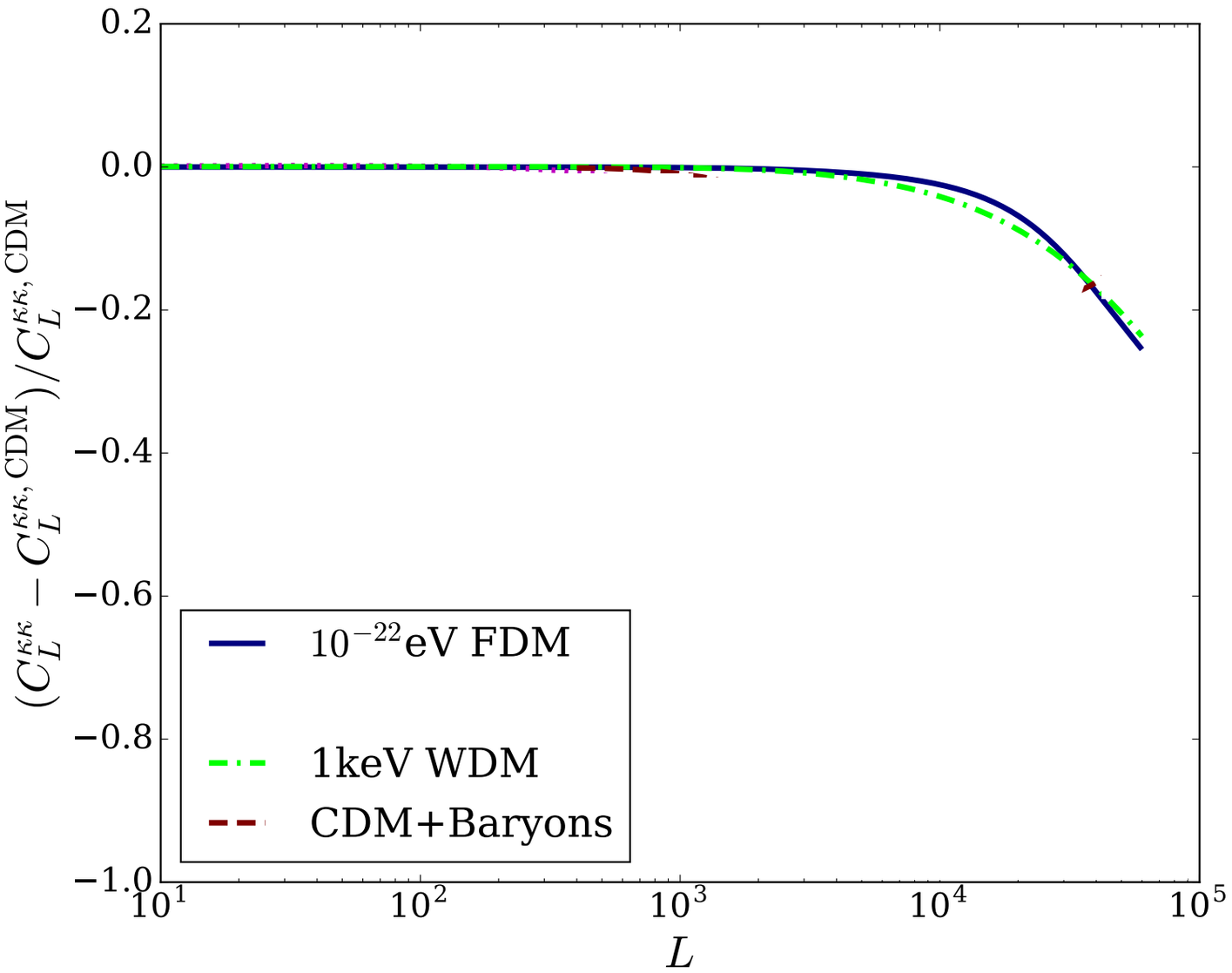
Contrast between CDM and DM models that wash out small-scale structure is larger at higher redshifts

CMB Lensing Power Spectrum for CDM Versus FDM/WDM



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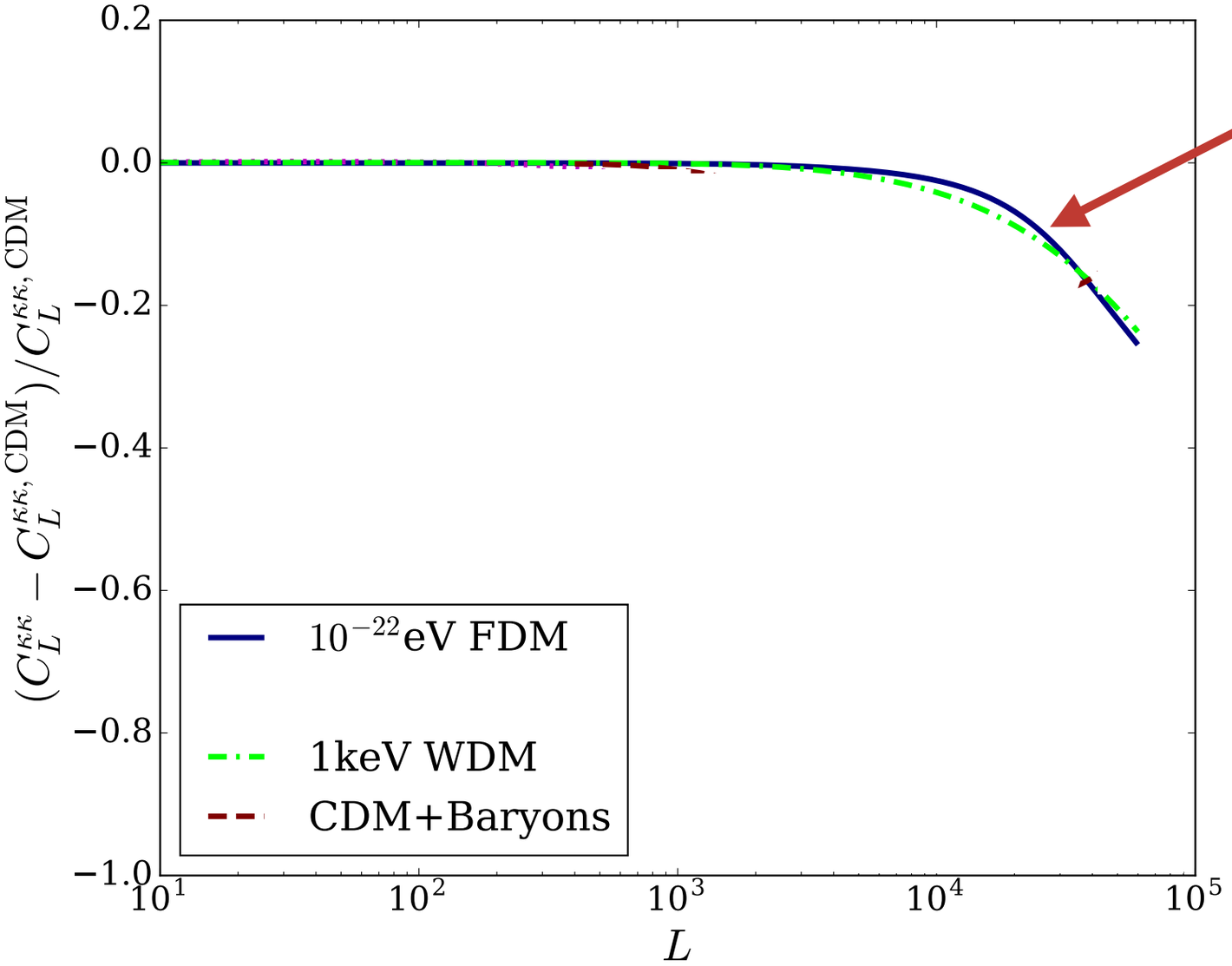

Fractional difference between FDM/WDM and CDM for the CMB lensing power spectrum

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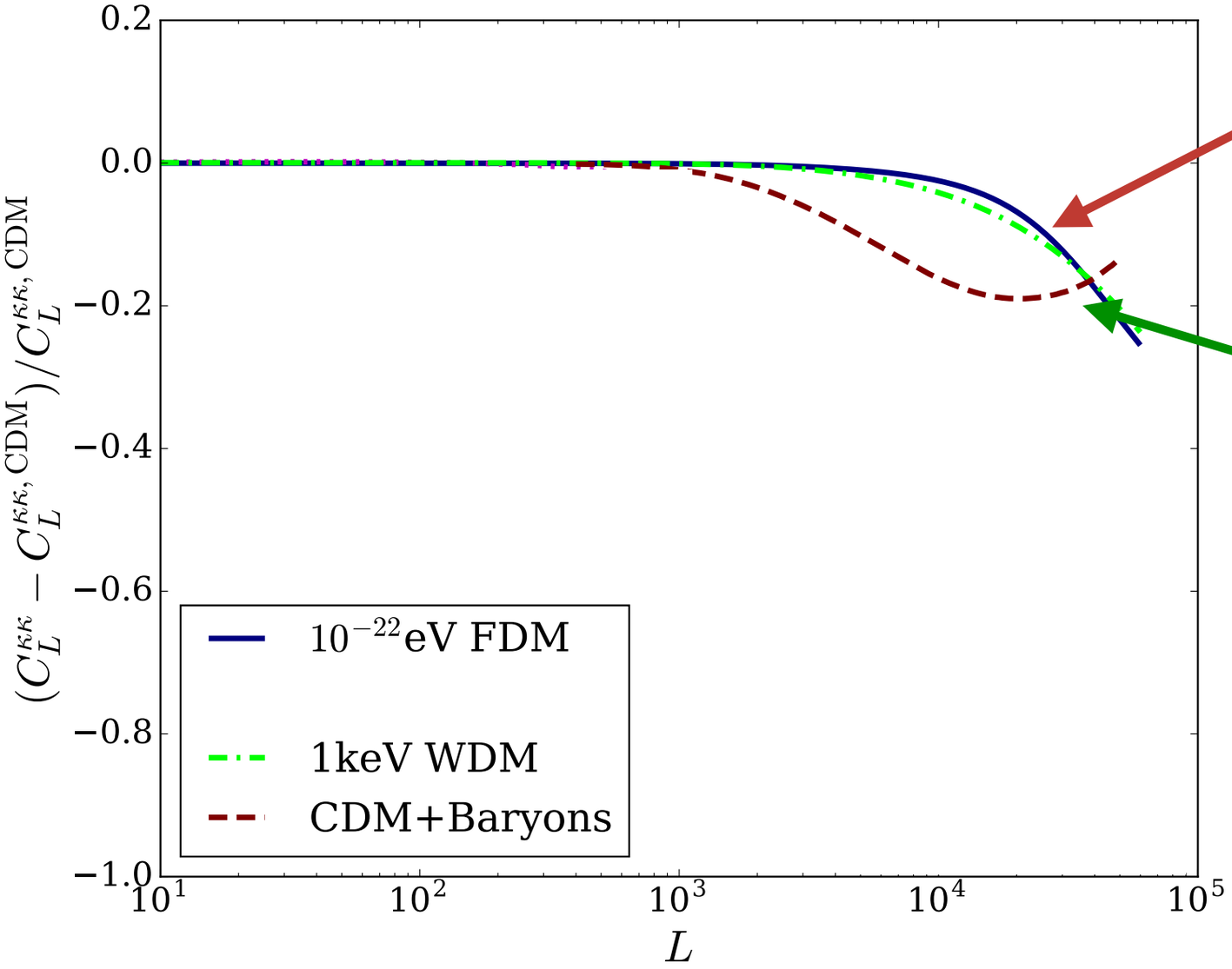

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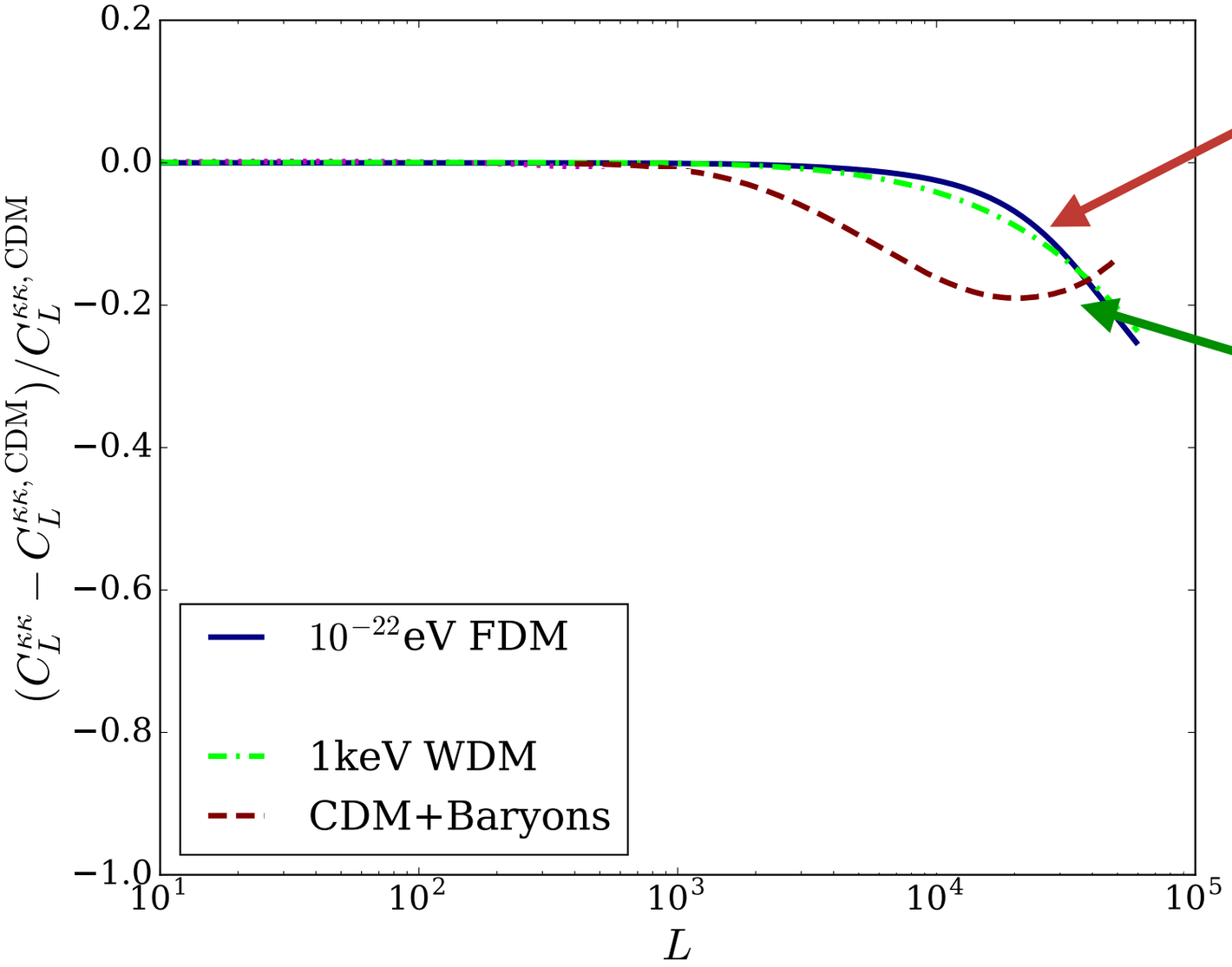

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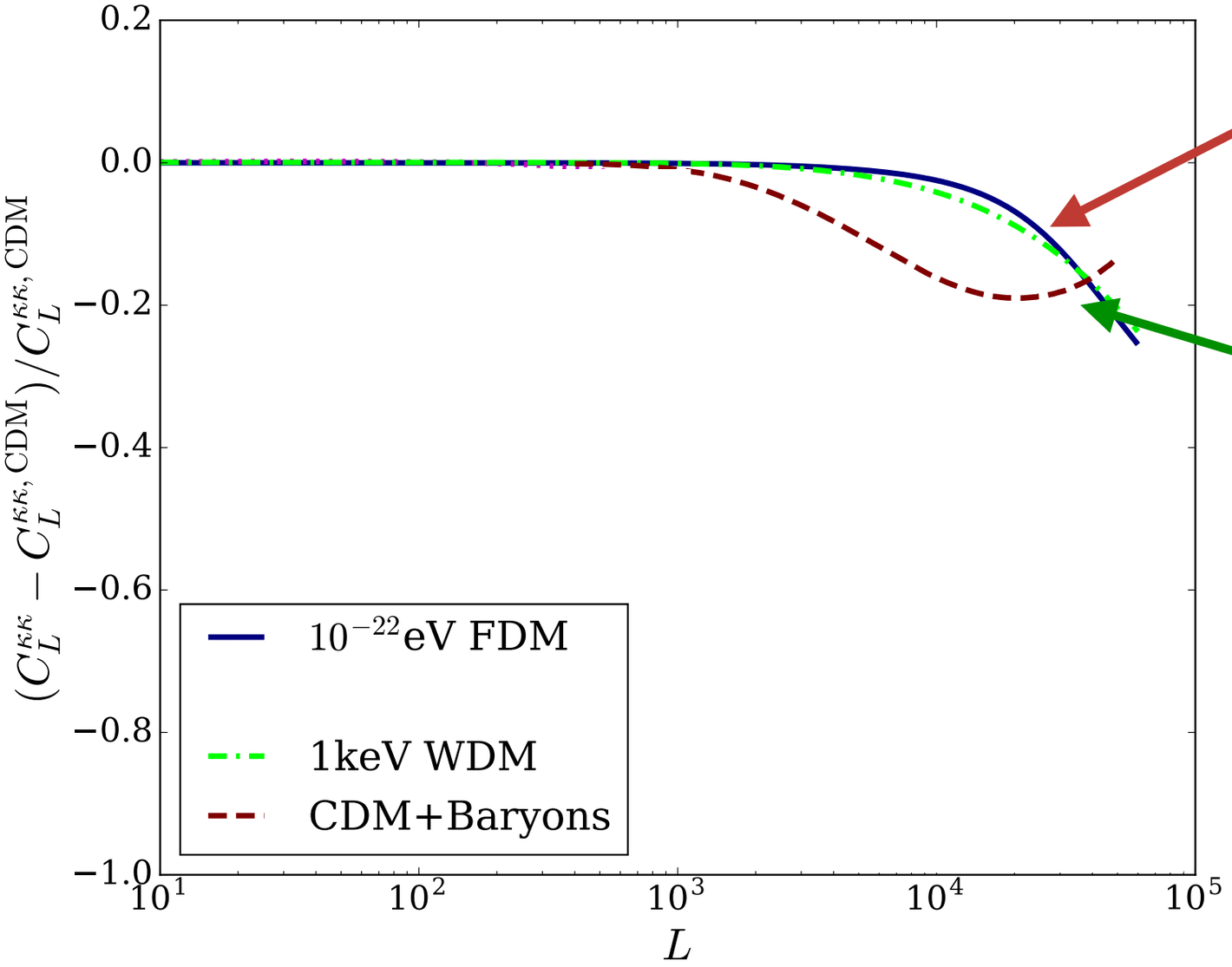

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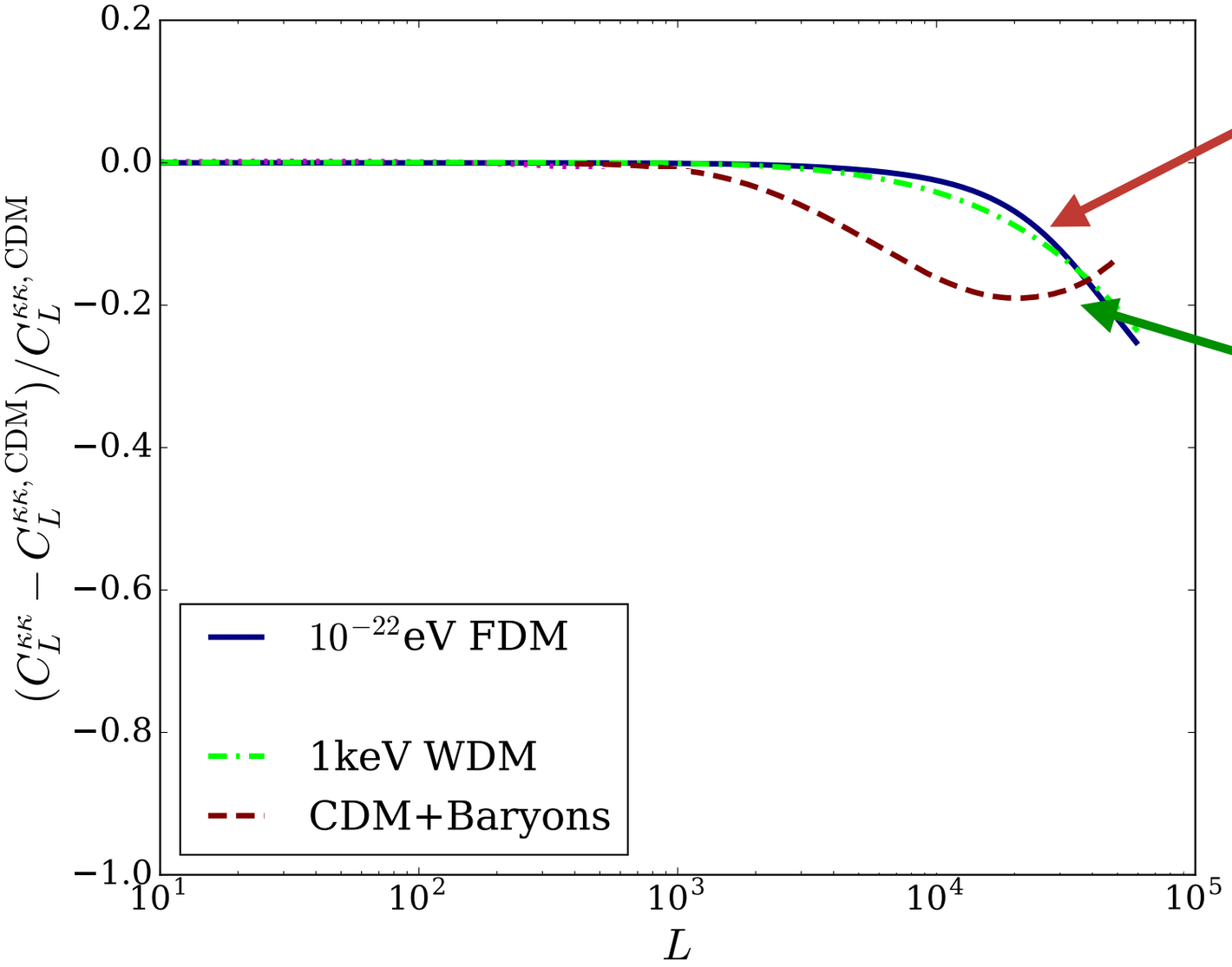

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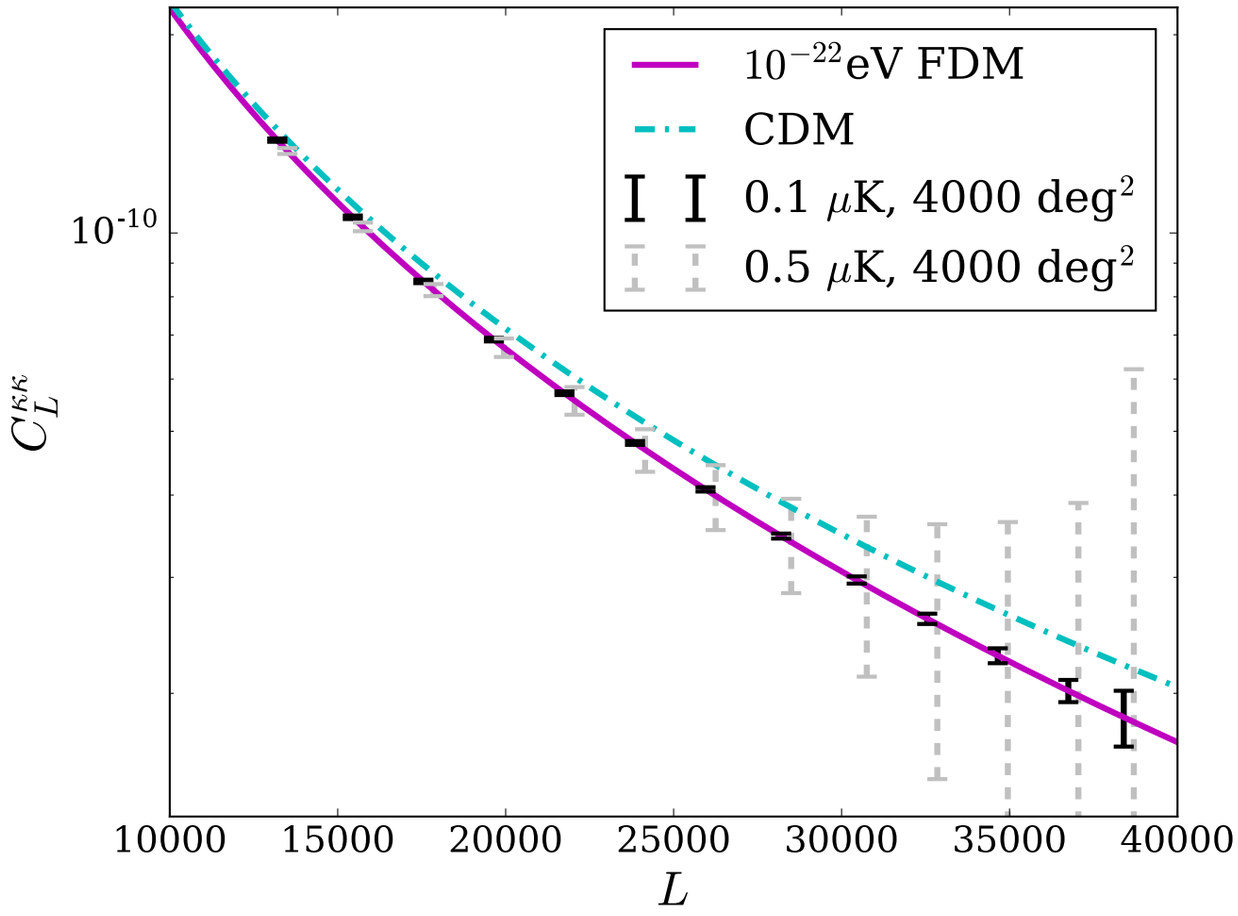
2.) If see significant deviation, then can potentially use shape of curve to determine whether it is due to baryons or alternative to CDM

Potential Ability to Distinguish Between Dark Matter Models



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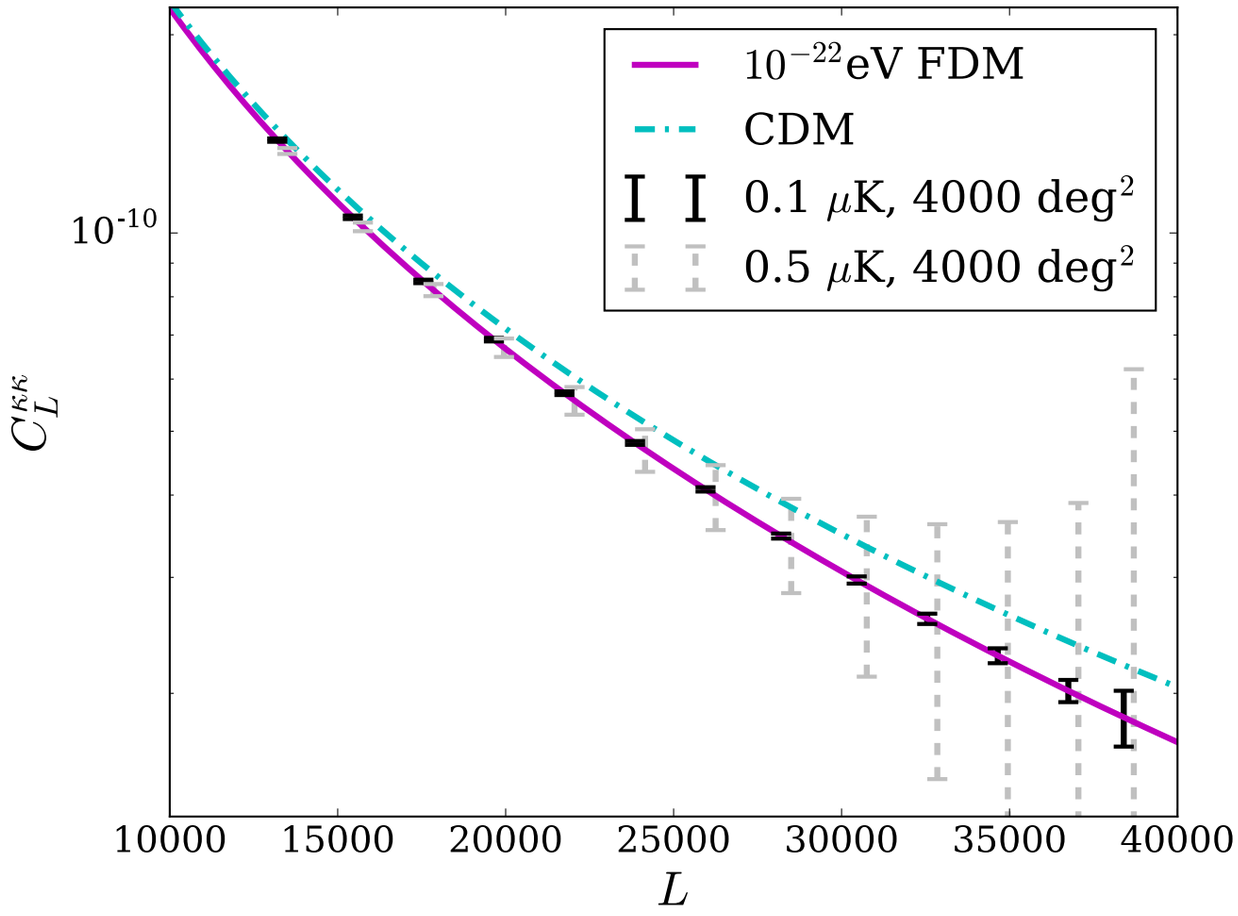

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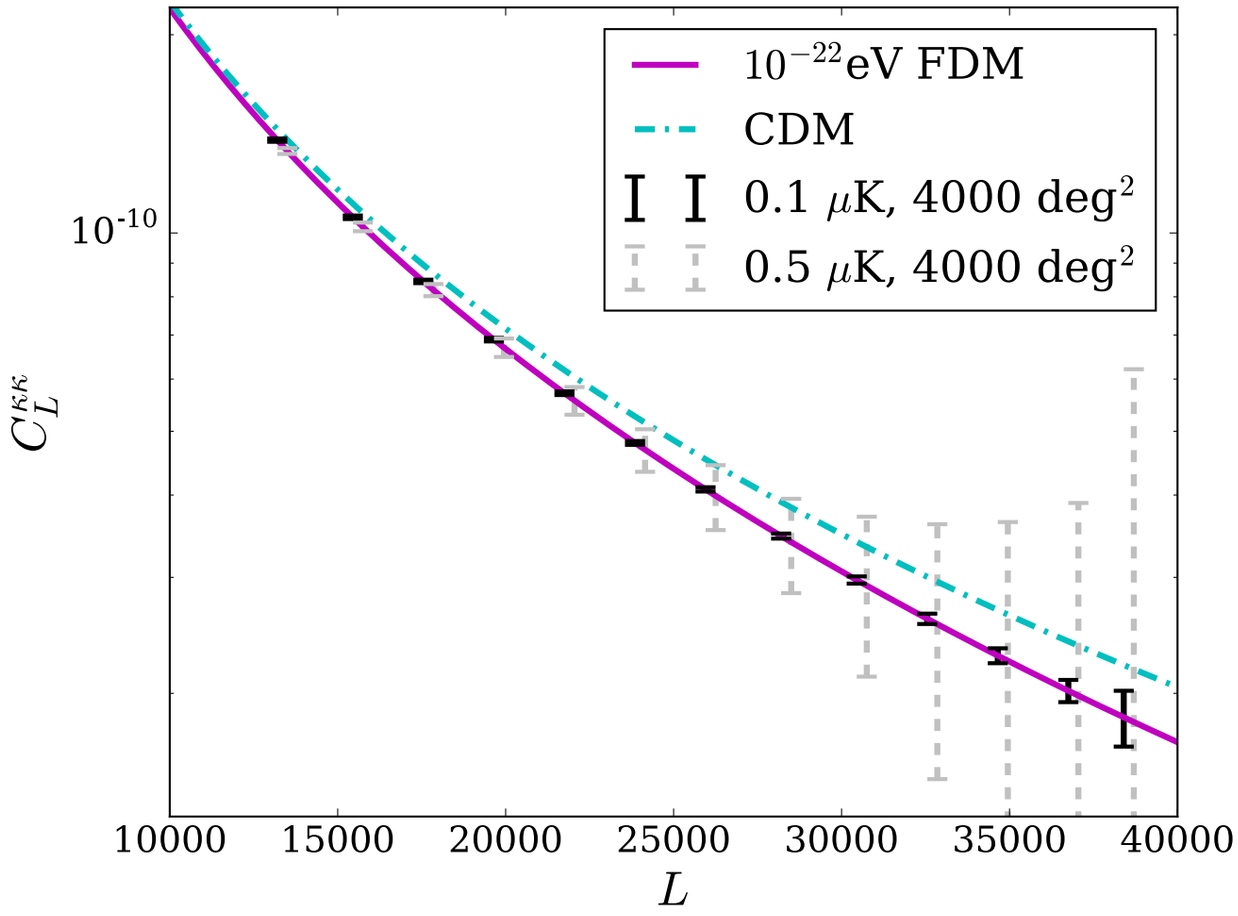

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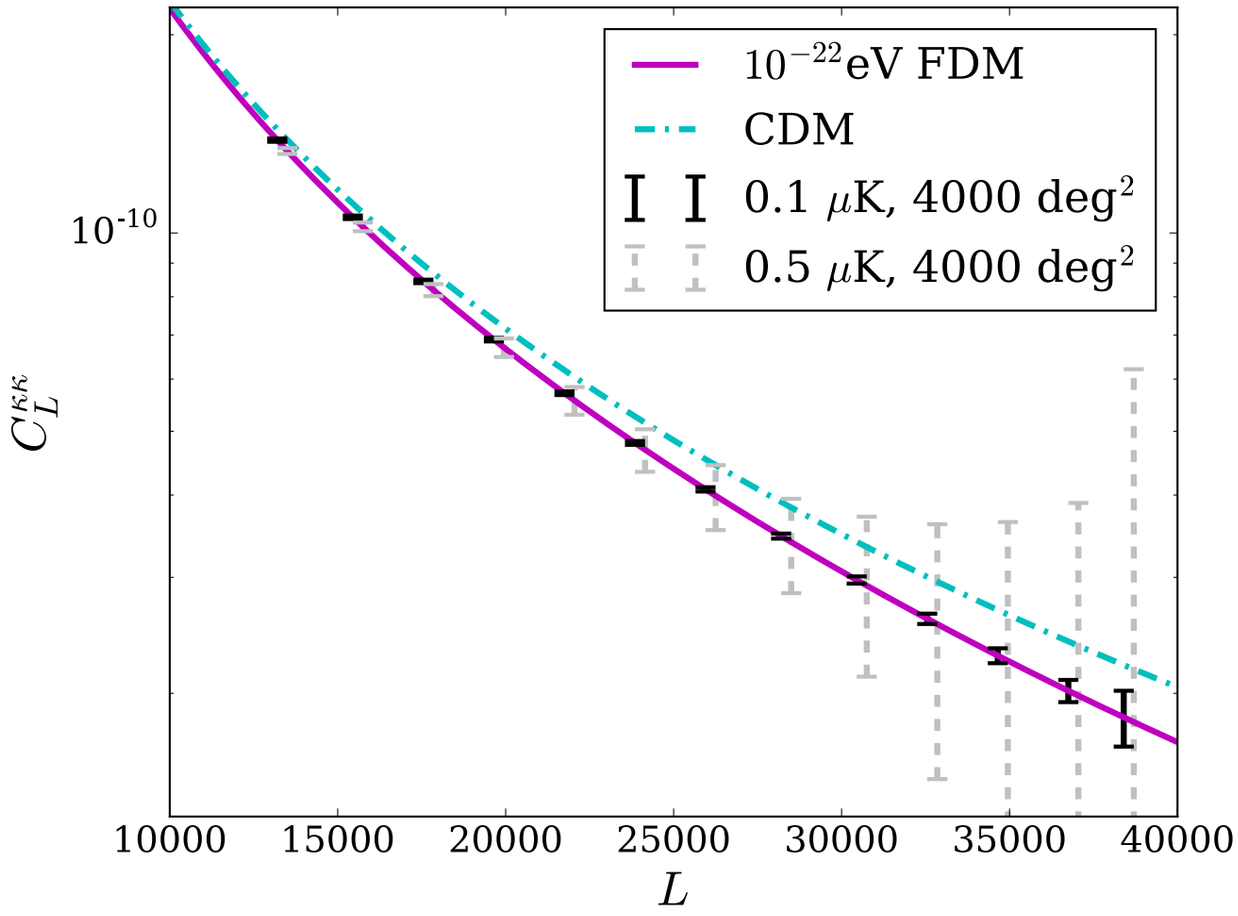

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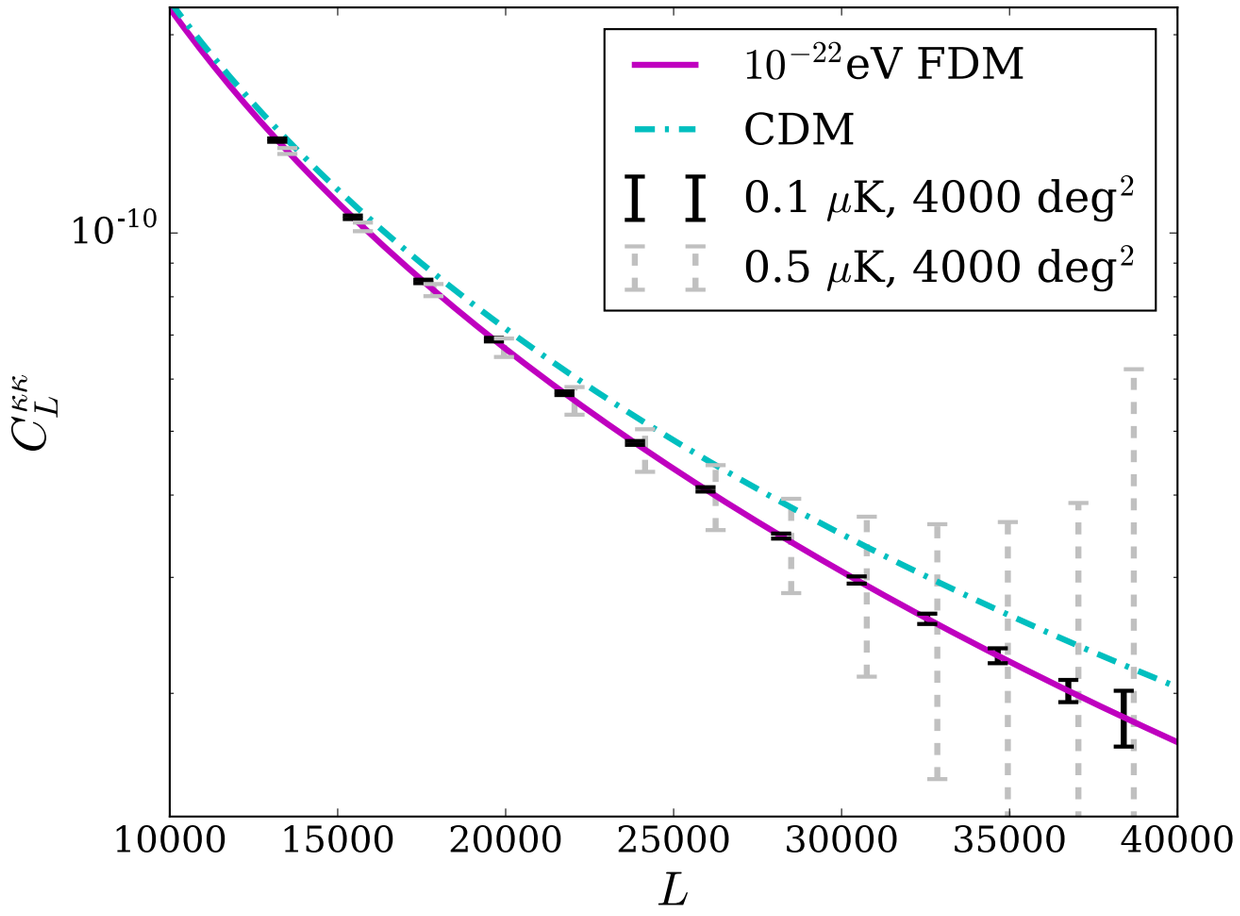

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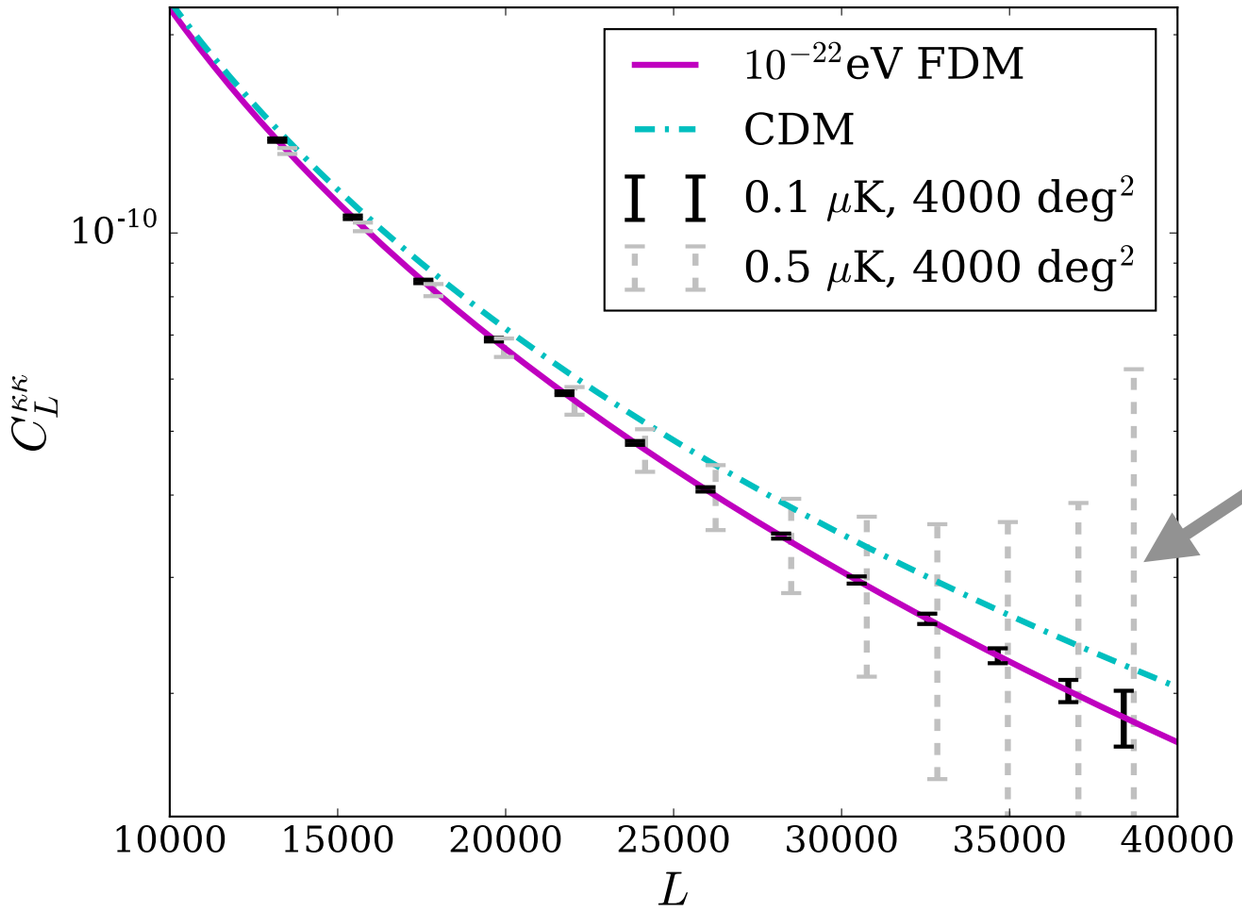

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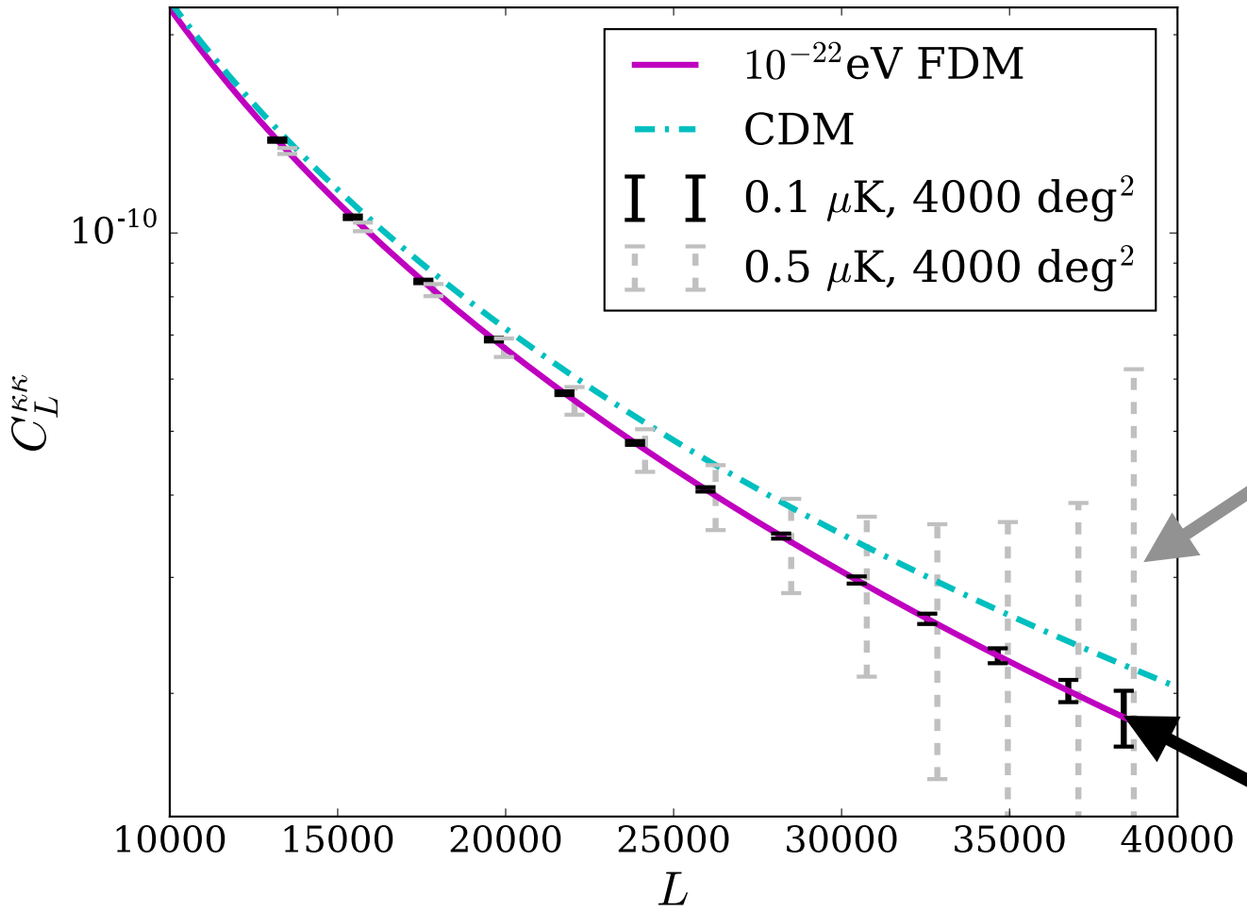

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Black: S/N ~ 30 for distinguishing between CDM and FDM/WDM

Requires: Camera few times more sensitive than CMB-S4 on 50-meter dish

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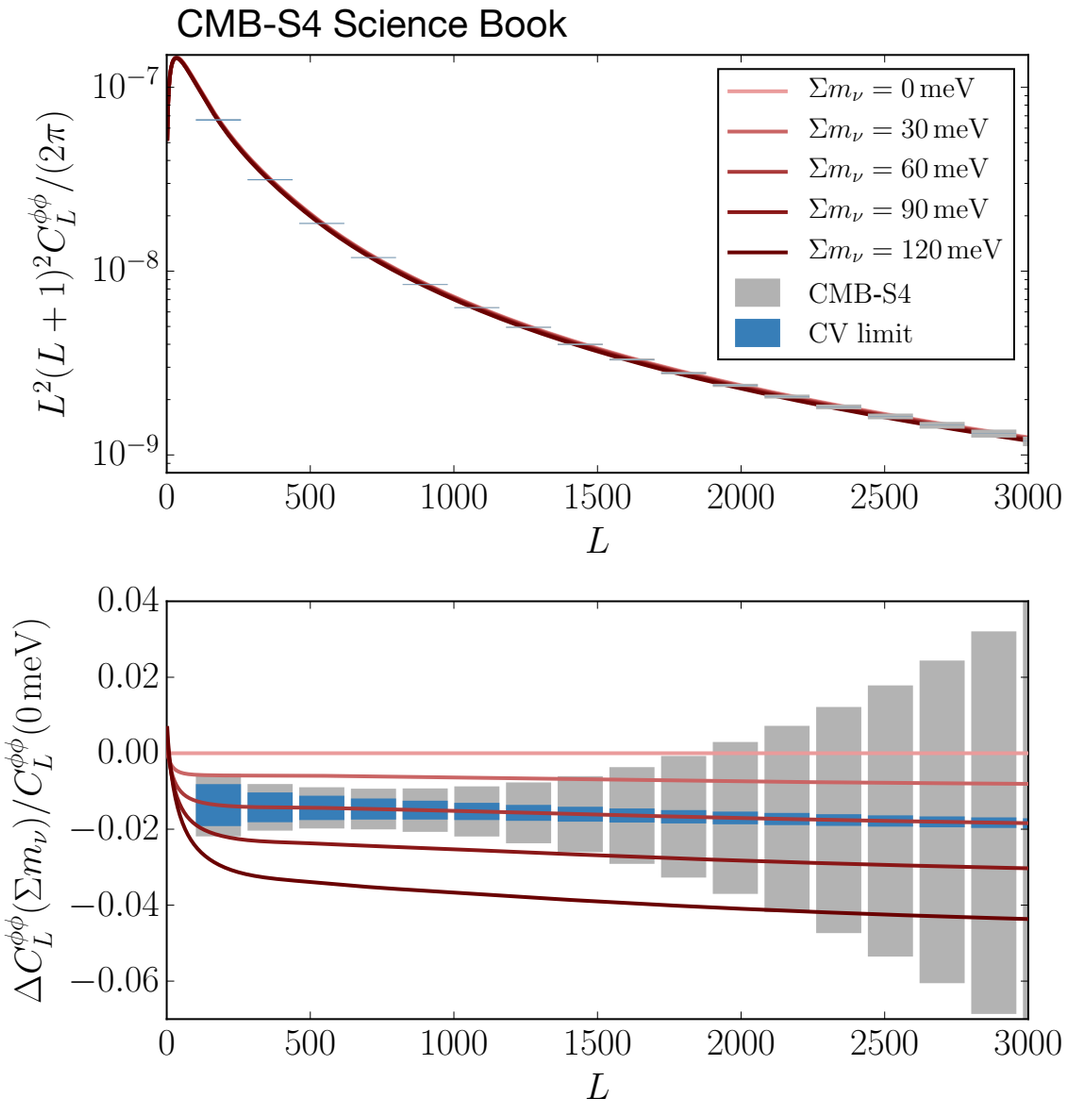

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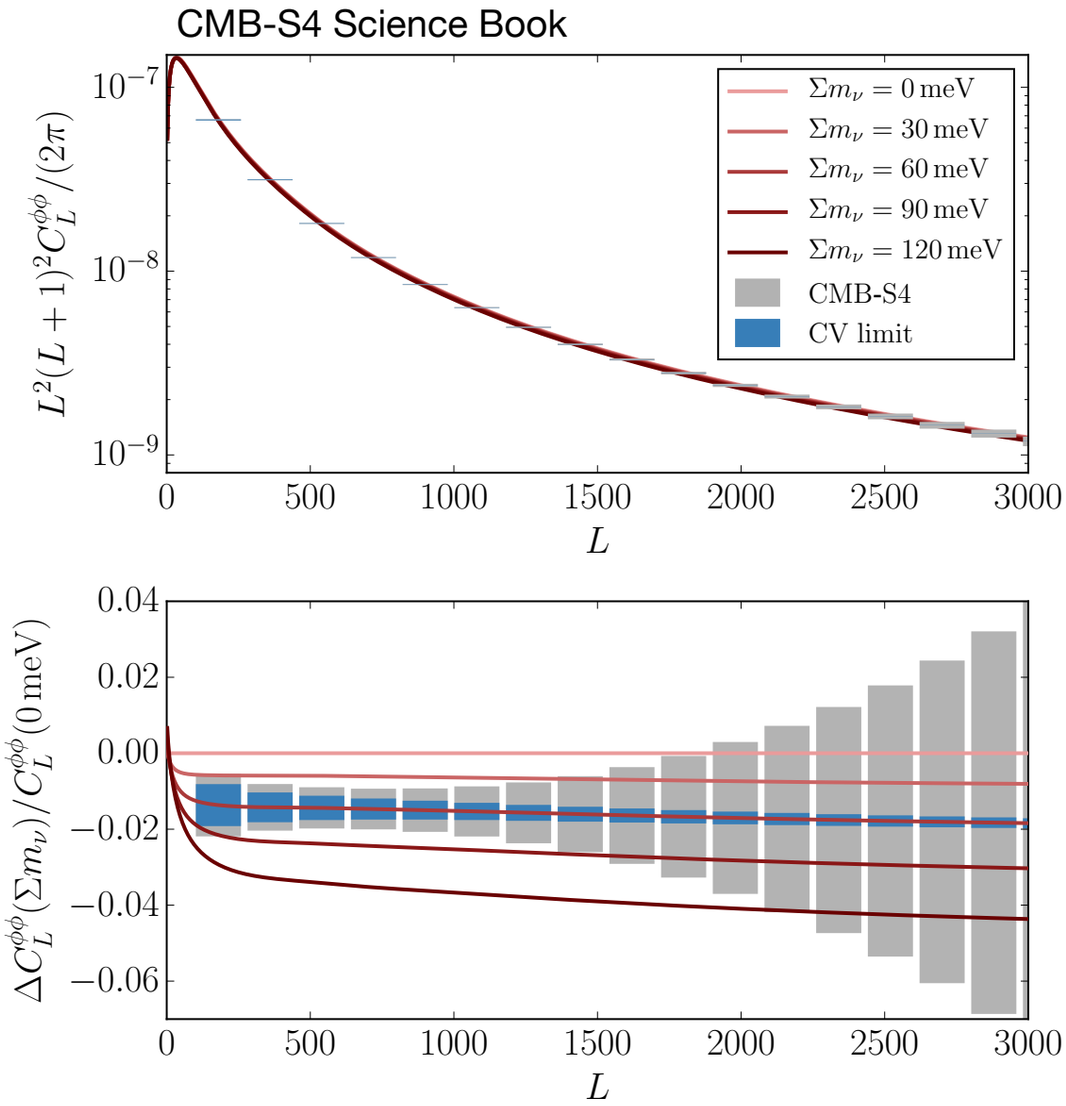

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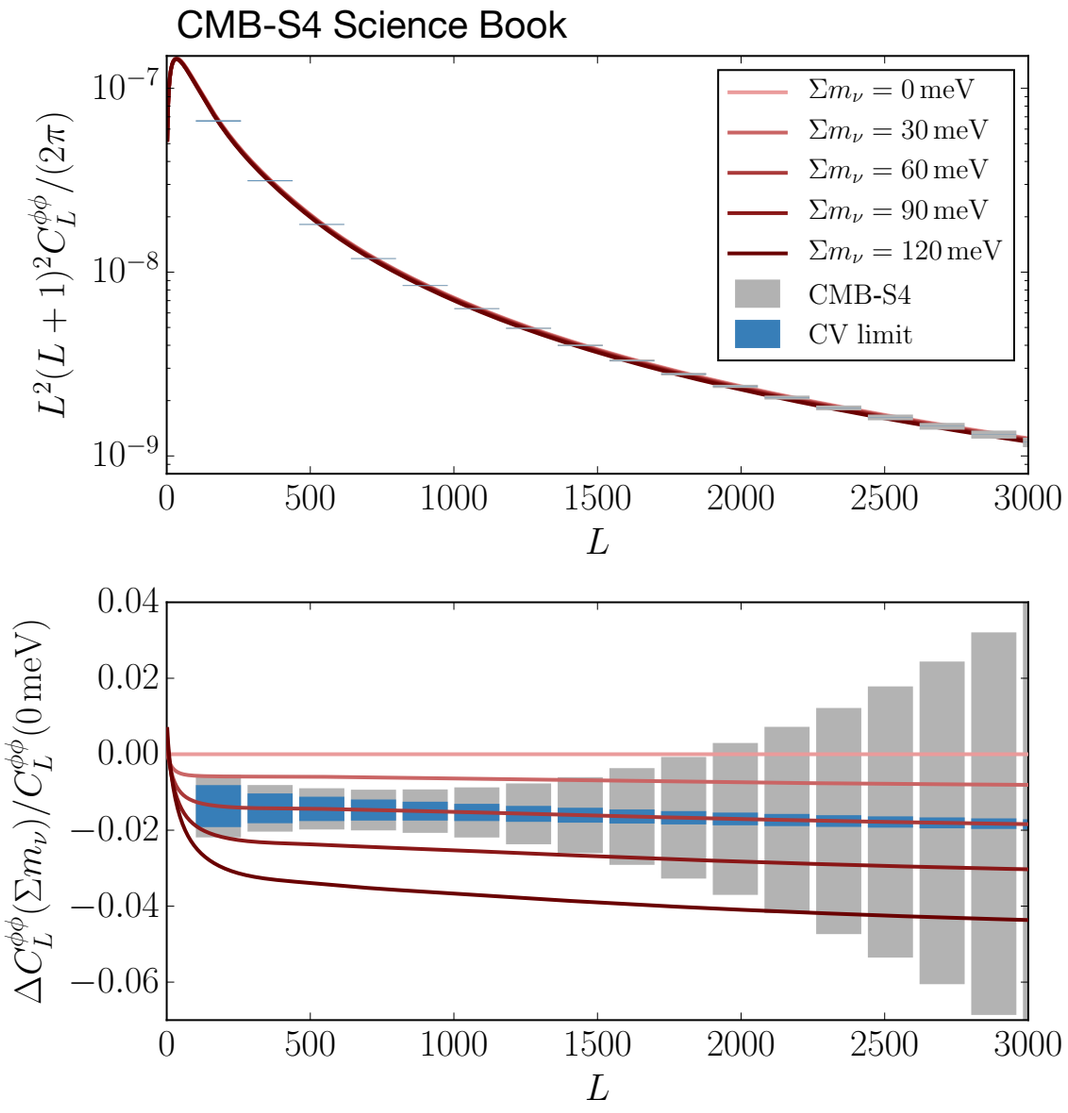

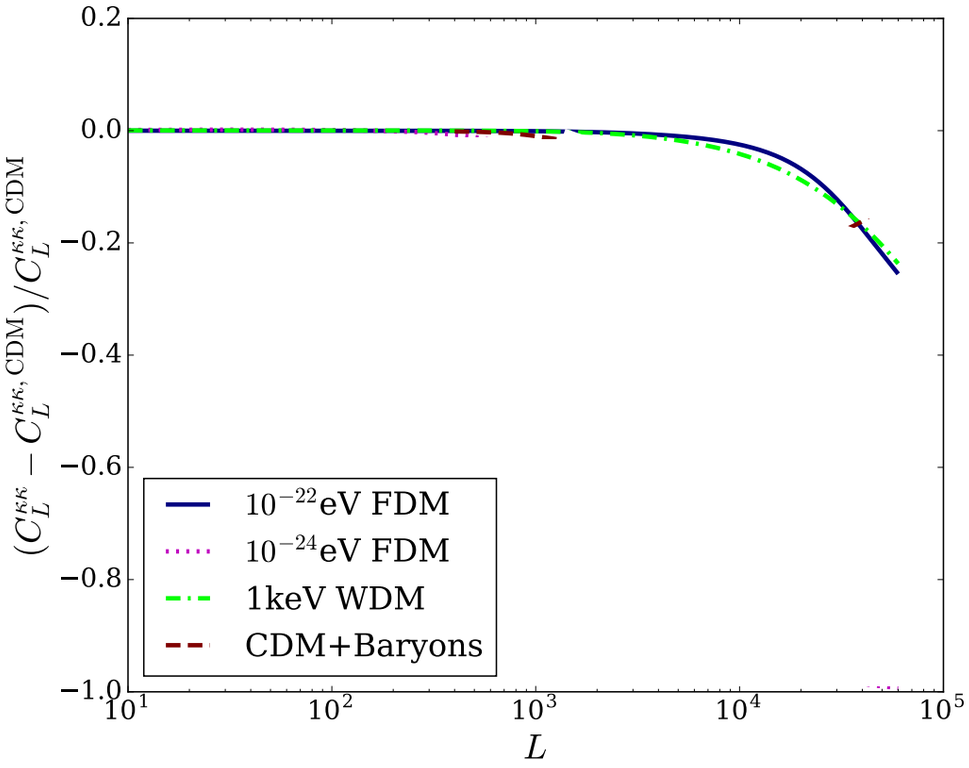

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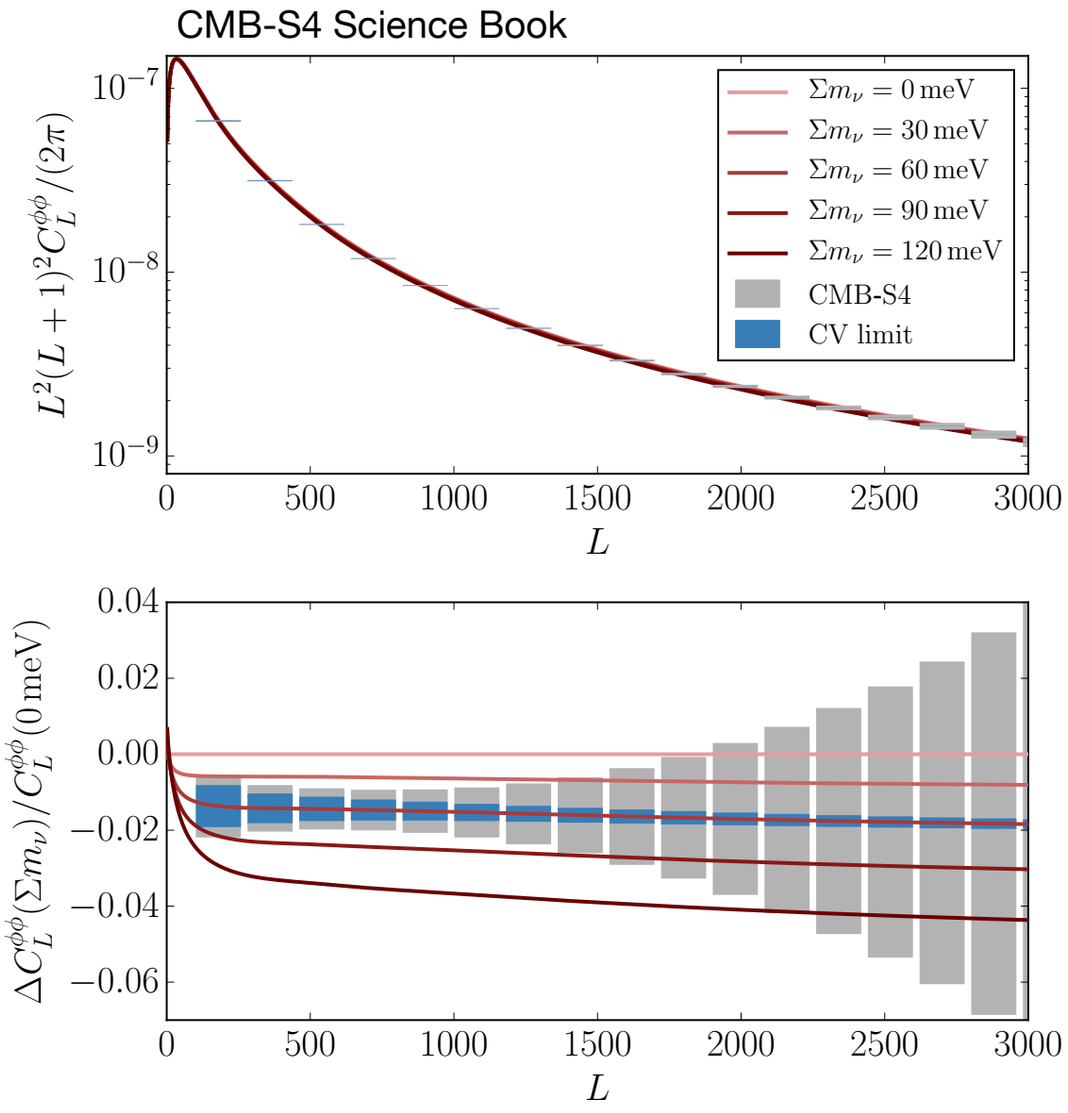

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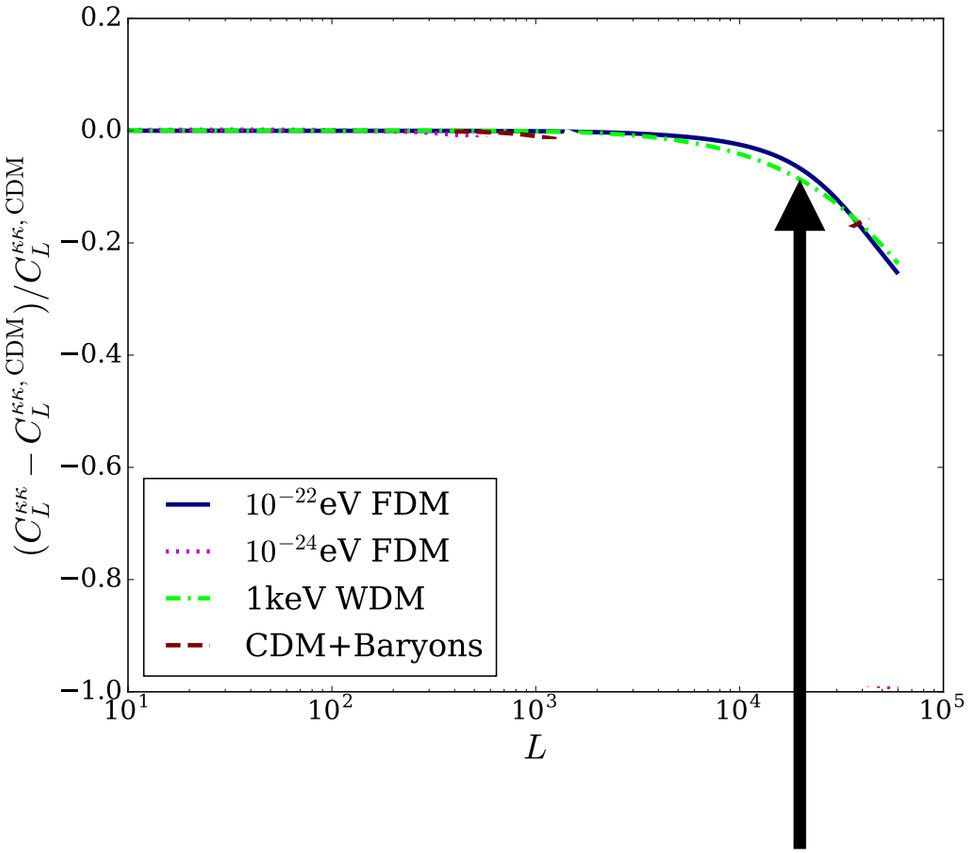

Alternative DM models of interest suppress power on much smaller scales

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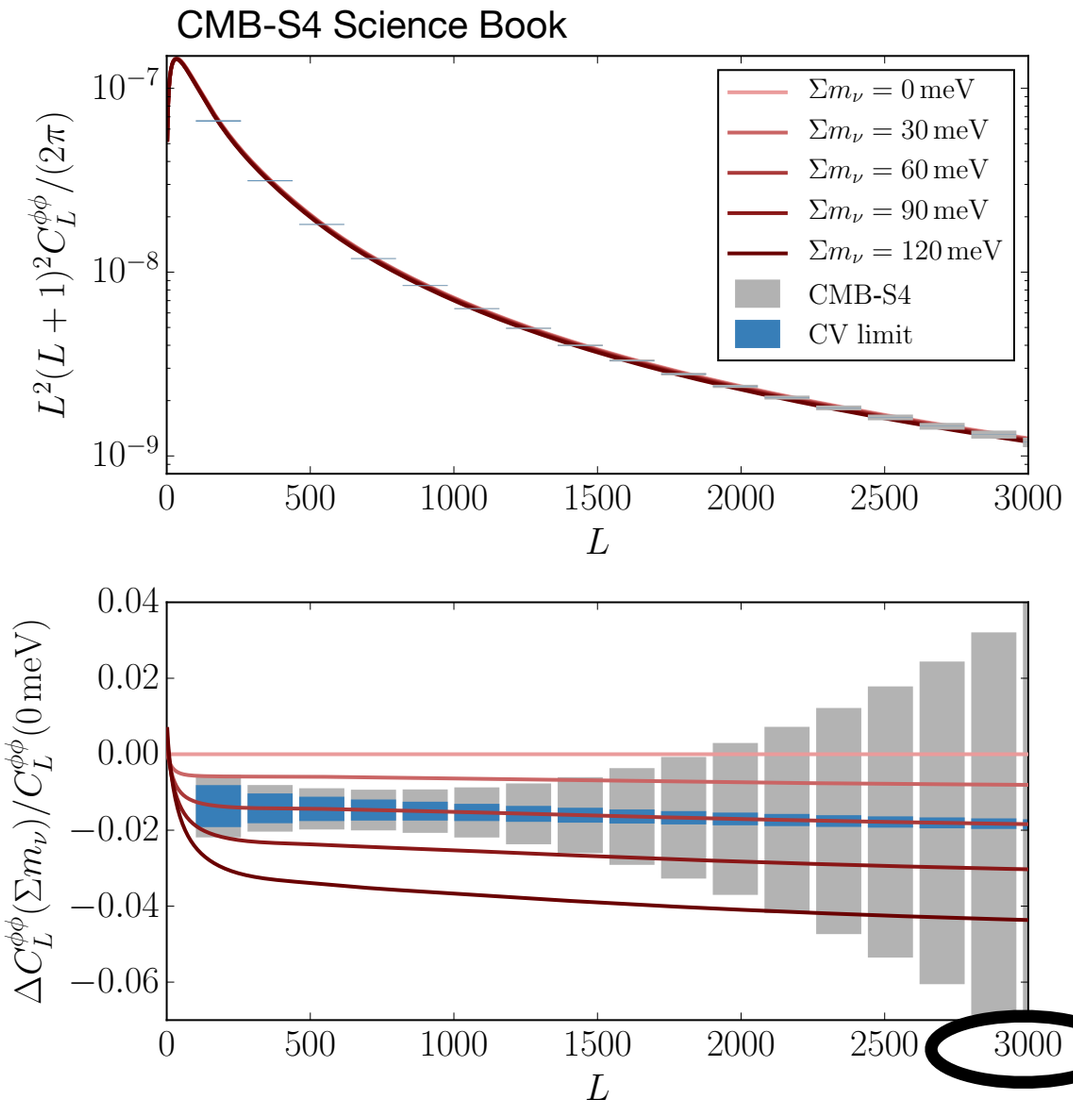

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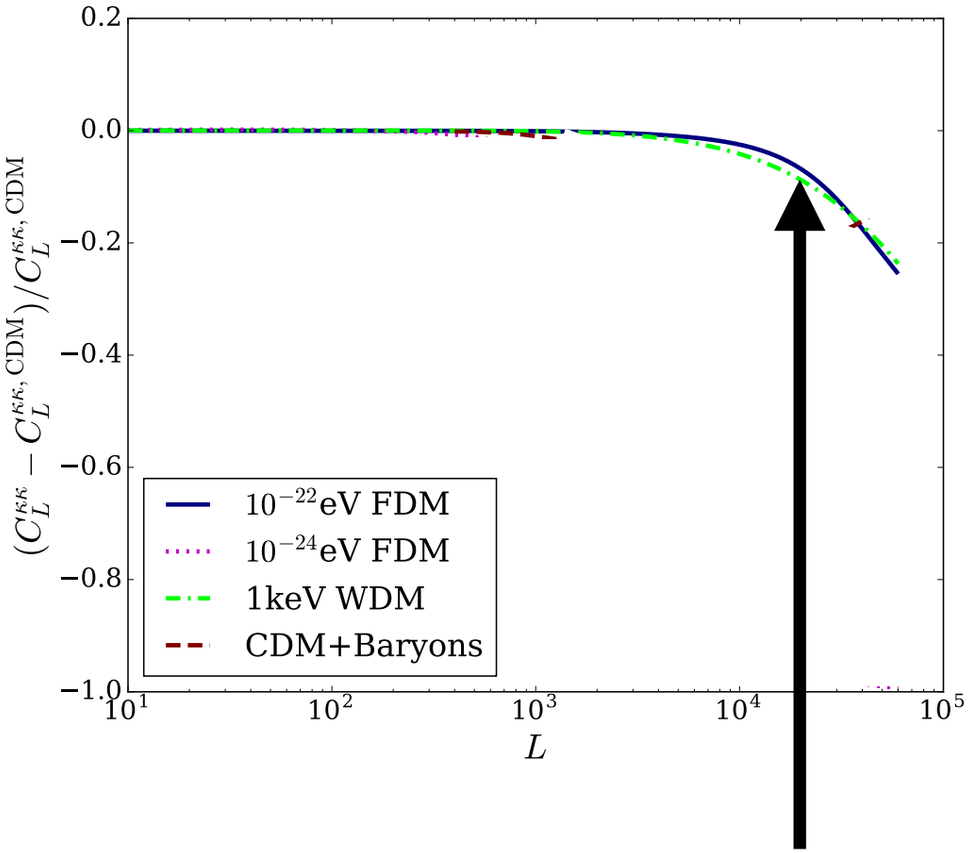

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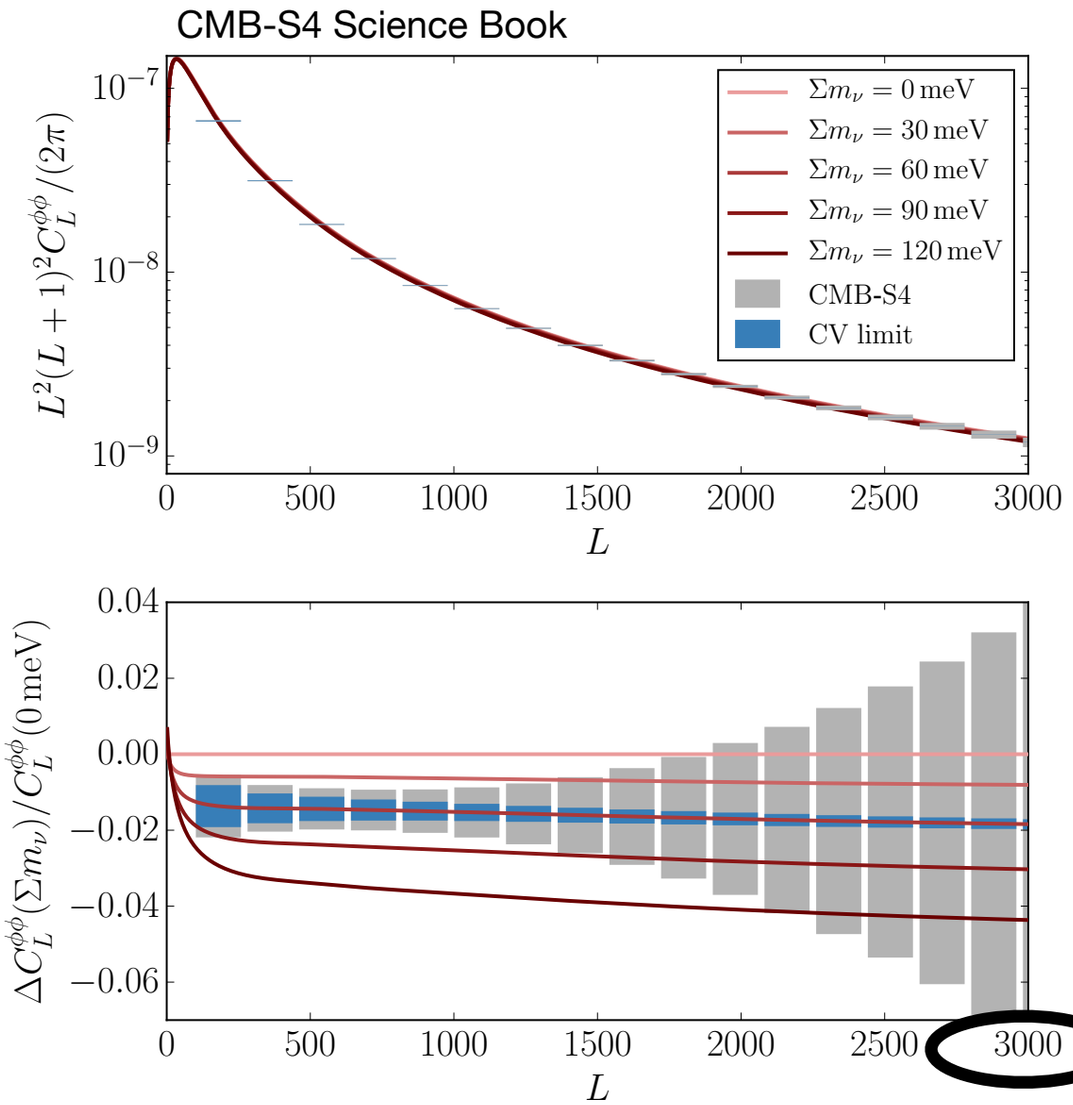

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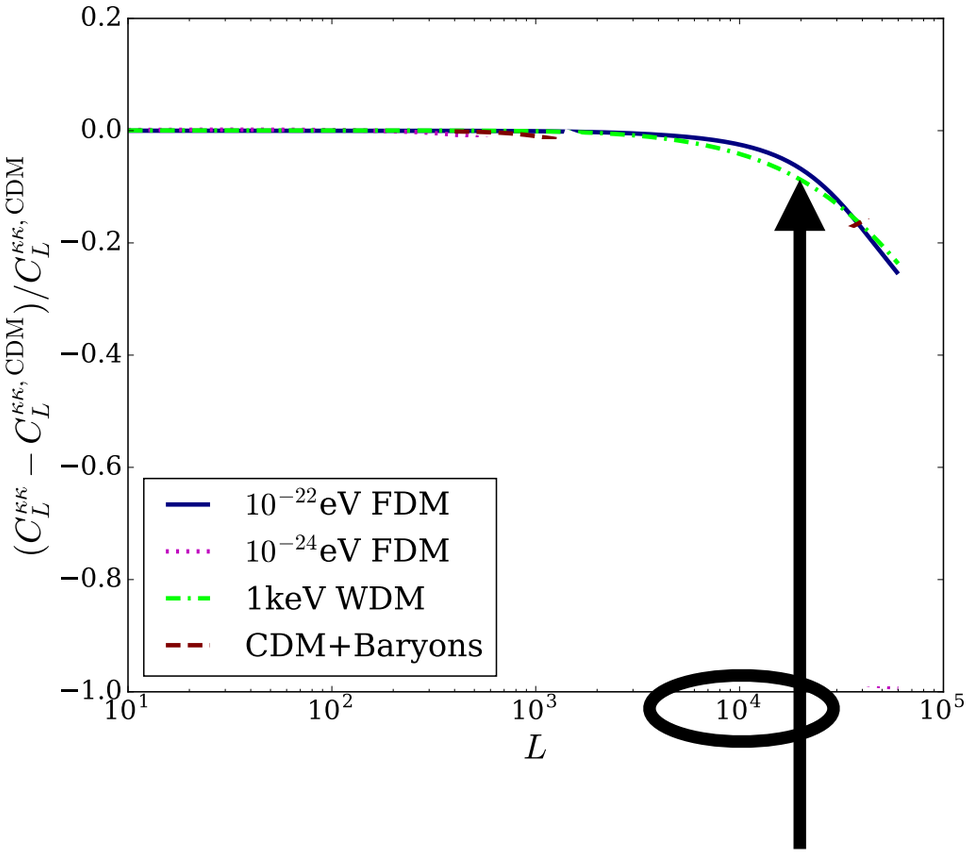

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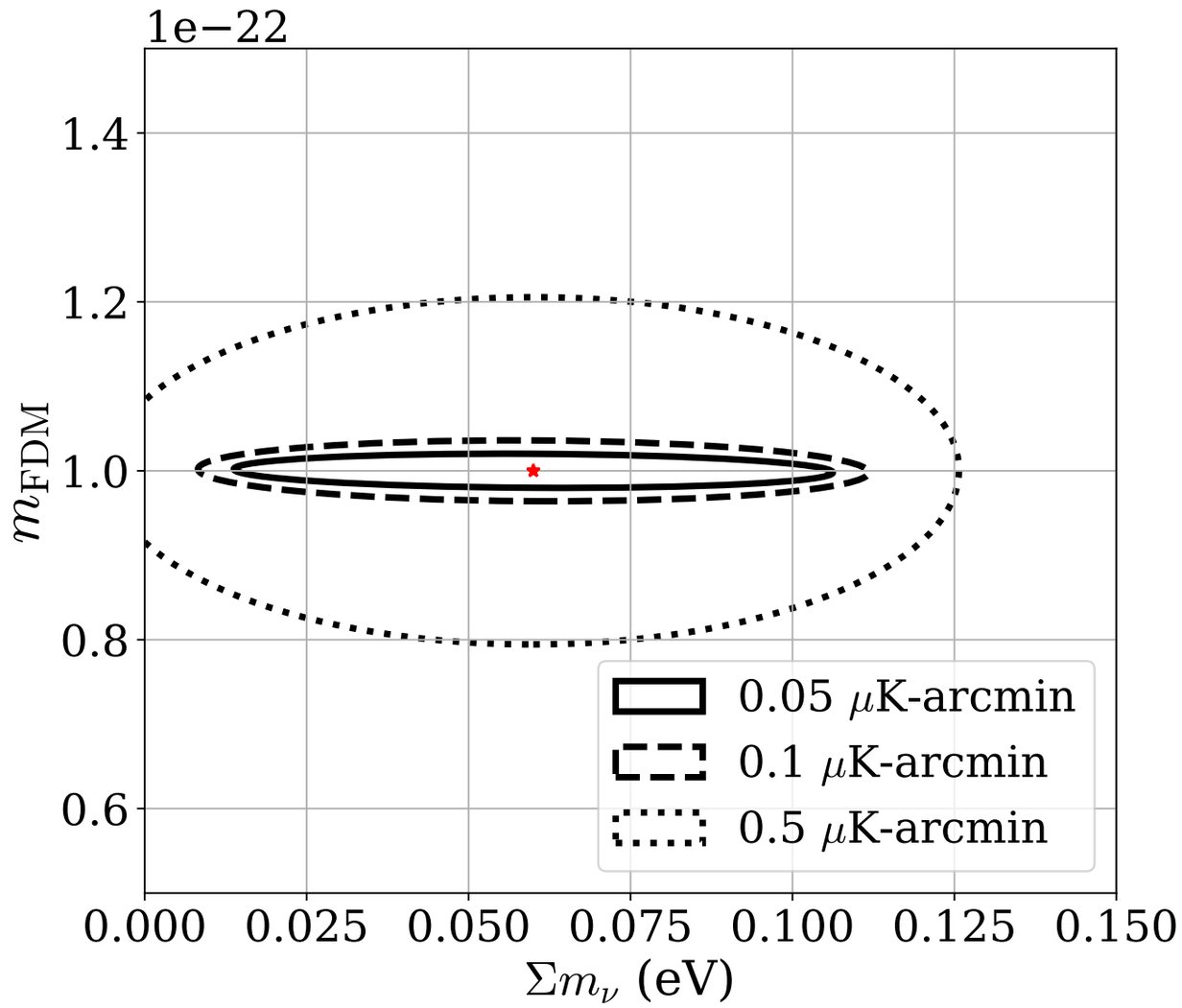

Neelima Sehgal, Stony Brook

Potential Advantage/Complementarity of CMB vs Optical Weak Lensing

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Small-scale matter power spectrum may also be measured by galaxy shear from optical surveys

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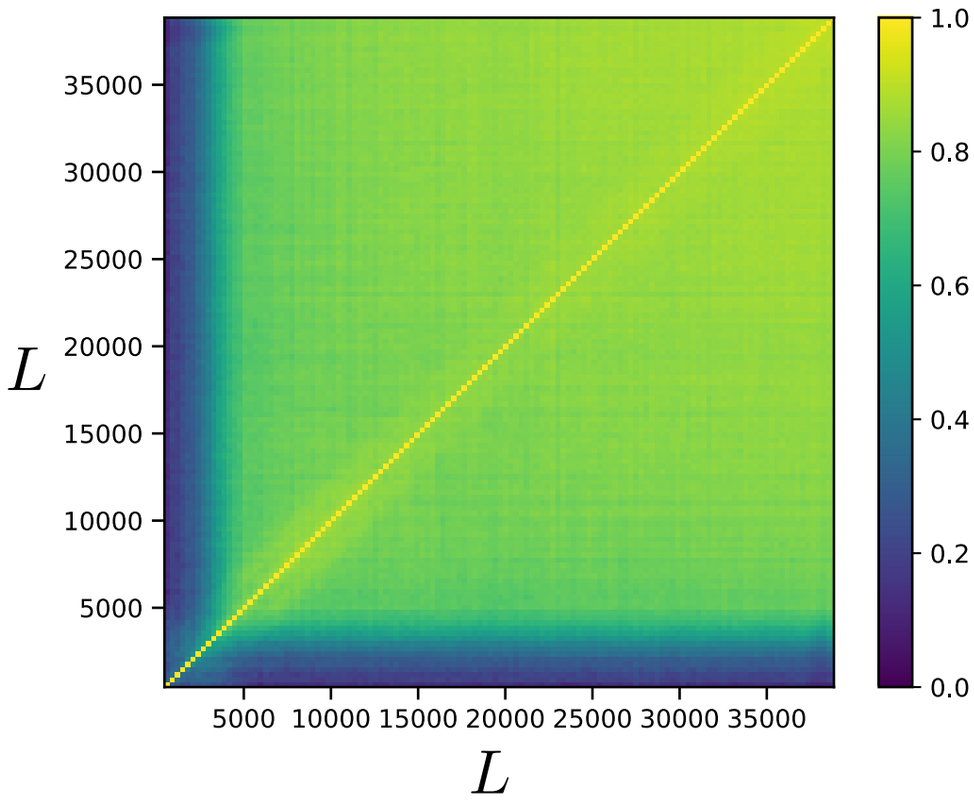

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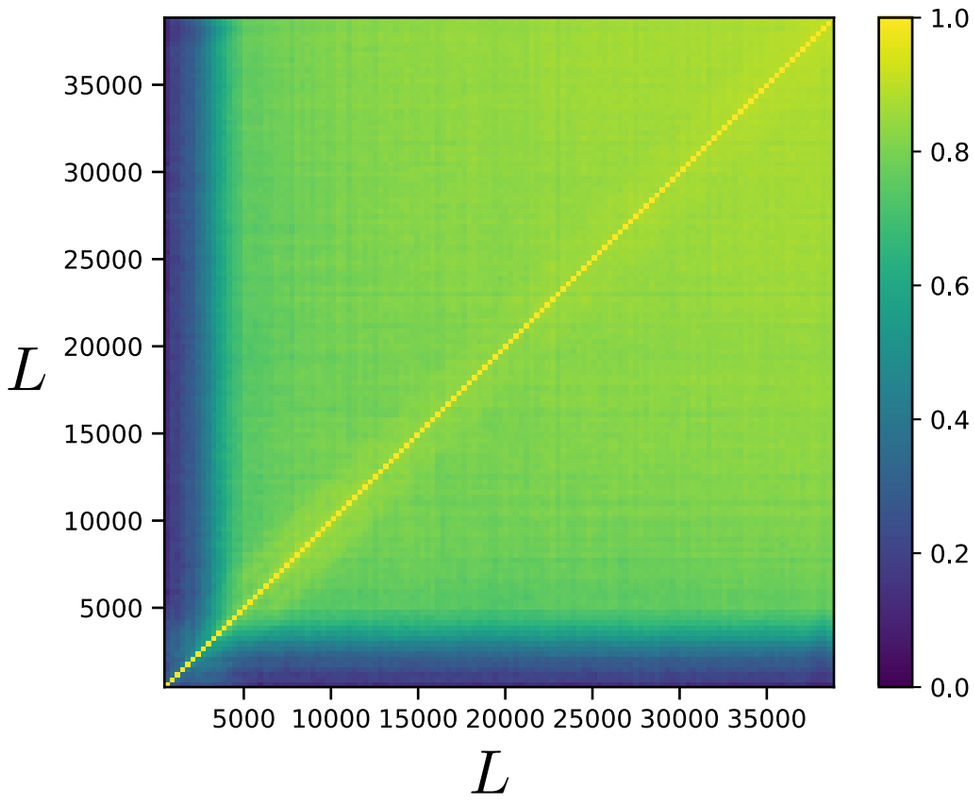

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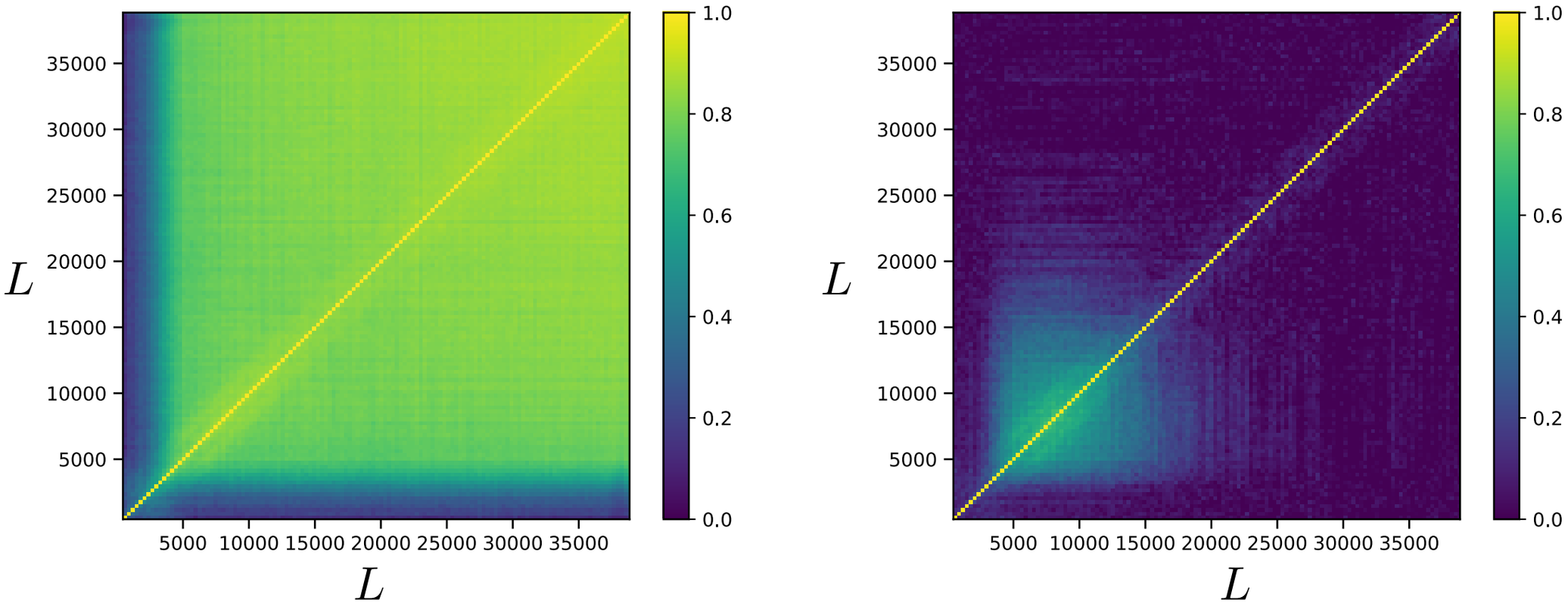

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New regime of CMB: tons of astrophysics, tSZ and kSZ science, and excellent synergy with optical surveys

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- Organizing workshop this fall at CCA to explore science case and instrumental feasibility for ultra high-res, low-noise CMB lensing survey - email me if you are interested