COSMOLOGICAL TESTS OF ULTRA-LIGHT AXIONS

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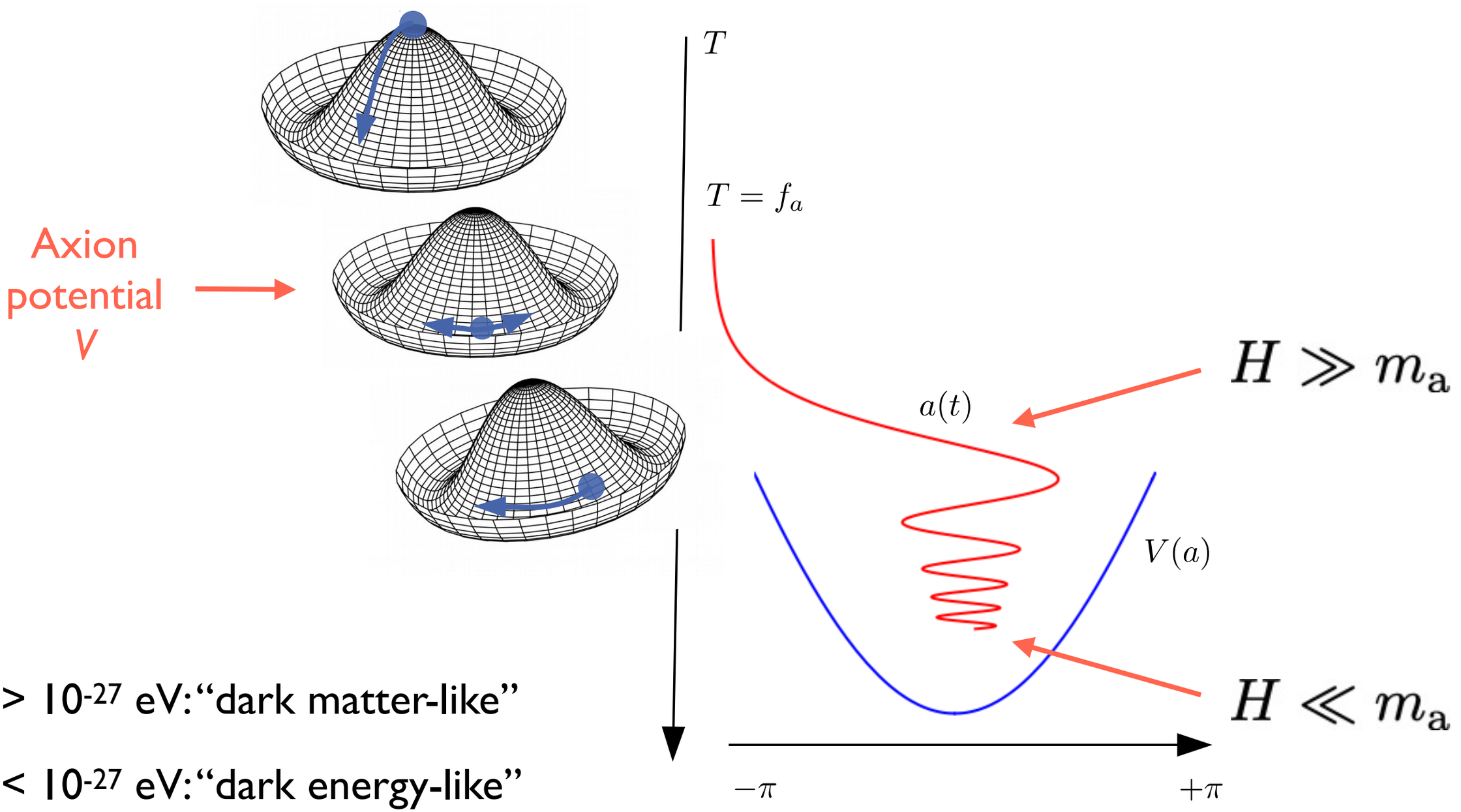
Axions are dark energy and dark matter candidates

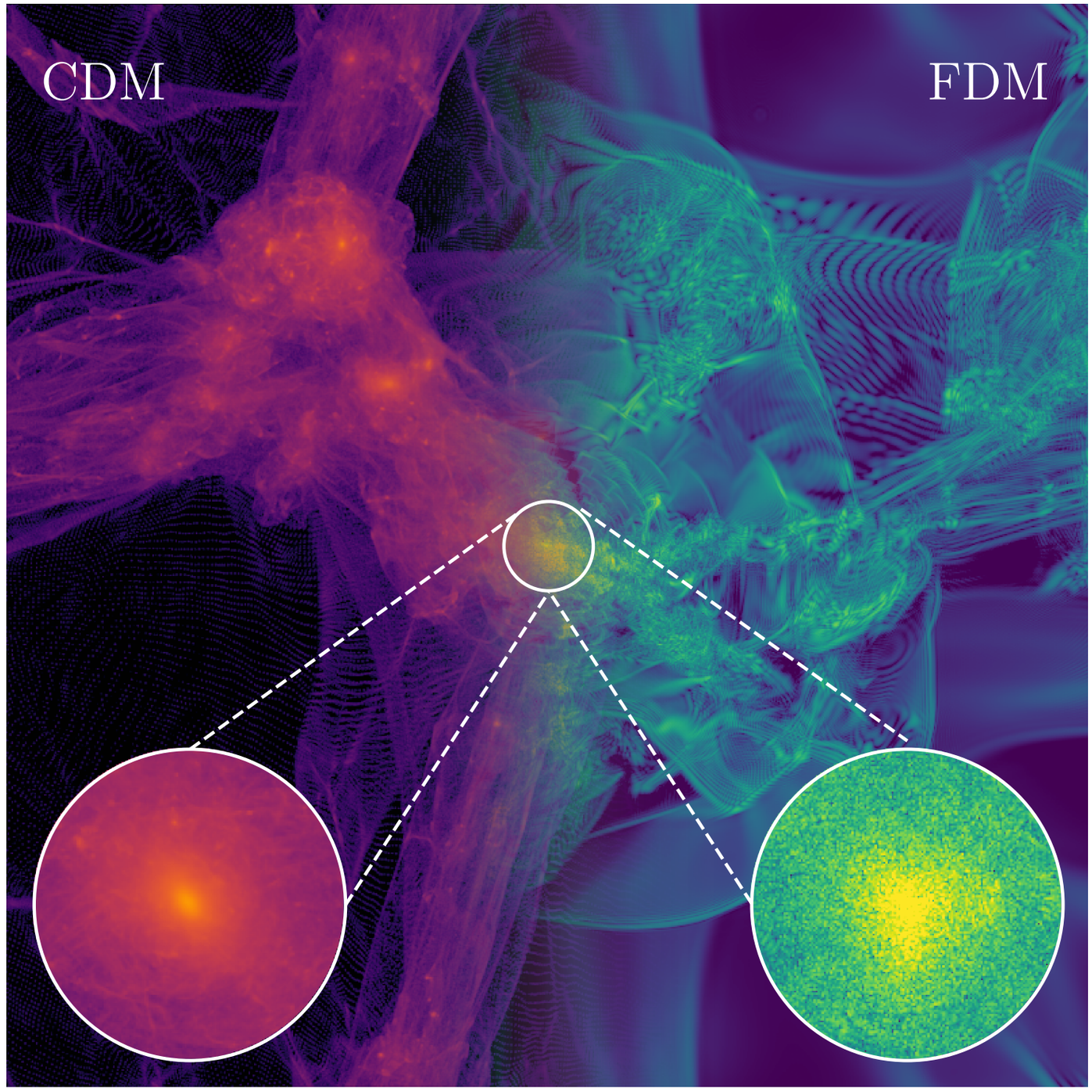


- $m_a > 10^{-27}$ eV: "dark matter-like"
- $m_a < 10^{-27}$ eV: "dark energy-like"
- $m_a = 10^{-33}$ eV: cosmological constant

Figure credit: Pargner (2019); Peccei & Quinn (1977); Weinberg (1978); Wilczek (1978)

Fuzzy axion dark matter forms interference fringes, halo cores and oscillating dark matter granules

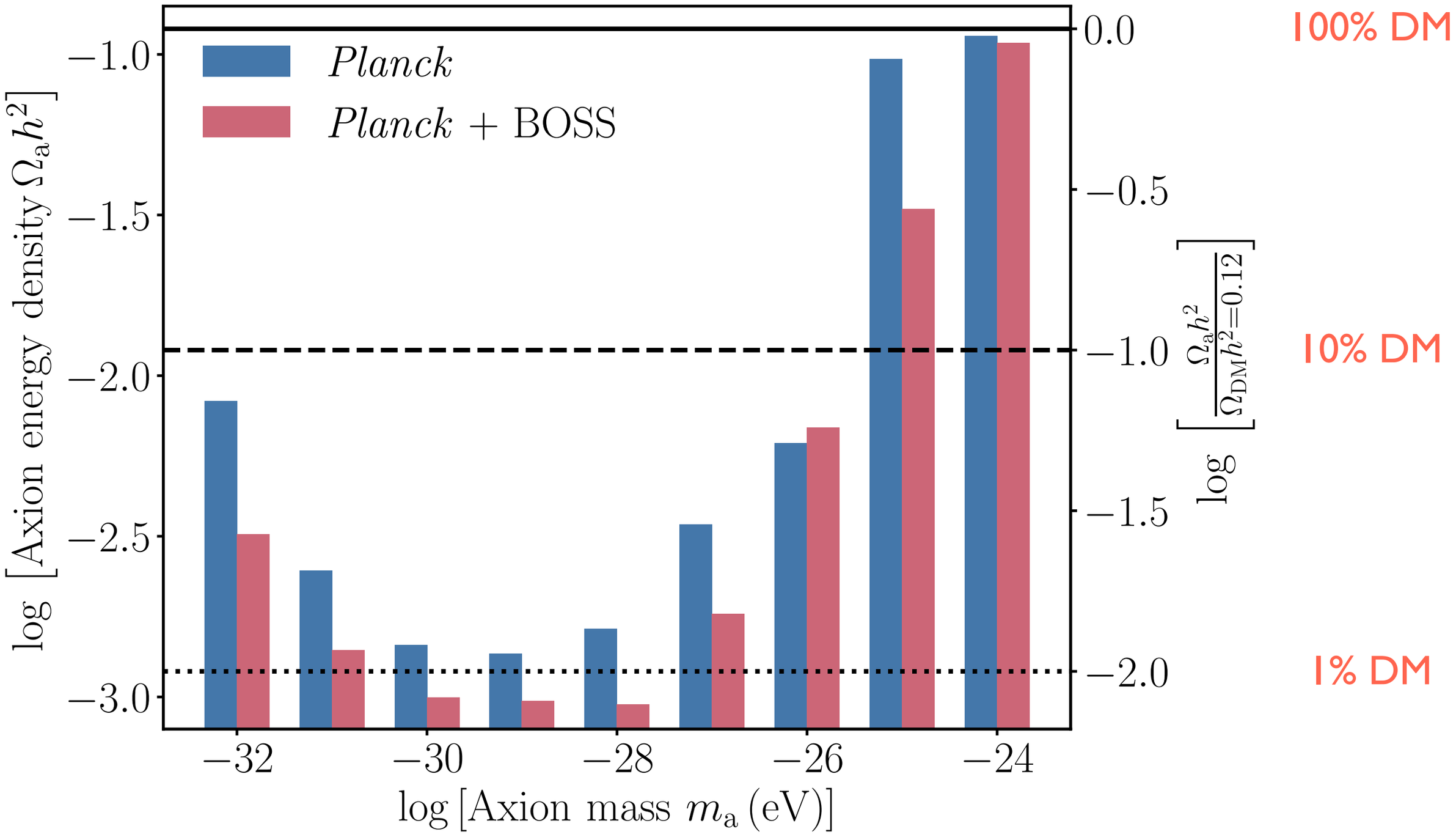
Dark matter density



$m_a = 10^{-22}$ eV
10% FDM
90% CDM

Schive et al. (2014); Mocz et al. (2019); Laguë, Schwabe, Hložek, Marsh, Rogers (PRD, 2024)

Linear and mildly non-linear cosmological constraints on axion dark matter



Rogers, Hložek, et al. (JCAP, 2023); ACT Collaboration et al. (inc. Hložek, Rogers; 2025)

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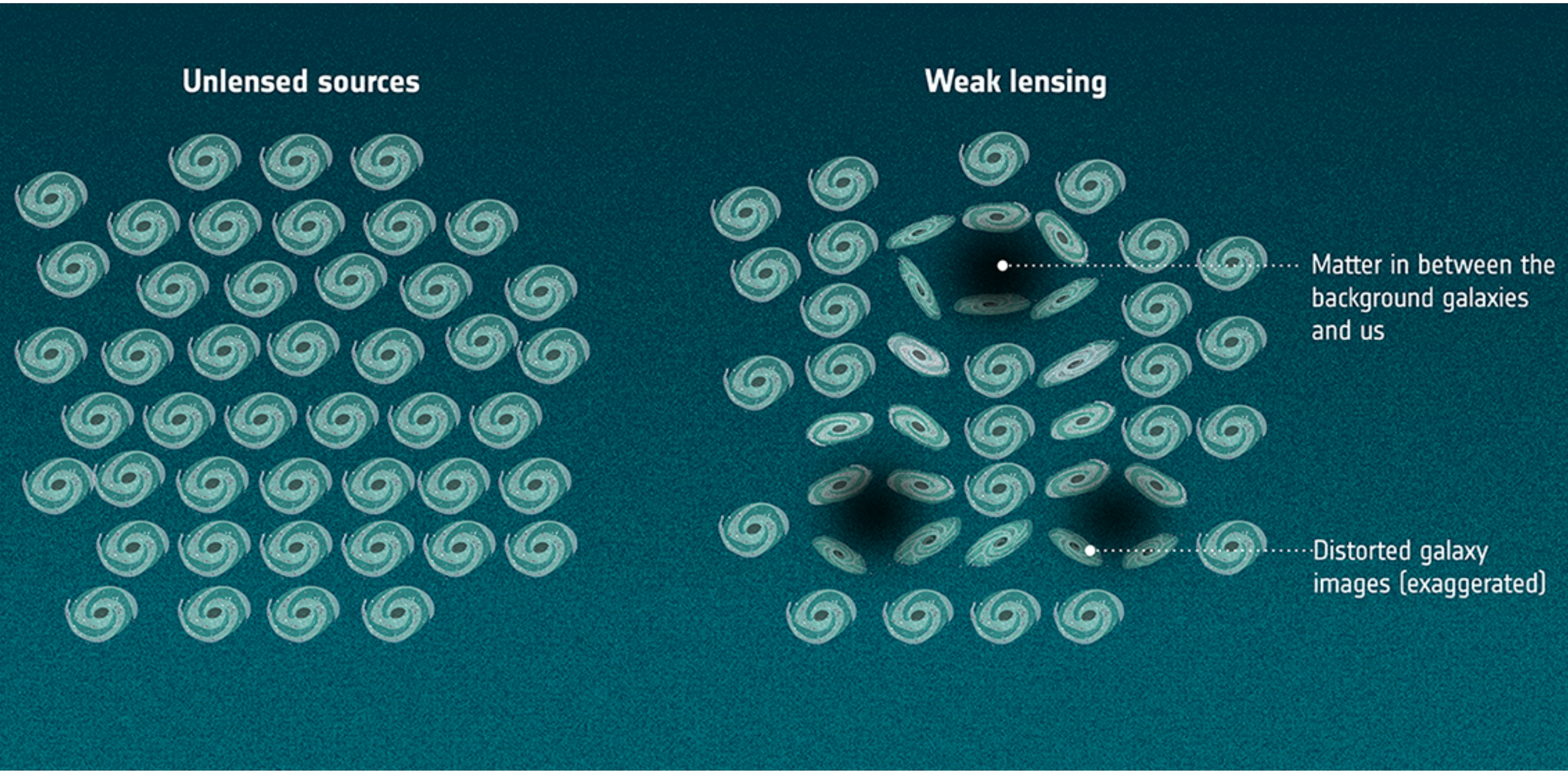
PROSPECTS FOR DISENTANGLING DARK MATTER WITH WEAK LENSING

arXiv: 2505.02233

with Calvin Preston, Alex Amon, George Efstathiou

Galaxy weak lensing traces dark matter distribution



Rubin Observatory's *Legacy Survey of Space and Time* will image 20 billion galaxies

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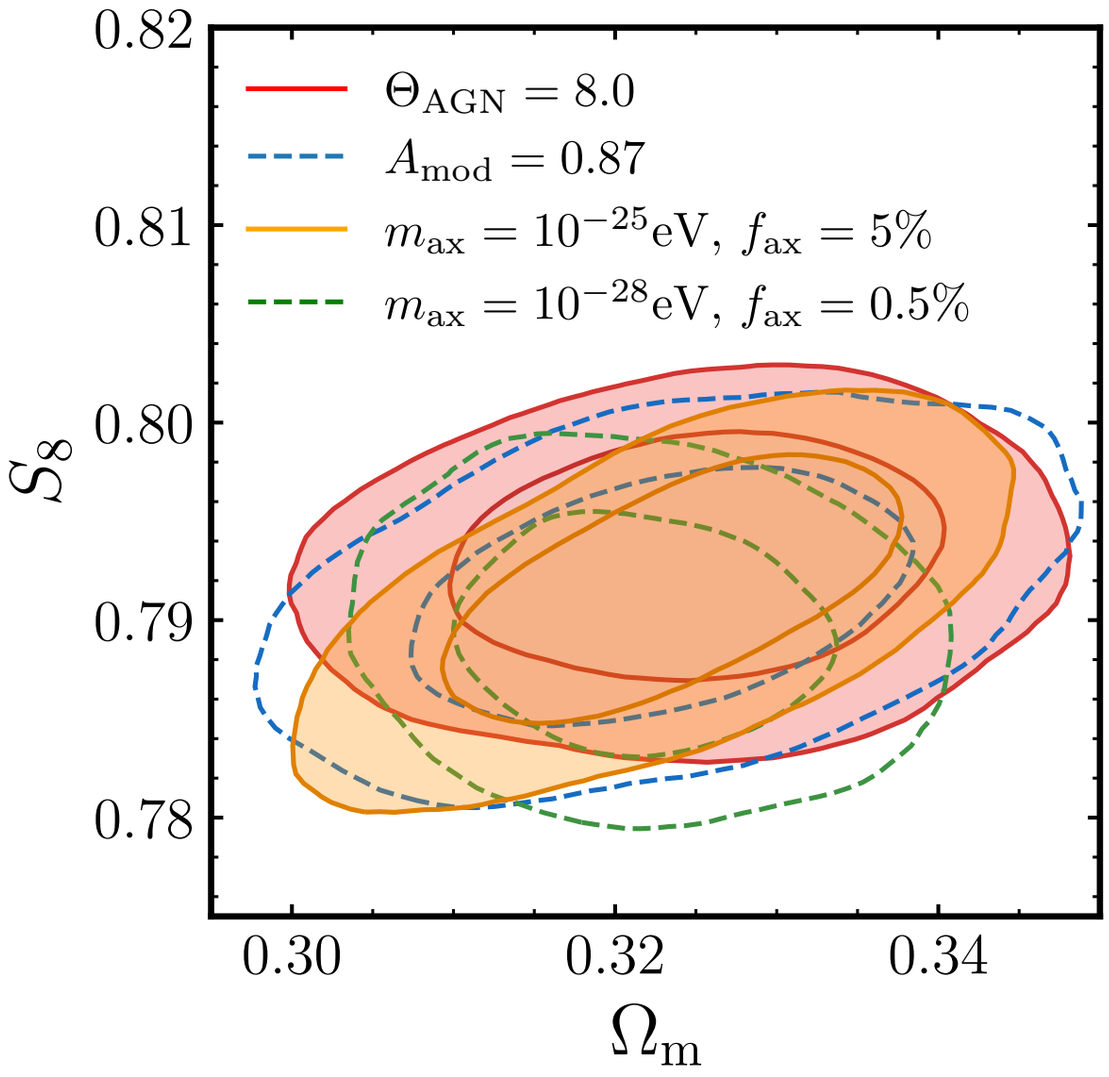
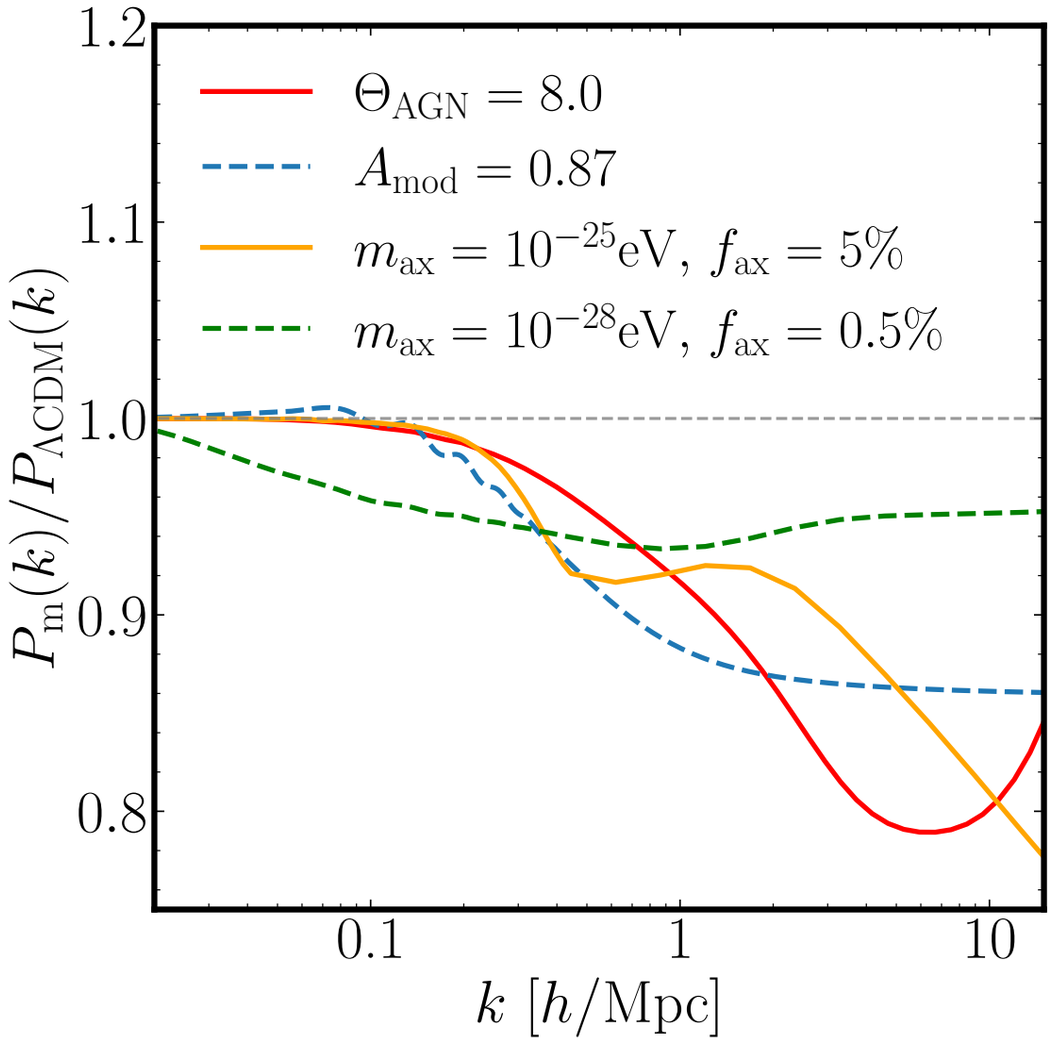
Axions and feedback indistinguishable in S_8 — is weak lensing sensitive to DM transfer function?

S_8 - Ω_m (LSST Y1 forecast)

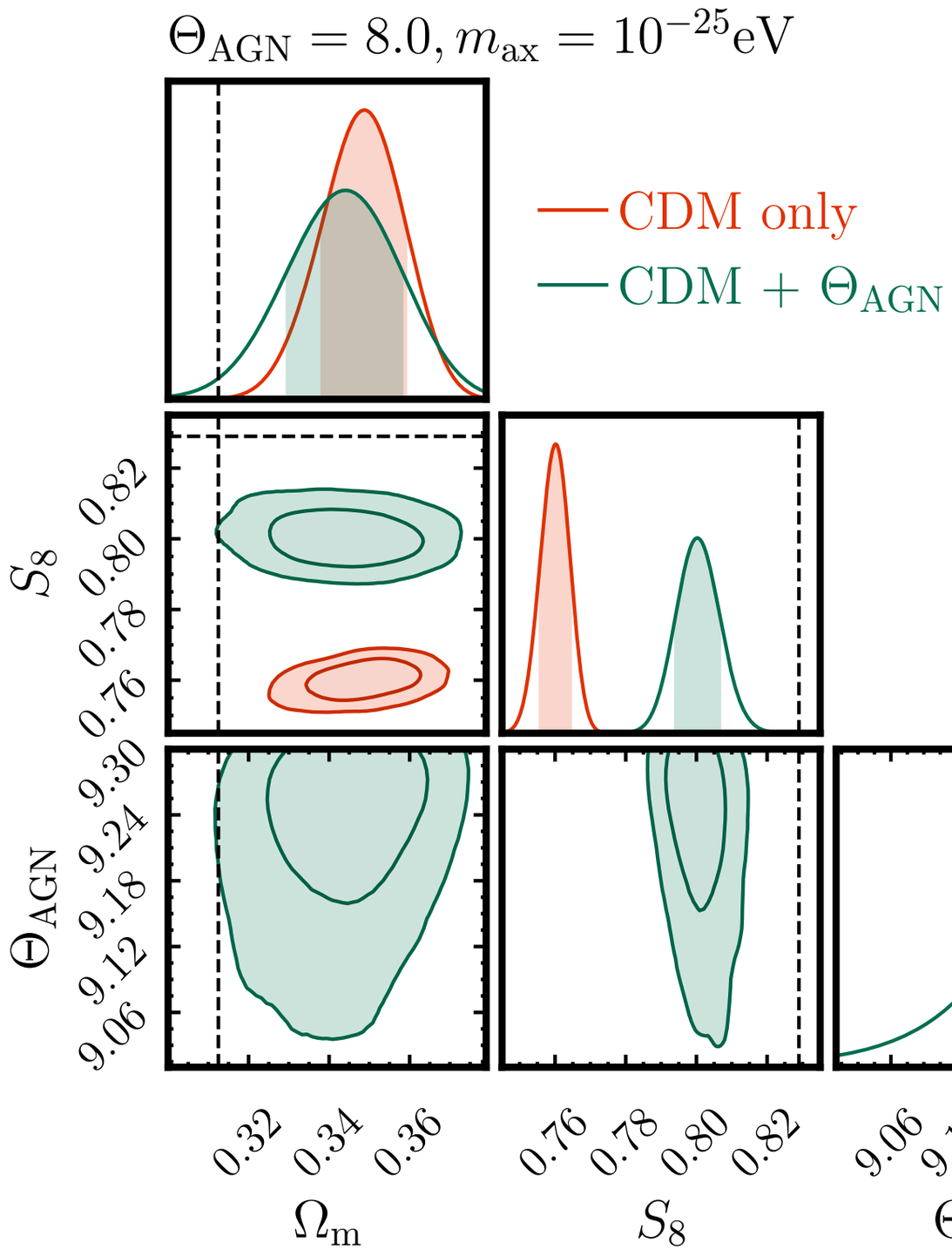


Non-linear transfer function



Preston, Rogers, Amon & Efstathiou (arXiv: 2505.02233)

The effect of ignoring axions in LSST Y1 if they exist

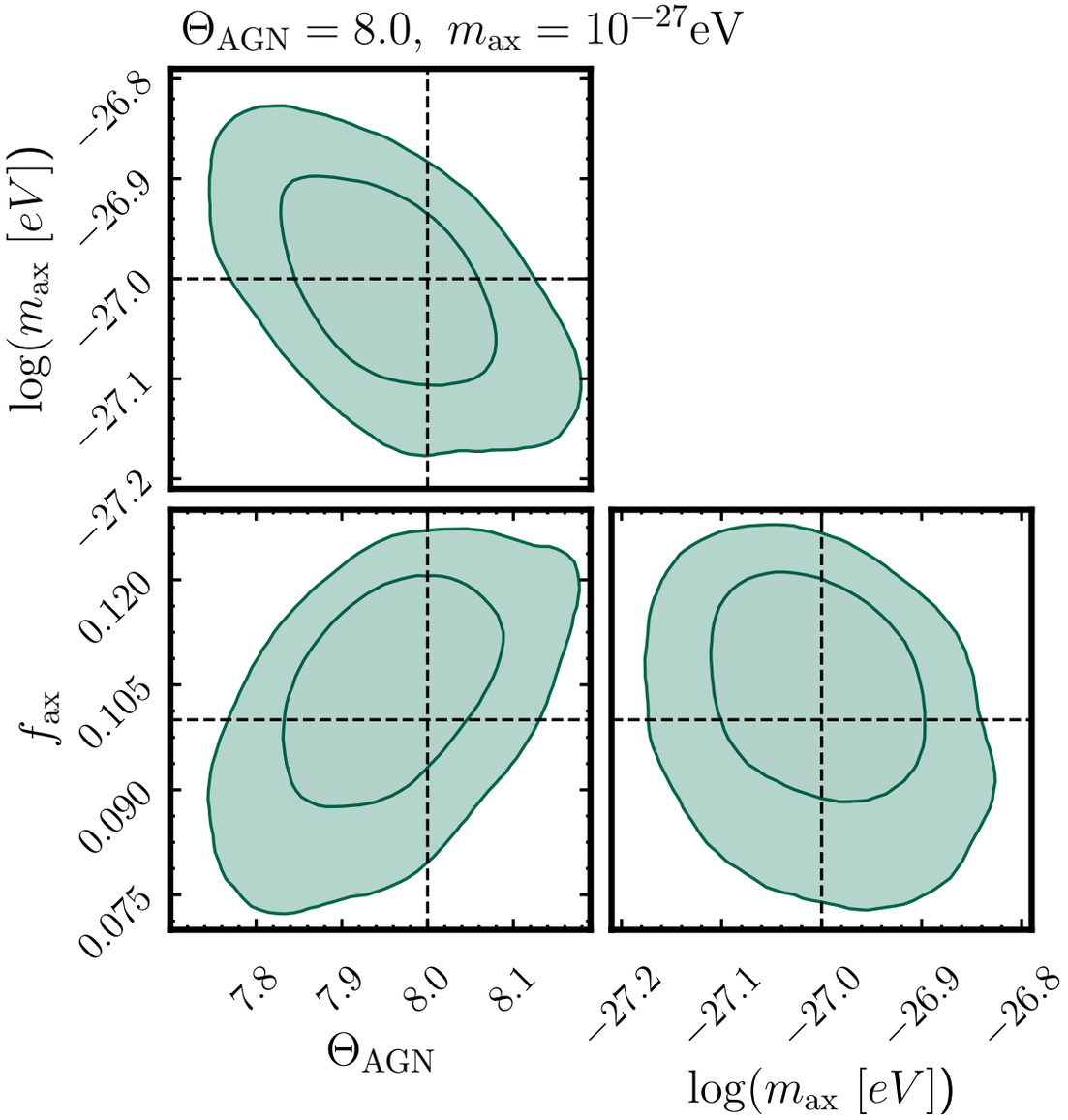


Axions cause "S_8 tension" ⇒

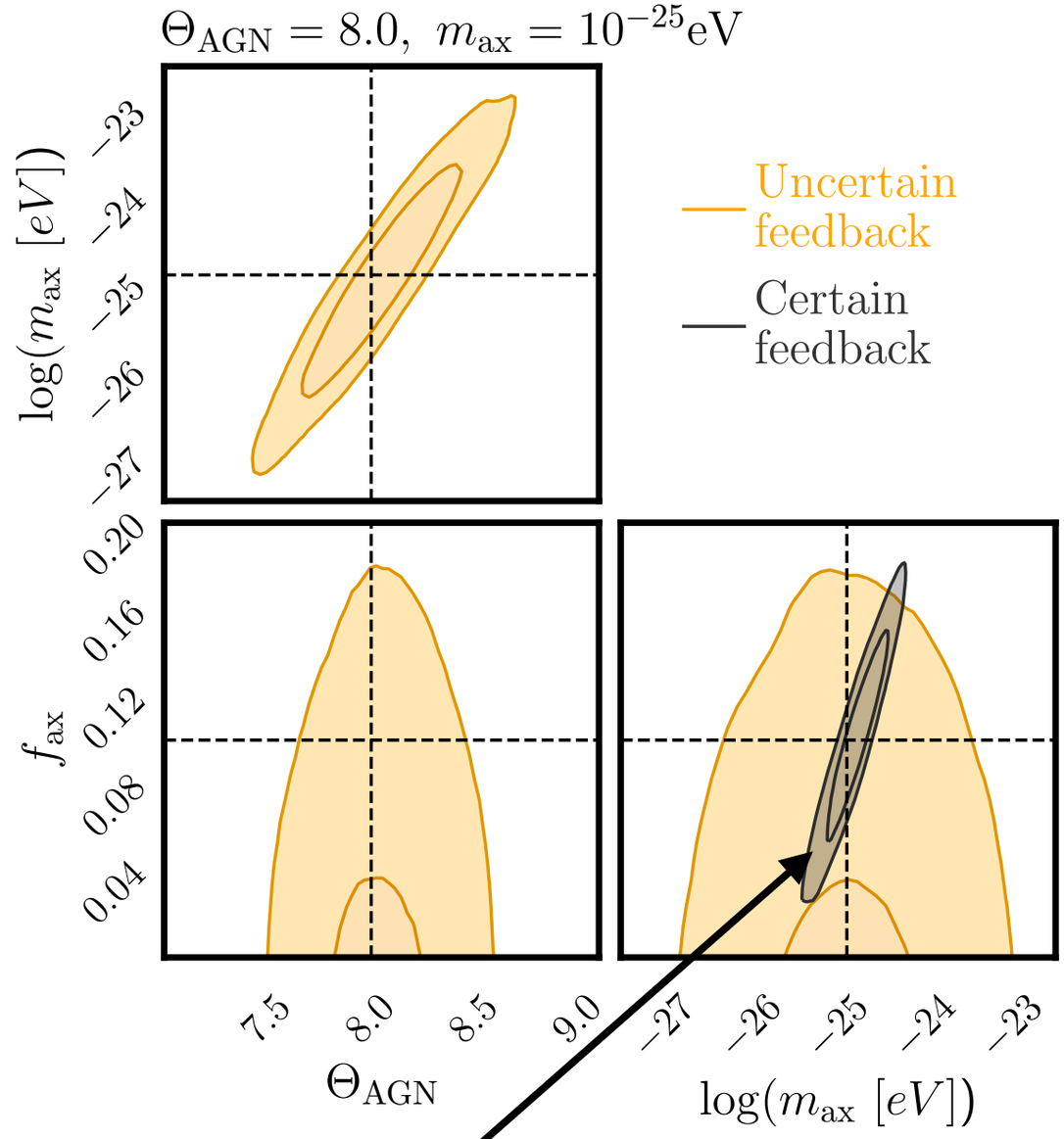
Literature using "S_8 prior" is wrong

Rogers, Hložek, et al. (JCAP, 2023); Preston, Rogers, Amon & Efstathiou (arXiv: 2505.02233)

LSST Y1 can detect DE-like axions



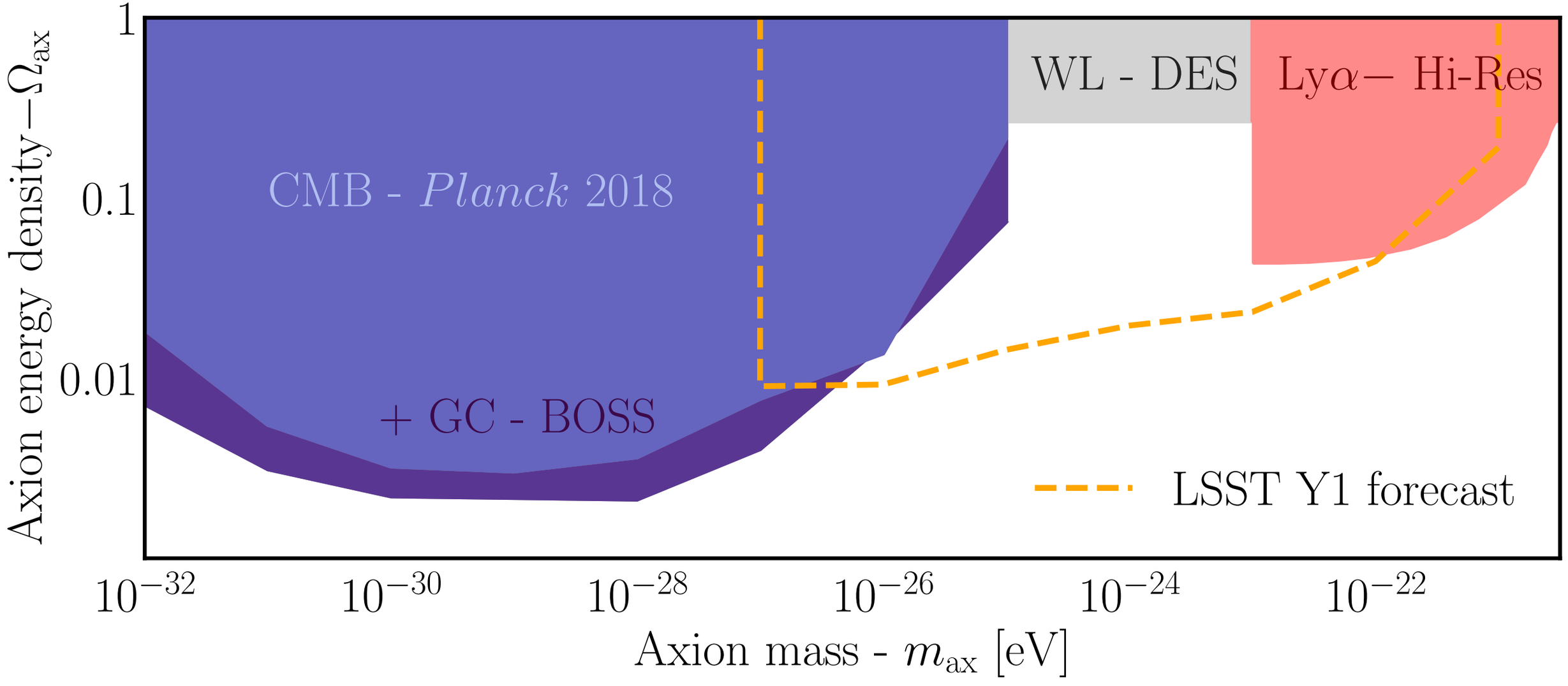
LSST Y1 can strongly limit DM-like axions



LSST Y1 can detect DM-like axions with feedback prior (e.g., CMB Sunyaev-Zeldovich effect)

Preston, Rogers, Amon & Efstathiou (arXiv: 2505.02233)

LSST Y1 weak lensing as a dark matter probe: strongest limits & discovery potential



Kobayashi+ (2017); Rogers+ (2021); Dentler+ (inc. Rogers, 2022); Preston, Rogers+ (2025)

Summary

- Ultralight axions < 10^{-26} eV can't be > 10% dark matter (CMB/galaxy power)

- *Rubin* LSST weak lensing will set strongest axion limits < 10^{-22} eV

- 3 sigma detection with external feedback information and better sims