SEARCHING FOR ULTRA-LIGHT AXION DARK MATTER IN BOSS GALAXY CLUSTERING & IMPLICATIONS FOR THE S_8 TENSION

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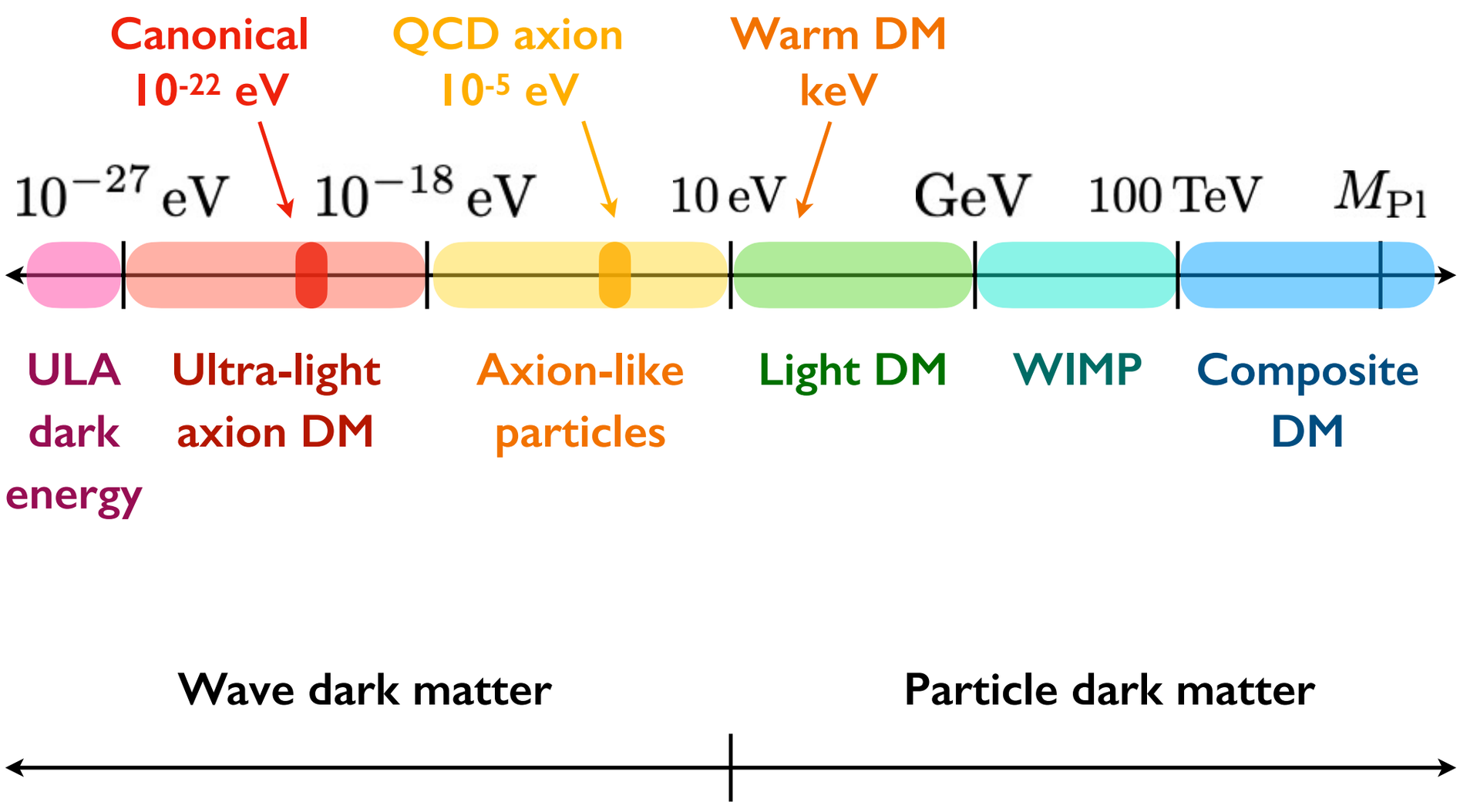
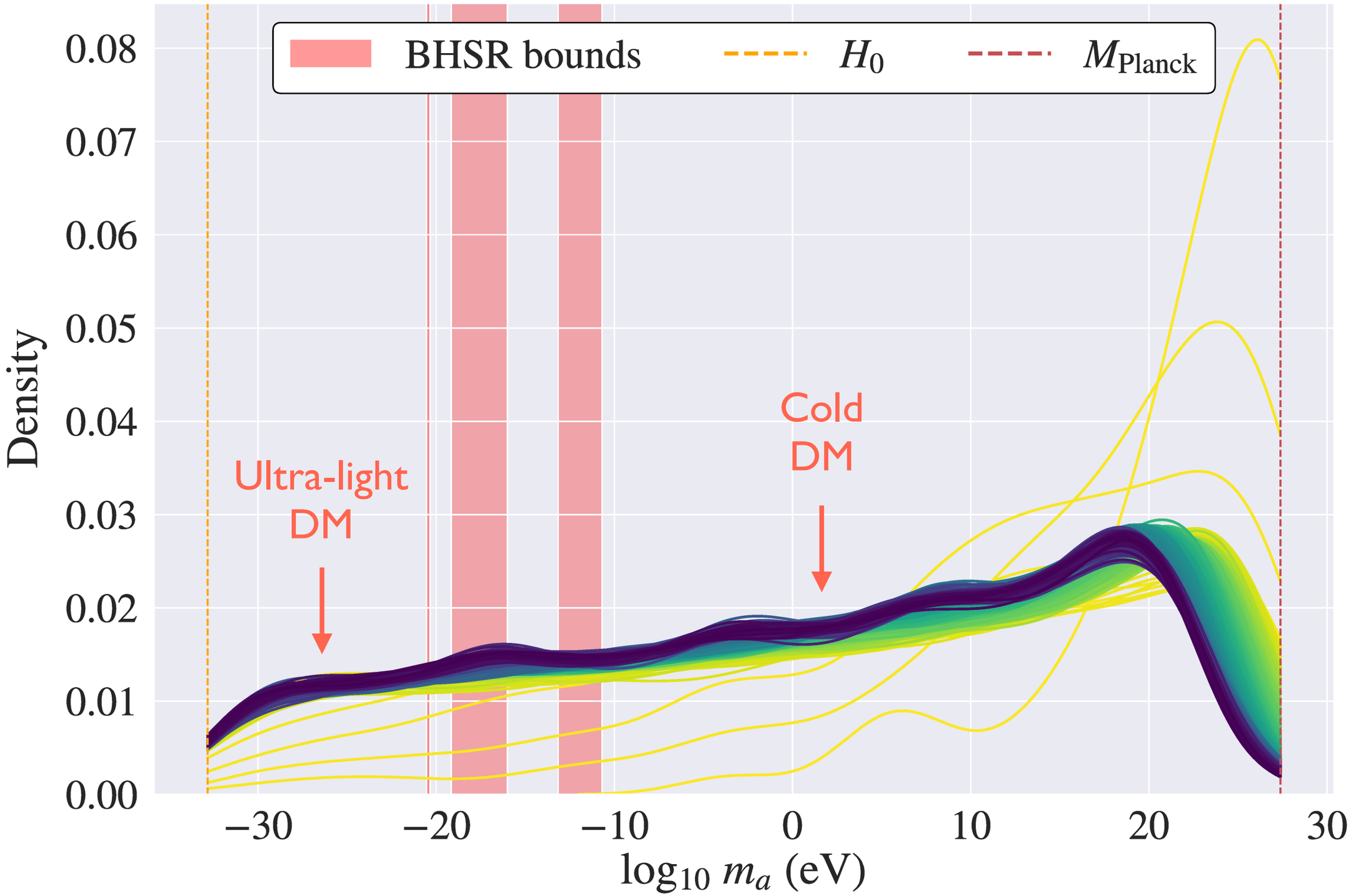
Beyond the WIMP: dark matter model space



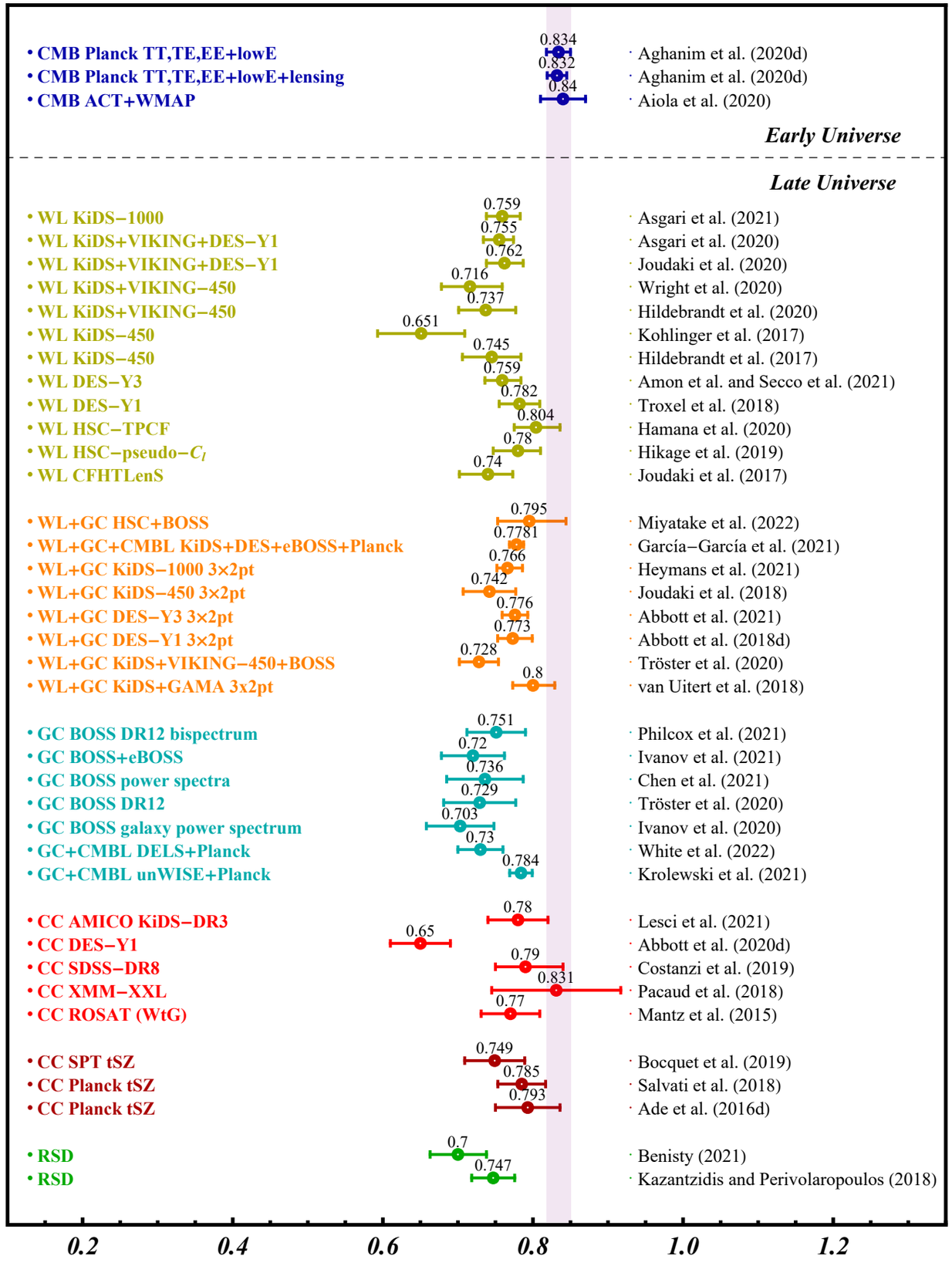
Canonical ULA DM: Rogers & Peiris (2021, PRL); *Light particle DM*: Rogers et al. (2022, PRL)

String axiverse predicts mixed cold + ultra-light axion dark matter



Mehta et al. (2021)

Larger scales



Smaller scales

S_8 tension

$$S_8 \equiv \sigma_8 \sqrt{\frac{\Omega_m}{0.3}}$$

S_8 ~ variance of matter clustering at 8 Mpc

Abdalla et al. (Snowmass 2022)

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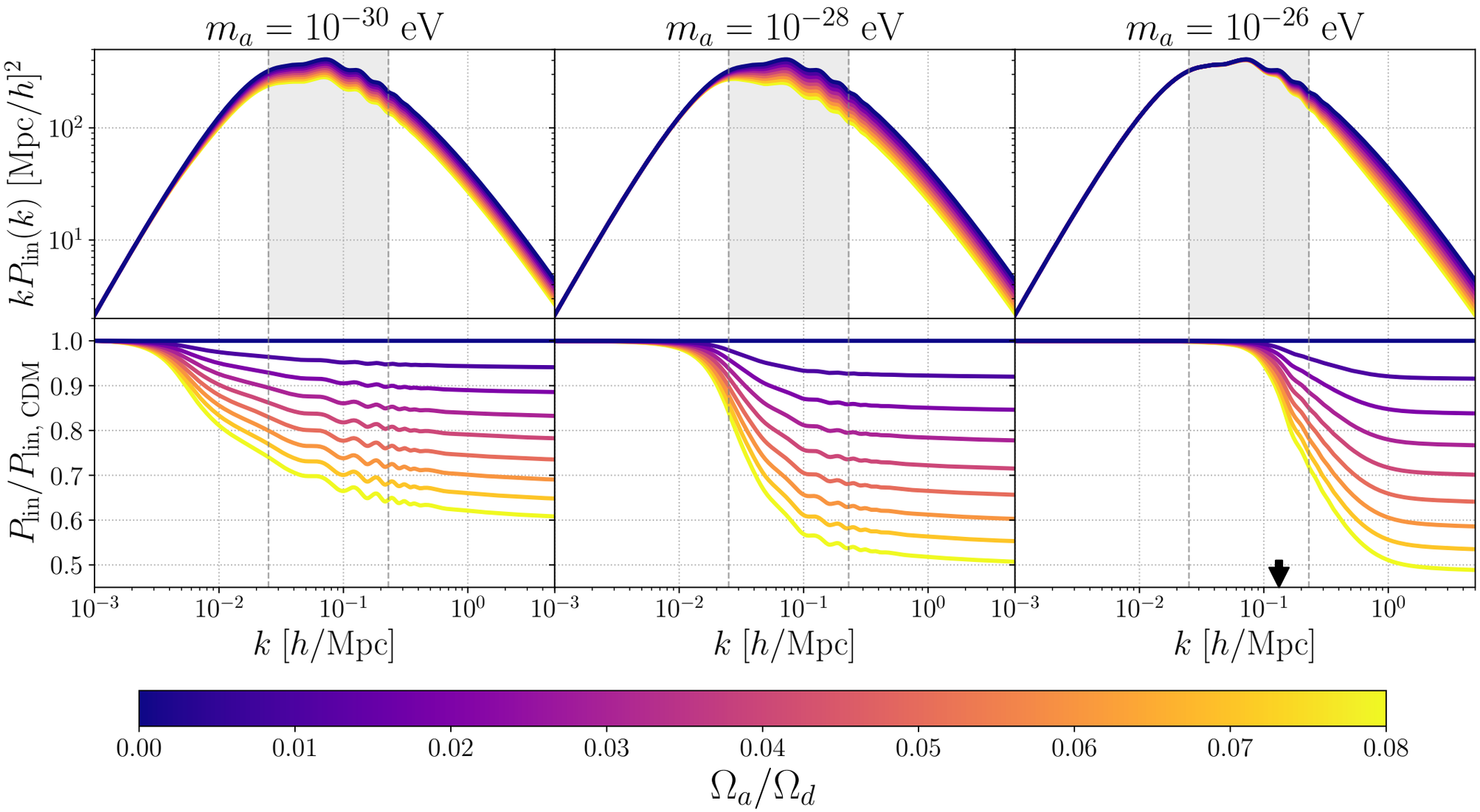
ULTRA-LIGHT AXION DARK MATTER & IMPLICATIONS FOR THE S_8 TENSION

with Hložek, Laguë, Bond, Marsh, Grin, Dentler, Philcox, Ivanov, Cabass, Akitsu

Ultra-light axion dark matter causes scale-dependent suppression in matter clustering

$$\lambda_{\rm Jeans} = 9.4\,(1+z)^{\frac{1}{4}} \left(\frac{\Omega_{\rm a} h^2}{0.12}\right)^{-\frac{1}{4}} \left(\frac{m}{10^{-26}\,{\rm eV}}\right)^{-\frac{1}{2}} {\rm Mpc}$$



Laguë, Bond, Hložek, Rogers, Marsh, Grin (2022)

Model galaxy clustering into mildly non-linear regime with effective field theory of large-scale structure

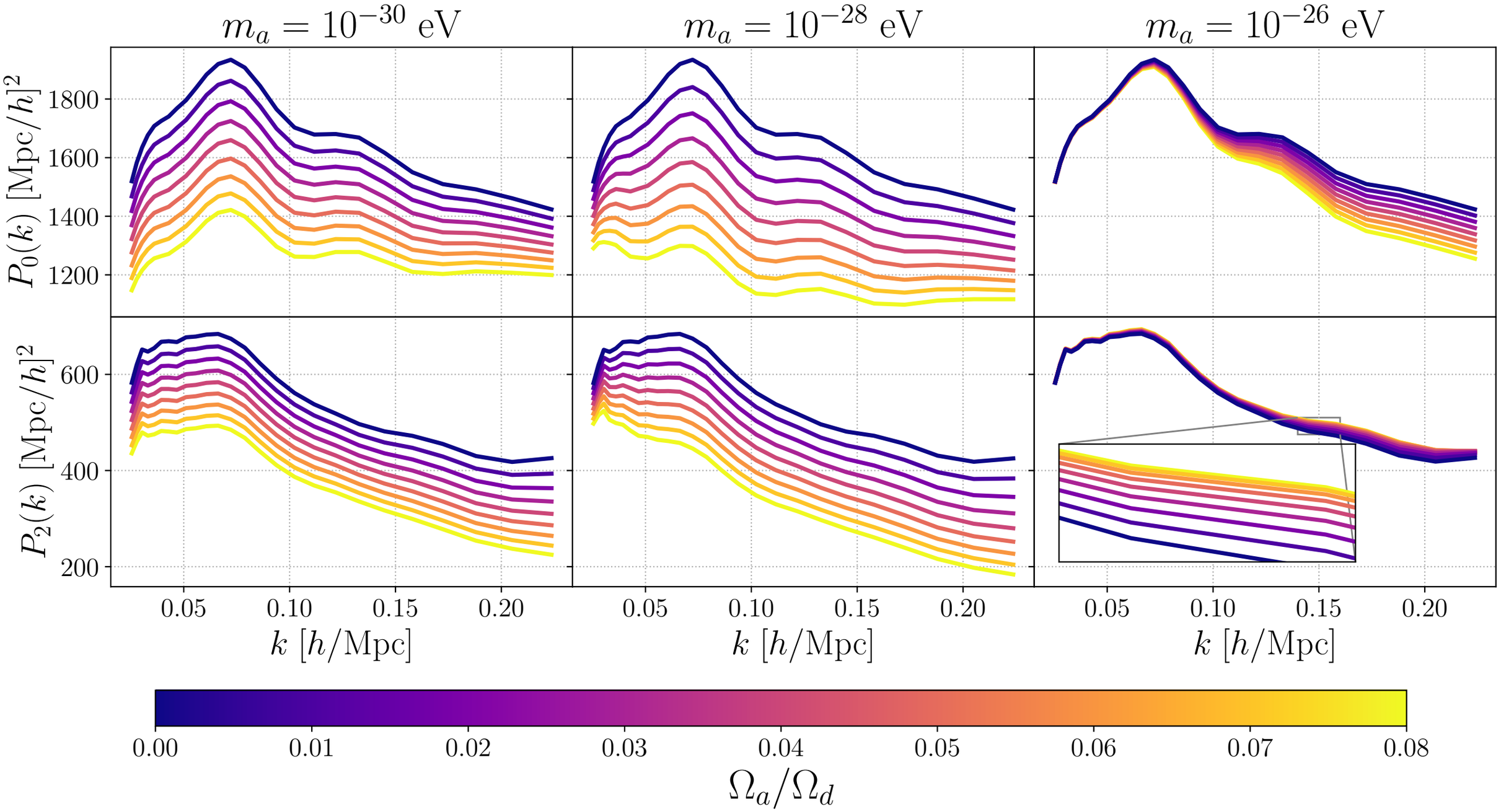
$$P_\ell(k) = P_\ell^{\rm Tree}(k) + P_\ell^{1-{\rm loop}}(k) + P_\ell^{\rm Counter}(k) + P_\ell^{\rm Stoch}(k)$$

Linear theory (Kaiser model)	Perturbation theory	Ultraviolet counterterms	Stochastic (shot noise/RSD)
$\propto P^{\rm Linear}(k)$	$\propto k^2 P^{\rm Linear}(k)$	$\propto k^2 P^{\rm Linear}(k)$	

+ Infrared resummation
+ Alcock-Paczynski distortion

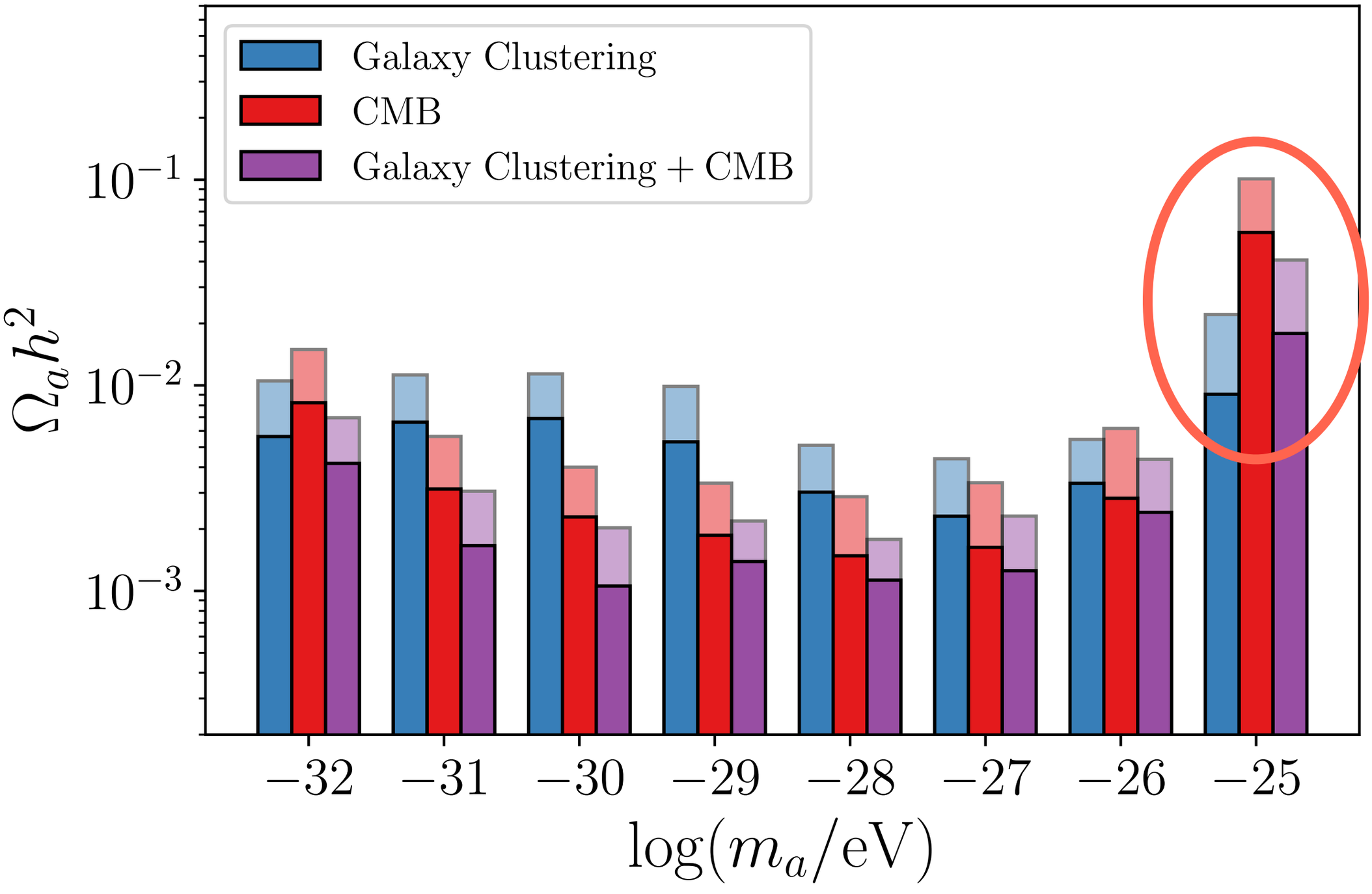
Rogers, Hložek, et al. (in prep); Philcox & Ivanov (2022)

Galaxy clustering traces dark matter clustering — revealing signature of ultra-light axions



Laguë, Bond, Hložek, Rogers, Marsh, Grin (2022)

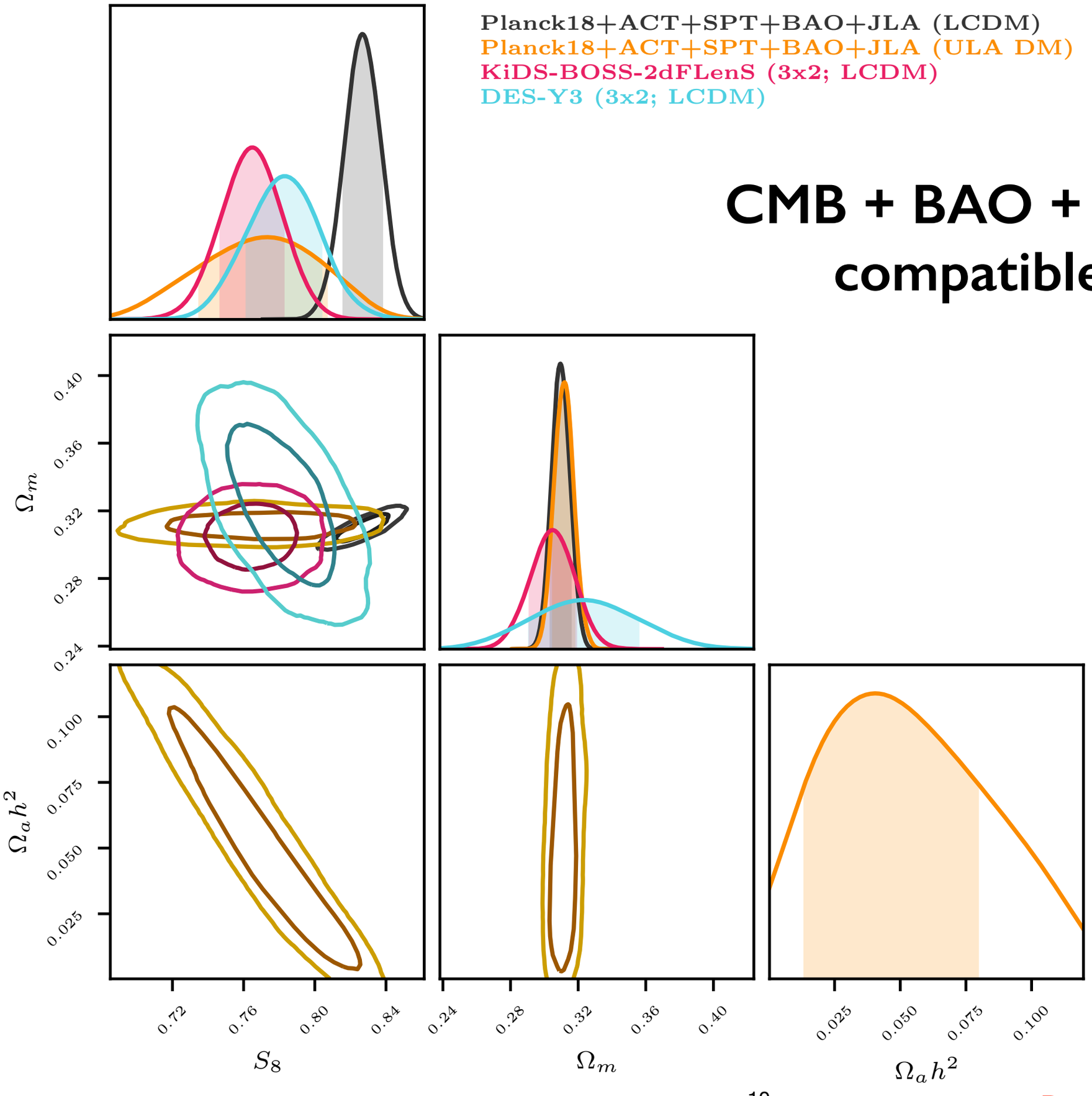
Strong bound on axions from CMB + galaxy clustering — higher masses still viable



Laguë, Bond, Hložek, Rogers, Marsh, Grin (2022)

Planck18+ACT+SPT+BAO+JLA (LCDM)
Planck18+ACT+SPT+BAO+JLA (ULA DM)
KiDS-BOSS-2dFLenS (3x2; LCDM)
DES-Y3 (3x2; LCDM)

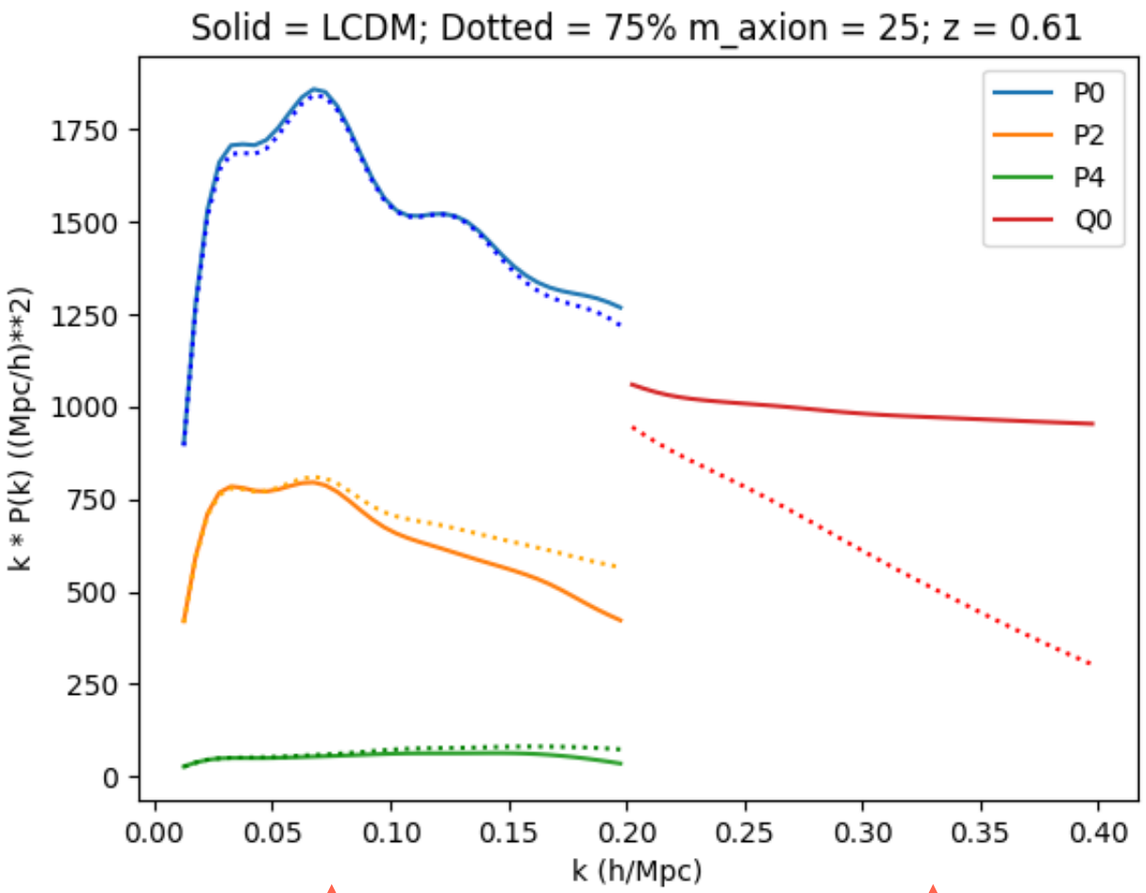
CMB + BAO + SNe + axion DM compatible with low S_8



$$m = 10^{-25}\,\mathrm{eV}$$

Rogers, Hložek, et al. (in prep)

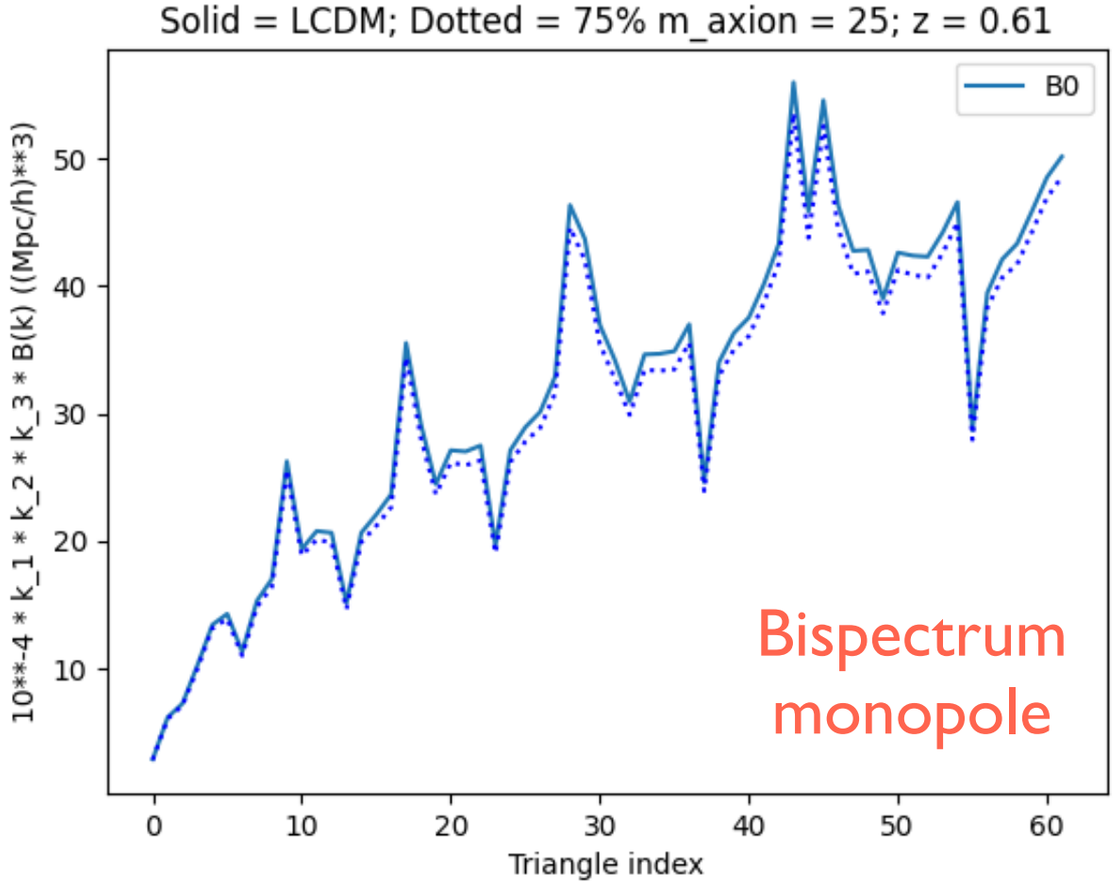
Galaxy clustering strengthens axion bounds and explores new mass regime



Redshift-space multipoles

Reconstructed real-space power spectrum

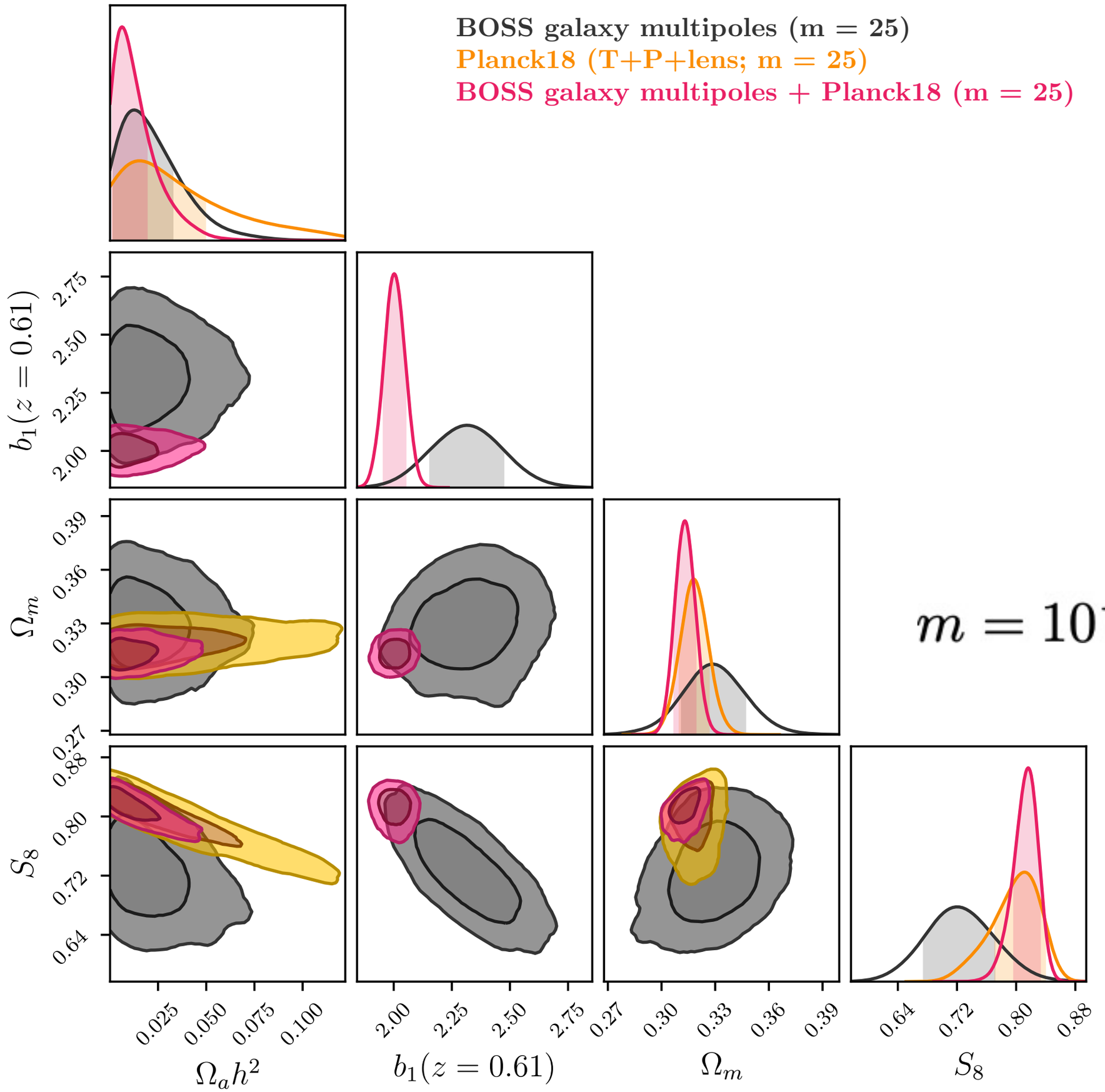
$$m = 10^{-25}\,\mathrm{eV}$$



Bispectrum monopole

Rogers, Hložek, et al. (in prep); Philcox & Ivanov (2022)

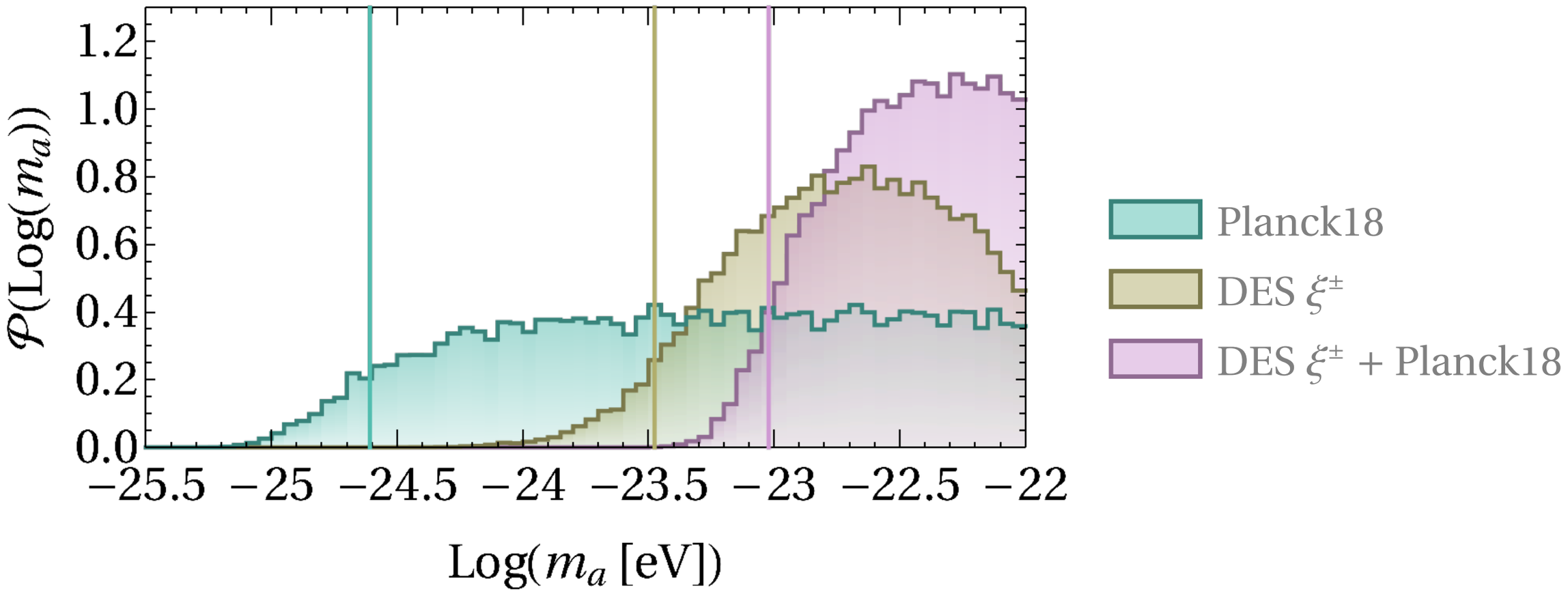
BOSS galaxy multipoles (m = 25)
Planck18 (T+P+lens; m = 25)
BOSS galaxy multipoles + Planck18 (m = 25)



$$m = 10^{-25}\,\mathrm{eV}$$

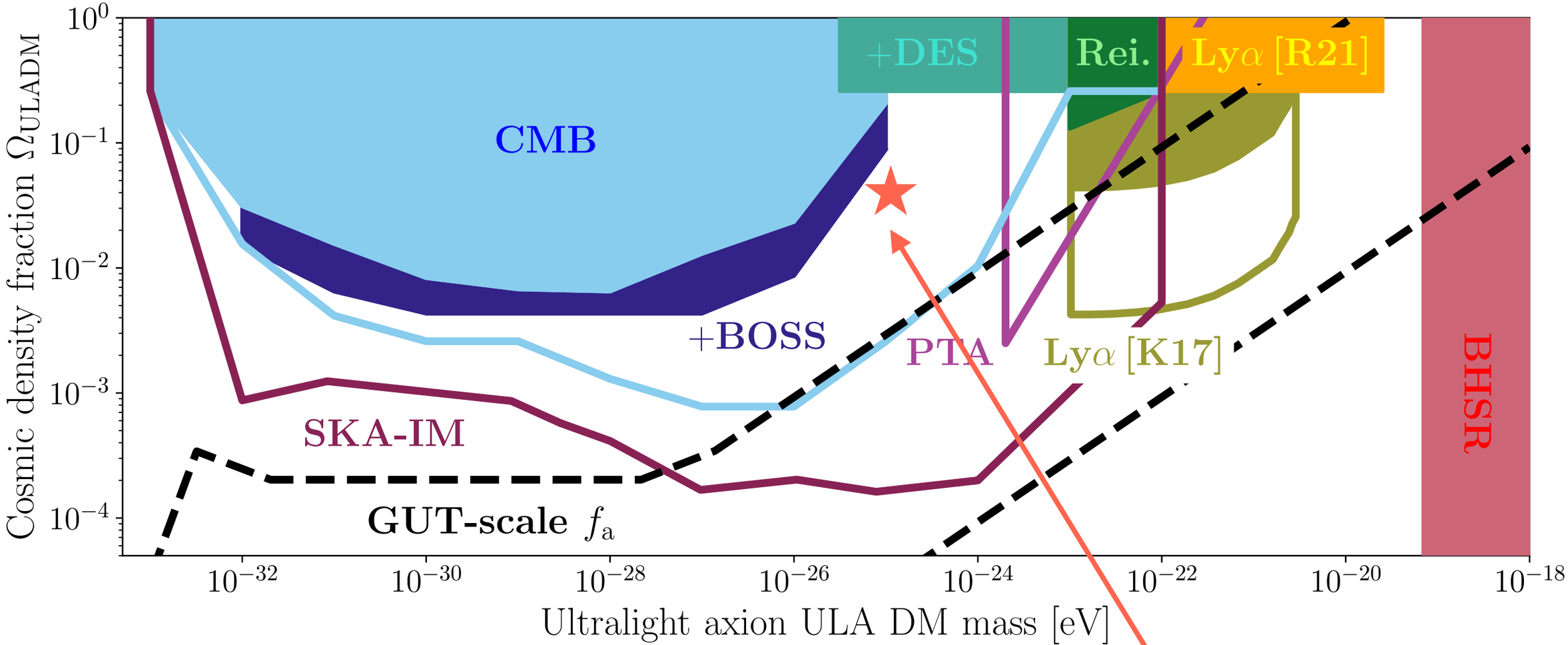
Rogers, Hložek, et al. (in prep)

Joint CMB & galaxy weak lensing bounds using axion dark matter halo model



Dentler, Marsh, Hložek, Laguë, Rogers, Grin (2021)

Multi-probe approach to detect ultra-light axions



Resolve S_8 tension?

Rogers, Hložek, et al. (in prep); https://keirkwame.github.io/DM_limits