Institute for Nuclear Physics (IKP)
Theoretical Astroparticle Physics

Axion Minicluster Power Spectrum and Mass Function.

Based on [1].

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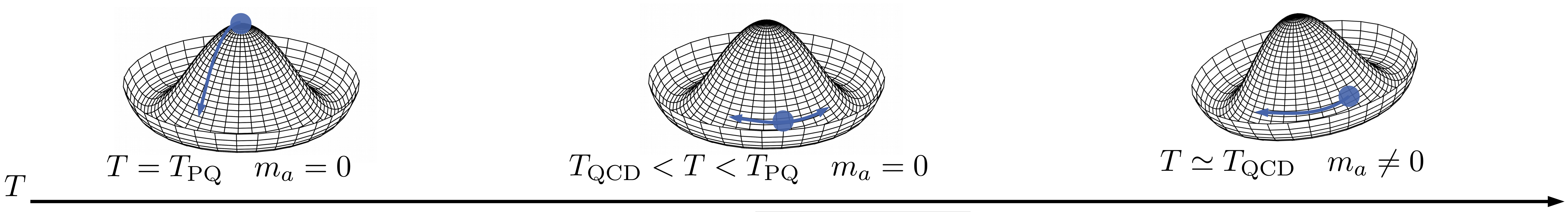
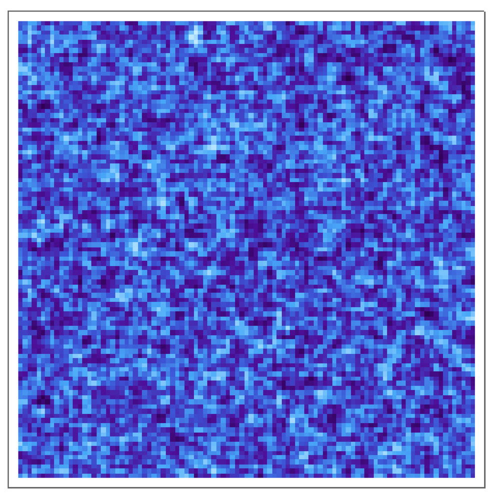
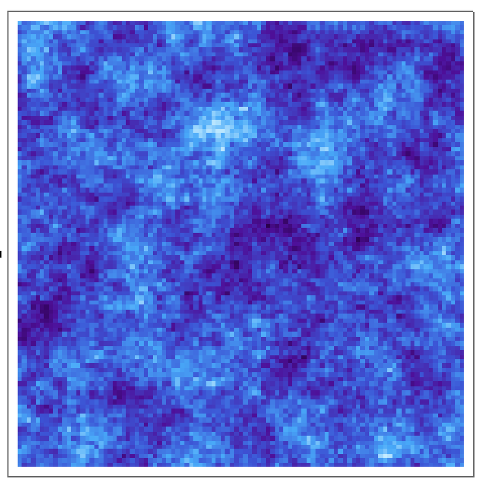
Evolution of the Axion Field: Vacuum Realignment in the post-inflation Scenario



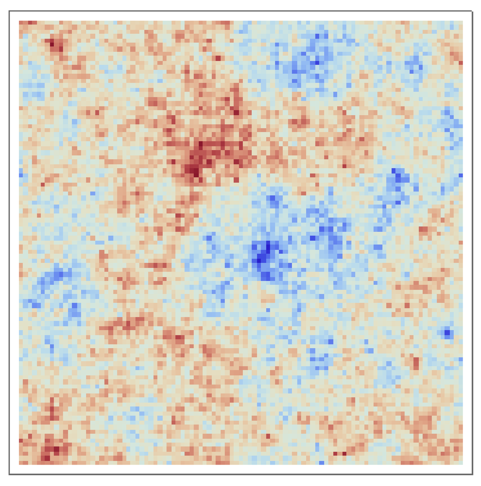
Random initial conditions lead to white noise field.



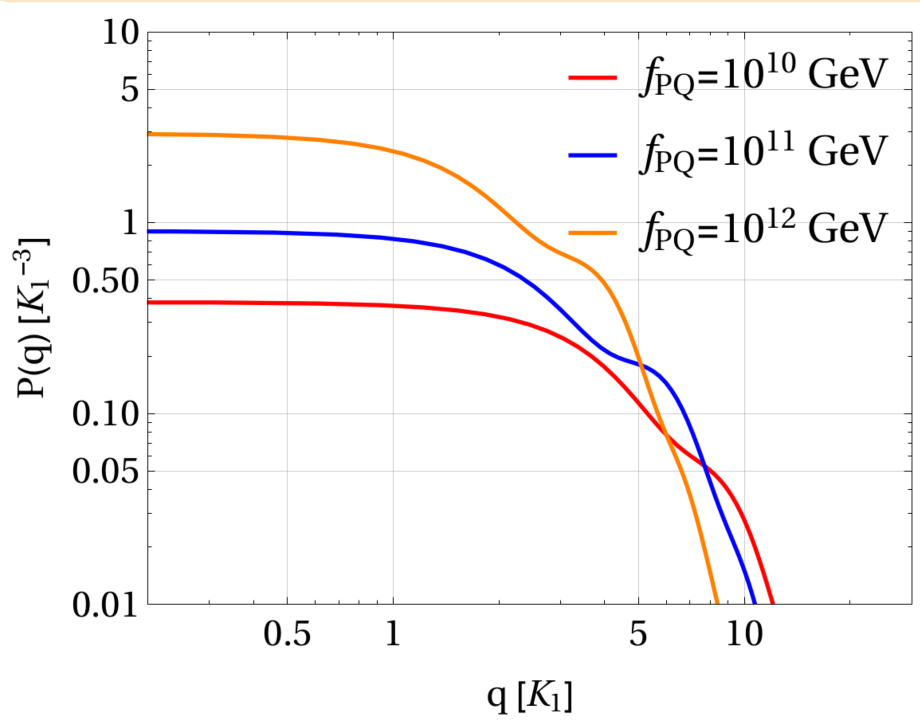
Field homogenizes up to Hubble horizon.

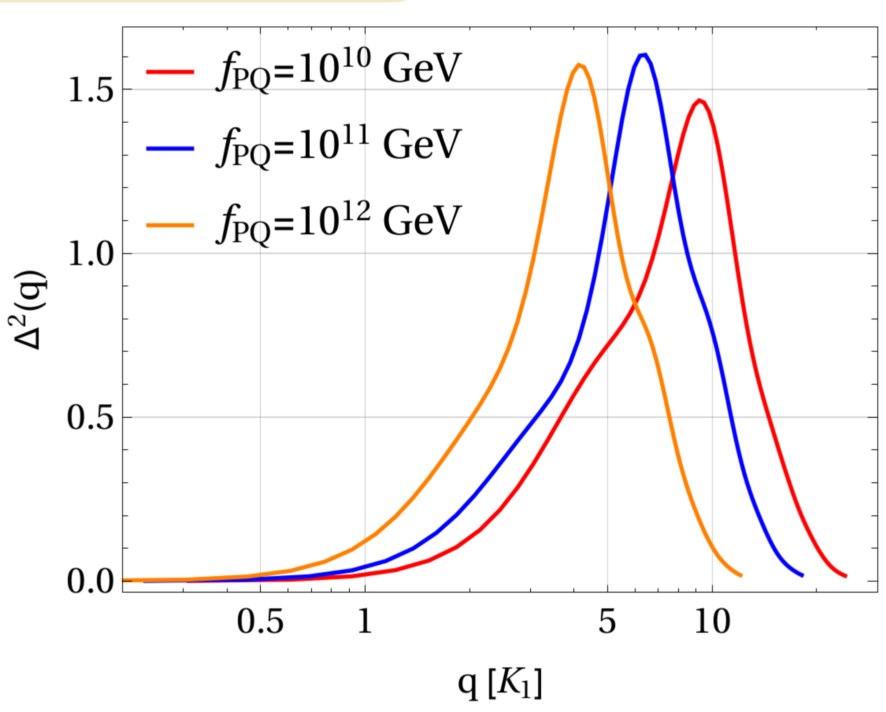


Field starts to oscillate. Inhomogeneities in the field leave imprint in the energy density.



Axion Energy Density Power Spectrum





Solve the axion field equation of motion with initial conditions

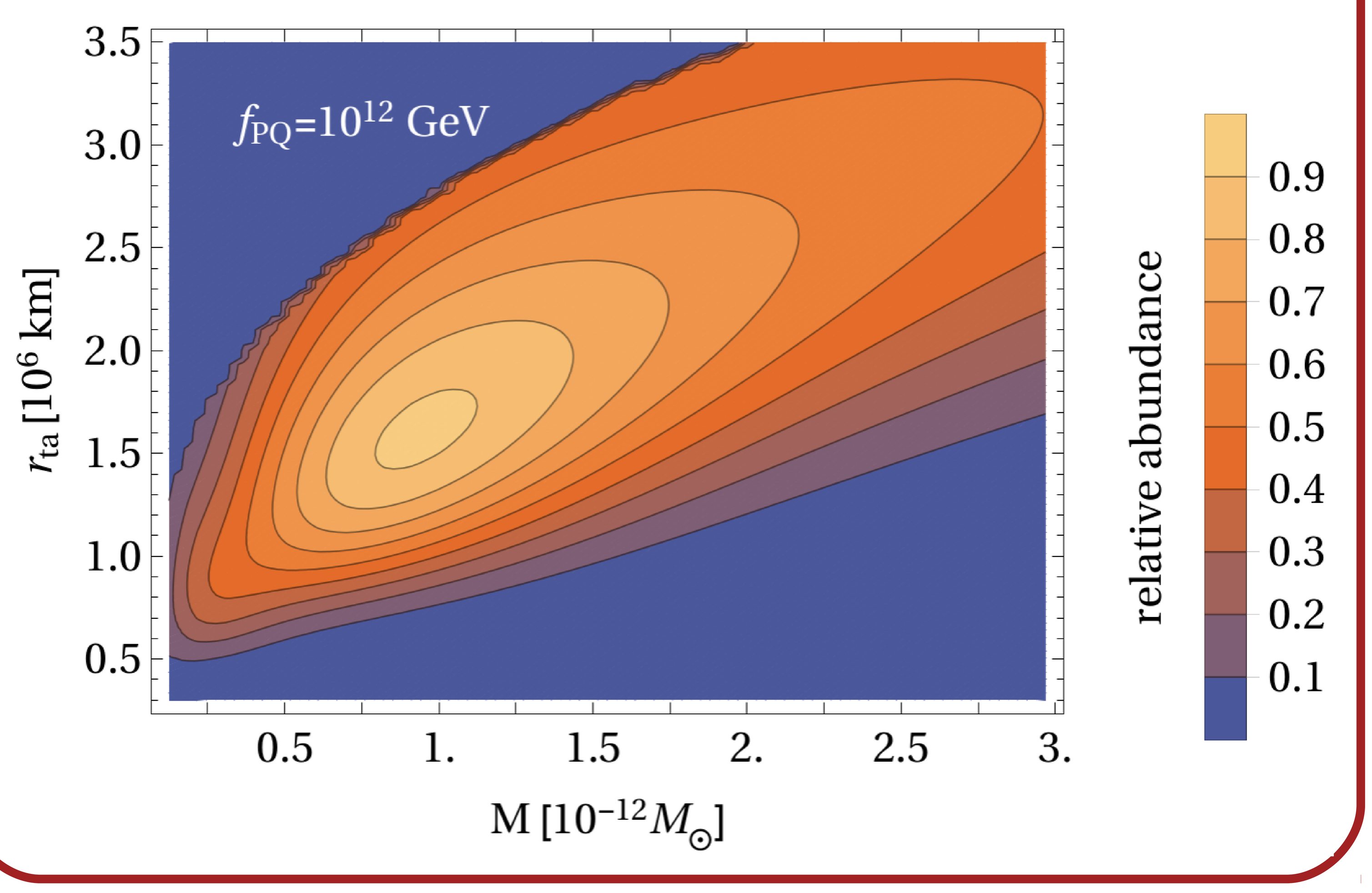
$$\langle \theta_k \theta_{k'} \rangle = (2\pi)^3 \delta(\vec{k} - \vec{k}') P_\theta(k) \qquad P_\theta(k) = \frac{8\pi^4}{3\sqrt{\pi} K^3} e^{-k^2/K^2}$$

$K = aH(T = T_i)$ Characteristic initial wave number

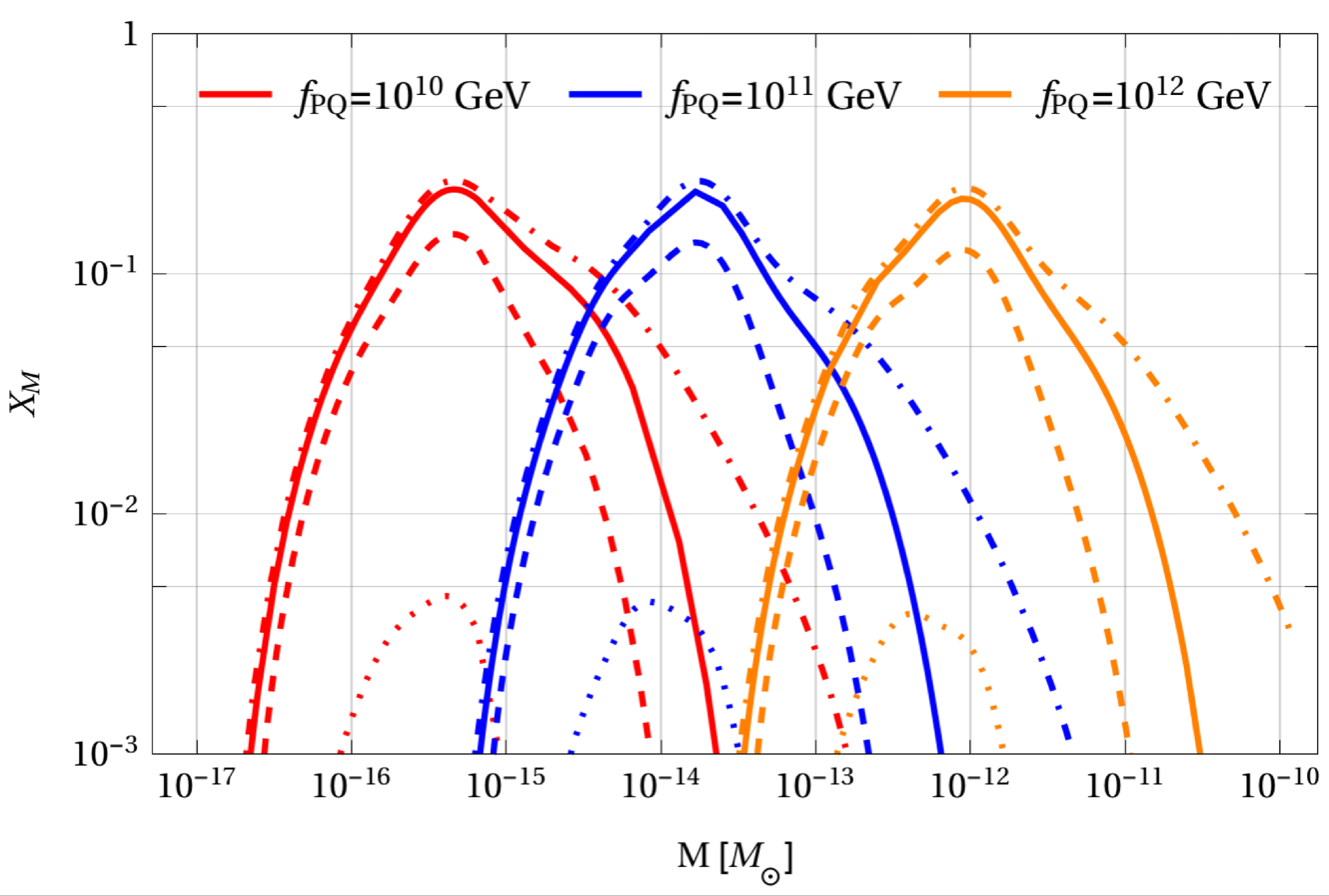
$K_1 = aH(T = 1\,\mathrm{GeV})$ Comoving reference scale

Size and Mass of Axion Miniclusters

- Consider decoupling of overdense regions from the Hubble flow.
- Distribution in mass and size via a modified Press-Schechter method.

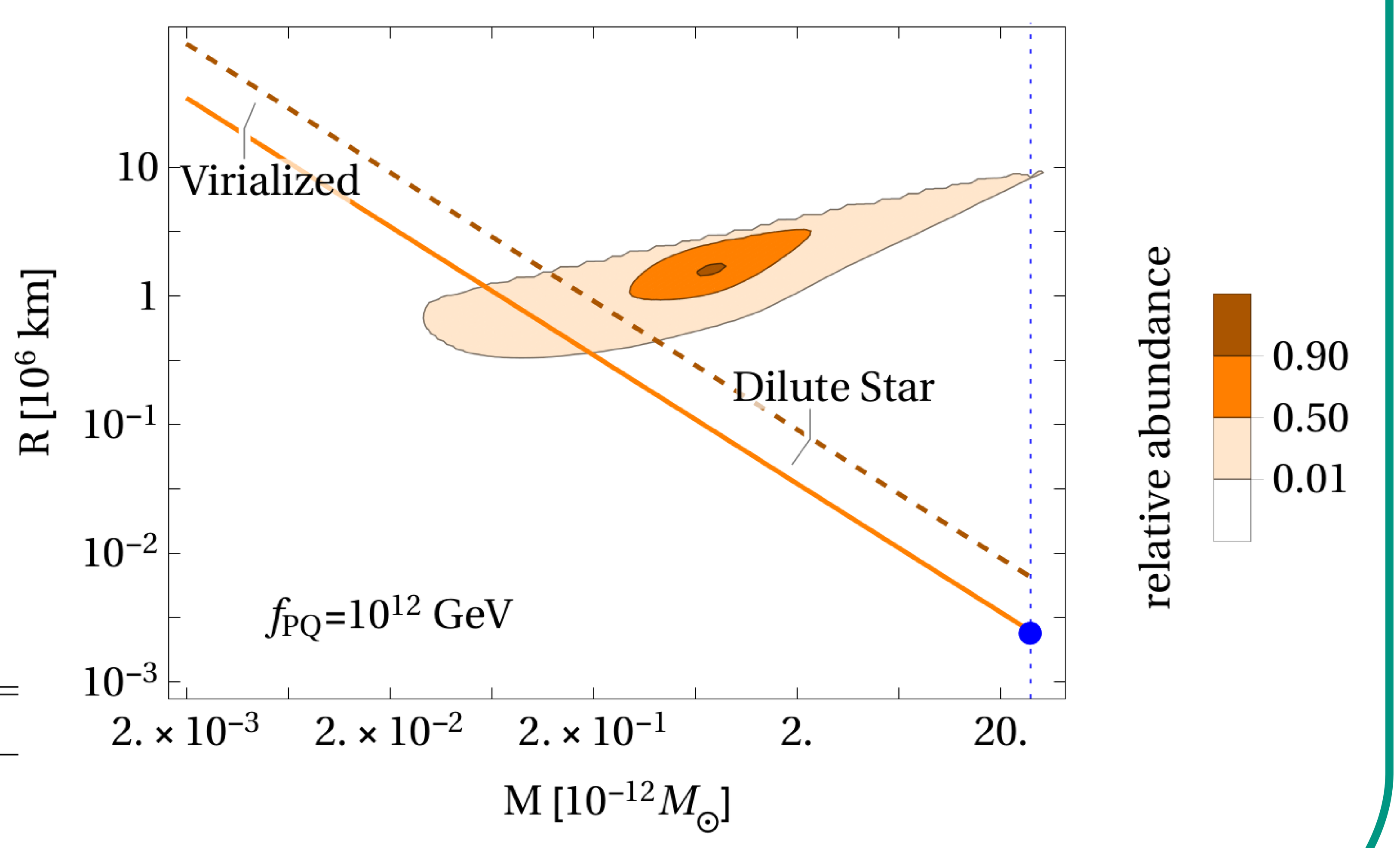


Results



$f_{\rm PQ}$ [GeV]	$M_{\rm peak}$ [$M_\odot$]	M range [$M_\odot$]	$r_{\rm ta}^{\rm peak}$ [km]	$r_{\rm ta}$ range [km]
10^{10}	4×10^{-16}	$[2 \times 10^{-17}, 1 \times 10^{-14}]$	4×10^4	$[2 \times 10^4, 2 \times 10^5]$
10^{11}	2×10^{-14}	$[5 \times 10^{-16}, 3 \times 10^{-13}]$	2×10^5	$[4 \times 10^4, 7 \times 10^5]$
10^{12}	8×10^{-13}	$[6 \times 10^{-14}, 2 \times 10^{-11}]$	2×10^6	$[7 \times 10^5, 7 \times 10^6]$

Future Directions: Fate of Miniclusters



[1] J. Enander, A. Pargner, and T. Schwetz, Axion minicluster power spectrum and mass function, JCAP 1712 (2017), no. 12 038, [1708.04466]