

AxionMinicluster

with
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elusive
neutrinos, dark matter & dark energy physics



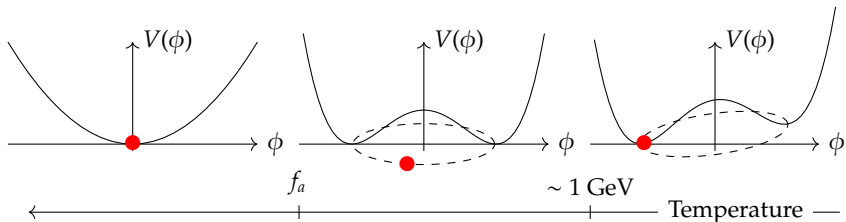
- ▶ Solves the strong CP problem.
- ▶ Makes up dark matter.

AxionMinicluster

$\mathcal{O}(1)$ density contrast
collapses to dense clumps of axions.

- ▶ Comoving scale ~ 0.02 pc
- ▶ Mass $10^{-12}M_{\odot}$
- ▶ Central density $10^{14}\rho_{DM}$

Axion Production



Suppose: $T_{\text{RH}} > f_a \Rightarrow$ **inhomogeneous initial value** θ_i .

Cosmic Strings

- ▶ Where the field winds from 0 to 2π .
- ▶ Decay into axions.

Domain Walls

- ▶ Form between strings.
- ▶ Decay into axions ($N_{\text{DW}} = 1$).

Vacuum Realignment

When $T_a \sim 3m_a$: θ starts oscillating around its minimum.

$$\rho_a(t_0) \simeq m_a f_a^2 H_a \theta_i^2 \left(\frac{R_a}{R_0} \right)^3$$

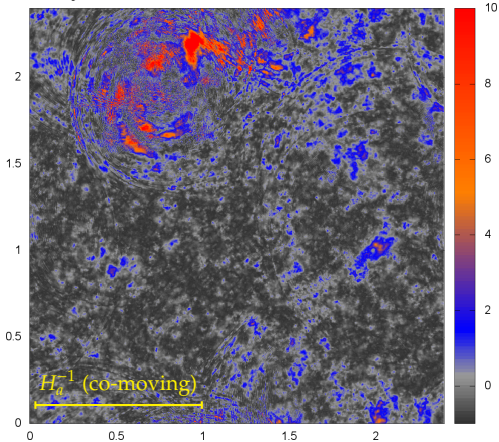


Inhomogeneous density
at scales H_a^{-1} .

Spatial distribution of axions?

Results

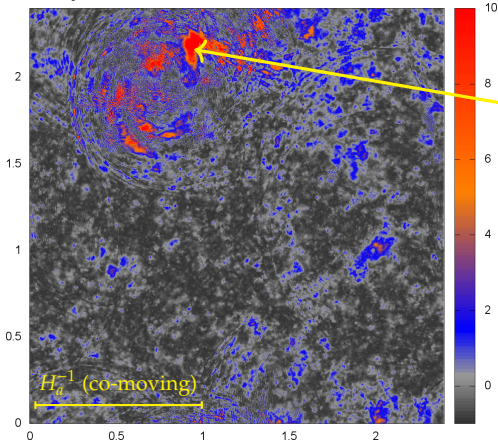
density contrast at $T_a/T = 2.5$



$$\delta(\mathbf{x}) = \frac{\rho(\mathbf{x}) - \rho_{av}}{\rho_{av}}$$

Results

density contrast at $T_a/T = 2.5$

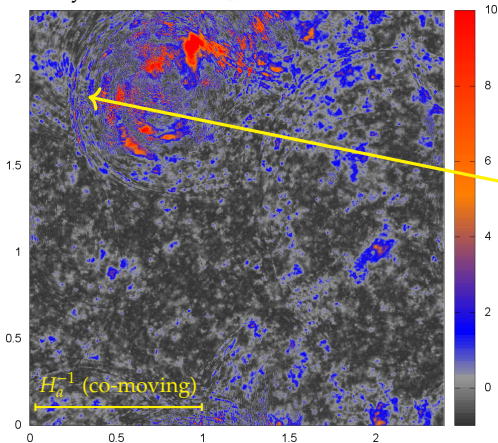


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Typical miniclusters

Results

density contrast at $T_a/T = 2.5$



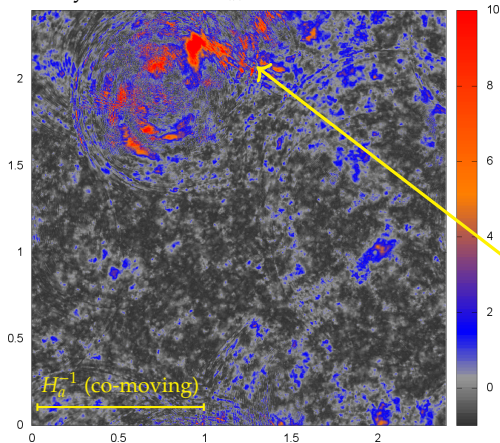
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Typical miniclusters

Spherical axion waves
from string/wall decay

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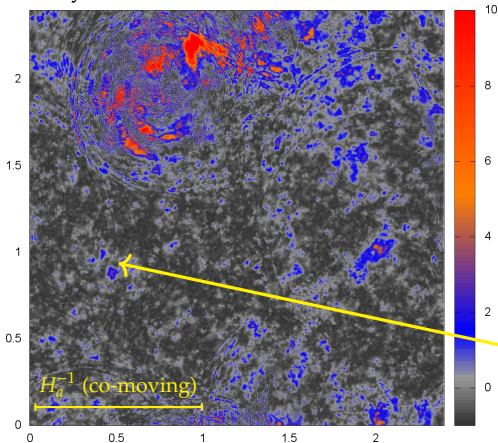
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Interference pattern

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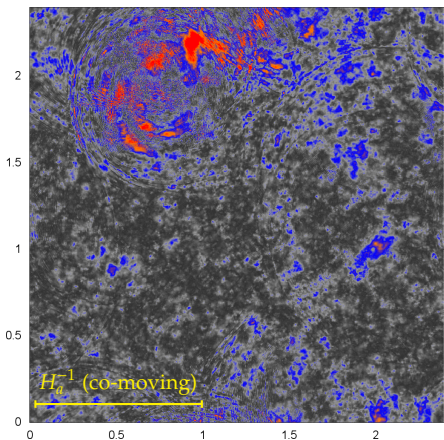
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Atypical miniclusters
 $O(1)$ fluctuations on small
scales

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⇒ Inclusion of strings and domain walls leads to substructure on even smaller scales.