The scaling density of axion strings

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Cosmic Defects

\[ \mathcal{L} = \frac{1}{2} \partial_{\mu} \Phi^i \partial^{\mu} \Phi^i - \frac{1}{4} \lambda (|\Phi|^2 - \eta^2)^2 \]

\( i = 1, \ldots, N \)

- Presence of Goldstone bosons -> energy not confined
- Long range interactions
Axions

• The Peccei-Quinn field proposed to solve the strong CP problem

• The *axion* is the angular excitation of the PQ field

• In the post-inflationary PQ scenario global strings or axionic strings are formed.

• Axionic strings survive until QCD phase transition

• In the meanwhile strings release energy via the emission of axions
Axions

\[ \mathcal{L} = \frac{1}{2} \partial_\mu \Phi \partial^\mu \Phi - \frac{\lambda}{4} (|\Phi|^2 - \eta^2)^2 \]
Field Theory Simulations

- Discrete e.o.m.
- Evolve e.o.m. in $L^3$ lattices
A second order differential equation solver written in c++
Acting in a 3D discrete lattice with the help of LATfield2
Analyses the evolution of a scalar field with N components

LATfield2:
Intuitive and easy to use library written in c++
For solving partial differential equations on cartesian meshes
Field Theory Simulations

- Discrete e.o.m.
- With Periodic Boundary conditions
- Random Initial Conditions
  - Gaussian random field
  - Correlation length $l_\phi$
- Radiation and matter eras

- We **don’t** reproduce the thermal phase transition
Evolution of a scalar field with 2 components (Axion strings) obtained with ON code
ARM

- Code compiled and run with:
  - GCC compiler
  - ARM compiler
- ARM compiler give a better performance
- Compared with dial (Dirac) runs:
  - Similar overall performance
  - Different performances in different parts of the code
- Really interesting information from ARM Forge
• Code compiled

• We have some problems running it

• After some research we found that our code needs to be analysed
Summary

- We have obtained a really useful information about the performance of the code

- New possible ways to improve the code has been proposed

- More work is needed to explore the possibilities

- All in all, a really useful and productive Hackathon
Axion String Evolution

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