Oscillons in multi-field theories

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Based partly on work in [arXiv:2010.07789]
Refresher: what are oscillons?

Localized configurations in real scalar fields
- Oscillating
- Attractive
- Long-lived (Cosmological relevance?)

Requirements on the theory
- (Effective) Potential “shallower” than quadratic
- Need to counteract dispersive effects
- Intuitive from the particle p.o.v.
The relevance of oscillons to the early universe

Oscillons might form efficiently during preheating
1. (Gaussian) fluctuations get amplified due to Floquet instabilities
2. Nonlinearities “settle” into the attractive oscillon configuration

In recent years studies have shown various Cosmological roles
1. Their formation is accompanied by a characteristic GW signature
2. Impact on late-time cosmology (due to long lifetimes)?

What about multi-field models?

arXiv:1807.03098
Resolving difficulties with symmetrization

Lifetime & Stability depend on spatial profiles

\[ V(\phi, \chi) = \frac{1}{2} \phi^2 + \frac{1}{2} \chi^2 - \frac{\phi^4}{4} - \frac{\chi^4}{4} + g \frac{\phi^6}{6} + g \frac{\chi^6}{6} - \frac{\Lambda}{2} \phi^2 \chi^2 \]

\[ \phi \leftrightarrow \chi \quad \phi \leftrightarrow -\chi \]
Simulations of preheating seem to move towards composite oscillons.
1. The properties of oscillons in general multi-field models
   • Symmetrization techniques might be used to symmetrize effective action
   • Perturbatively move away from symmetric models (relaxation)
   • Cosmologically relevant models (multi-field inflation)

2. The dynamics of multi-field oscillon formation in the early universe
   • Studying the formation of multi-field oscillons in preheating scenarios
   • Their observational signatures