Oscillons are bound states sustained by self-interactions that appear in rather generic scalar models. They can be extremely long-lived and have a built-in formation mechanism — parametric resonance instability. These features suggest that oscillons can affect the standard picture of scalar ultra-light dark matter (ULDM) models.

We find that scalar potentials that occur in well motivated axion-like models can lead to oscillons that live up to $10^{10}$ cycles or more. For a wide range of axion masses, oscillons decay around or after matter-radiation equality and can thus act as early seeds for structure formation. We also discuss the possibility that oscillons survive up to today. In this case they can most easily play the role of dark matter.

**Abstract**

- $\phi^2 p_0 < p < 1$ \(\phi^2 \) const.
- $V(\phi)$

**Properties**

- Spherically-symmetric localized objects
- With typical masses, sizes and lifetimes:
  - $r_{osc} \sim 2 \times 10^3 pc \sim 10^{-20} eV m$
  - $M_{osc} \sim (10^7 \times 10^{15}) GeV$
  - $\tau_{osc} \geq 10^6$ yr.

Bound state of a large number of such particles. Heavy and long-lived. Sustained by self-interactions!

(Ultra) light axion-like particles

Cold Dark Matter model with 2 components:
- Ultra light free scalar particles, \( m \sim 10^{-20} - 10^{-6} \) eV
- Much heavier objects (oscillons), \( M \sim O(100) \ F^2 \ m^{-1} \)

\( (F = 10^{10} - 10^{15} \ GeV) \)

Seeds for structure formation, PBHs …