Cosmological Simulations with Ultralight Axion Dark Matter

Jan Veltmaat

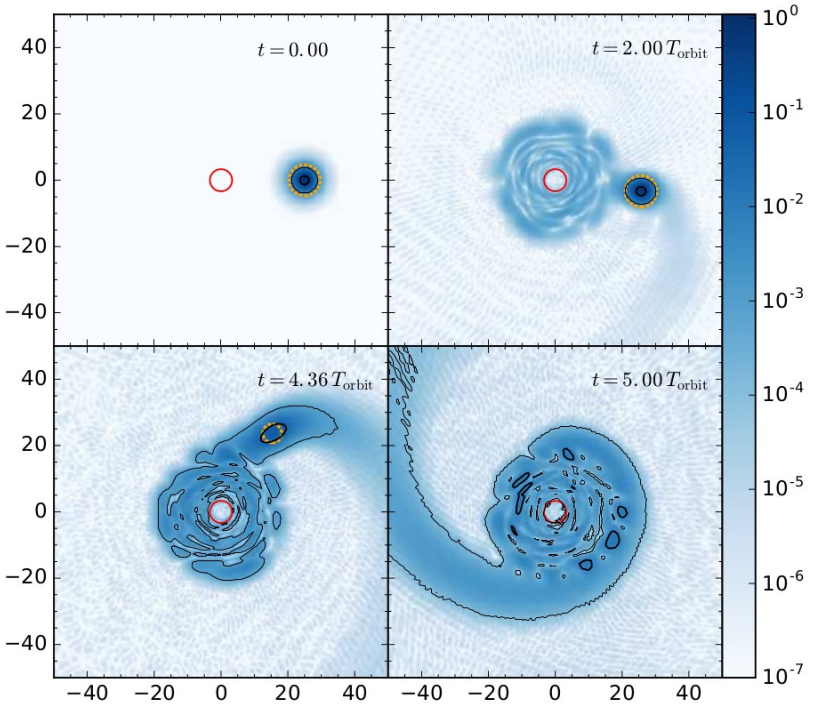
Universität Göttingen

GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Ultralight Axion Dark Matter in the late universe is described by a classical non-relativistic scalar field

$$i\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2ma^2}\nabla^2\Psi + Vm\Psi$$

$$\nabla^2 V = \frac{4\pi G}{a}(\rho - \overline{\rho})$$



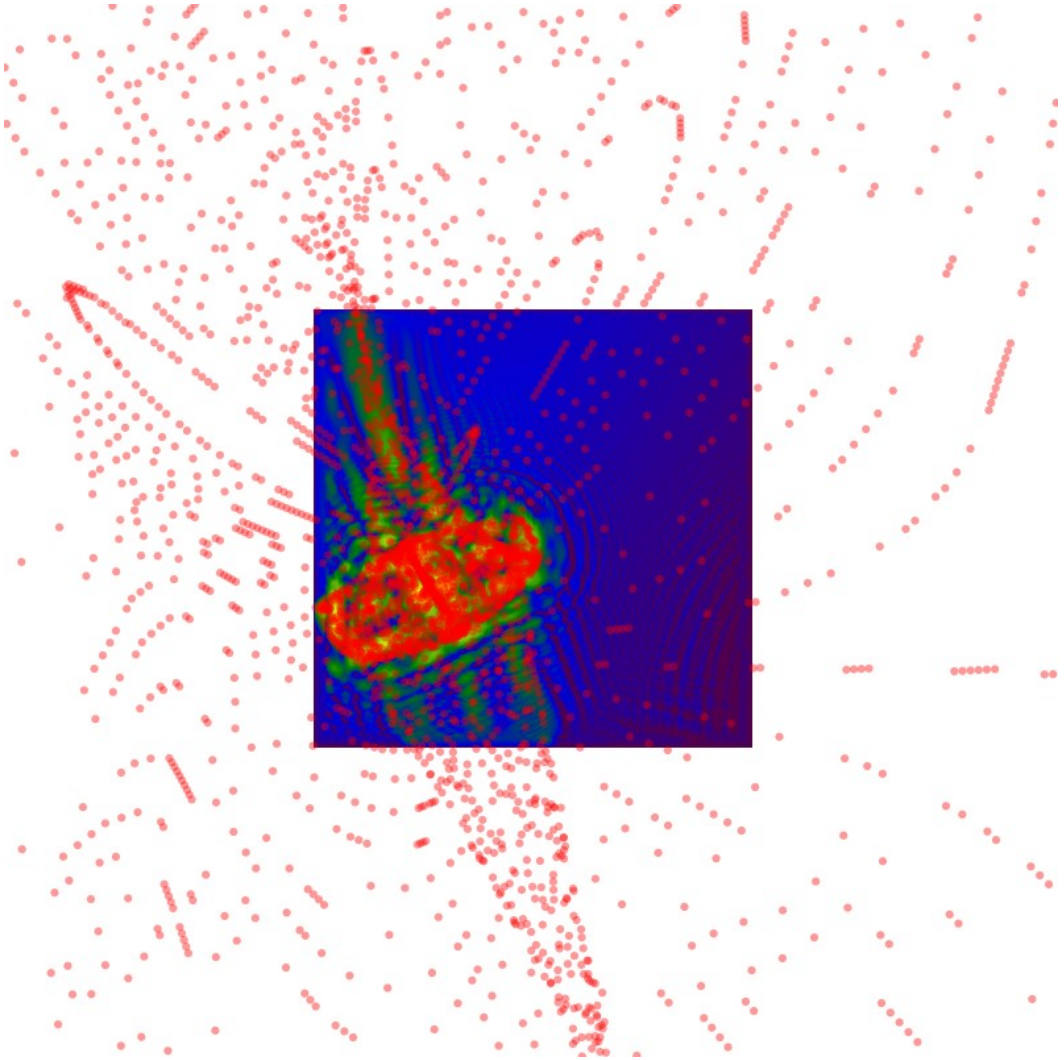
For $\mathrm{m} = 10^{-22}$ eV the linear Powerspectrum has a cut-off at $\approx$1 Mpc

The de Broglie wave length in a $M = 10^9 M_\odot$ halo is $\approx$1kpc

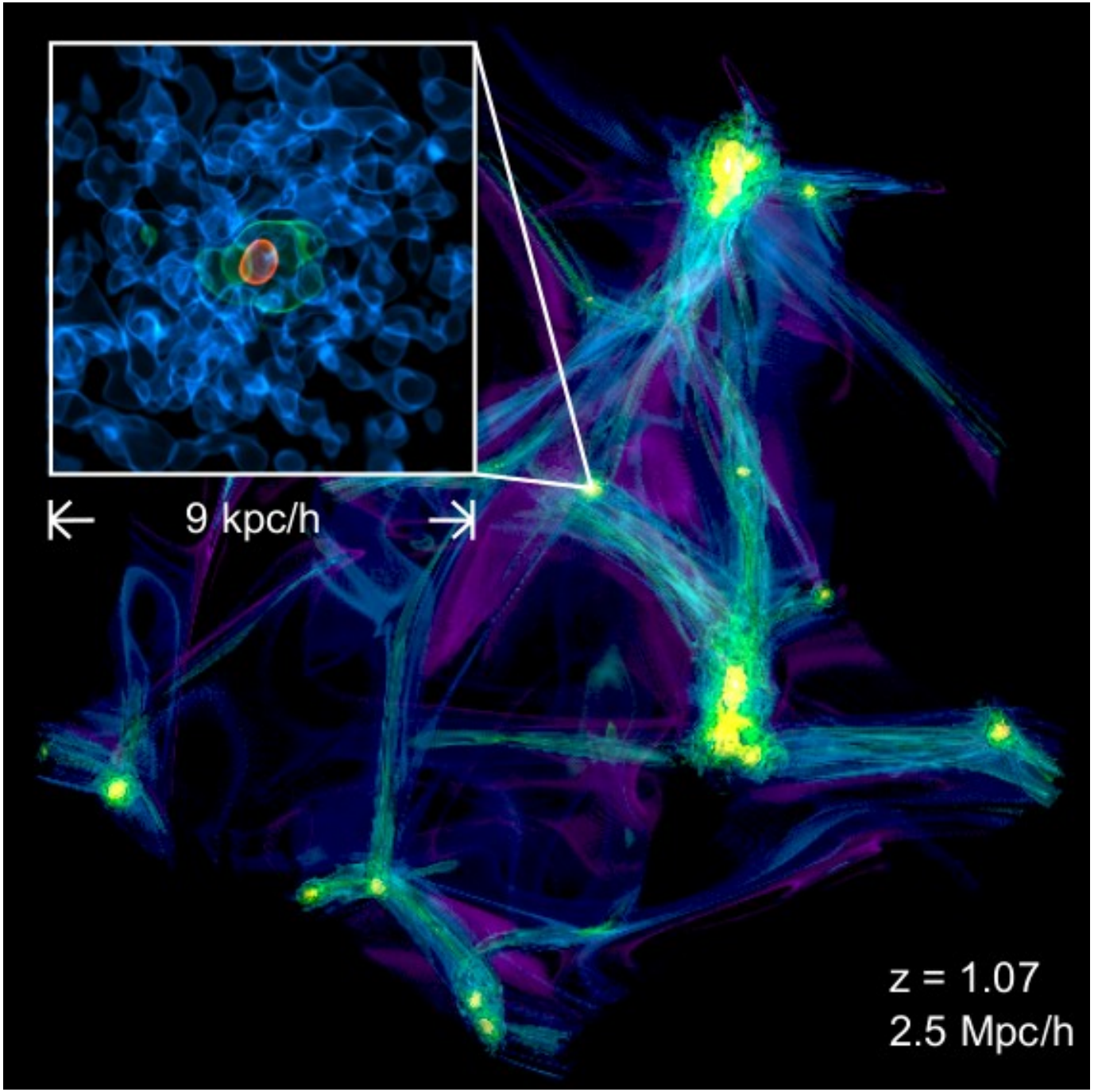
Unigrid simulations are not suitable for cosmological simulations of ultralight axion dark matter

Du, Schwabe, Niemeyer, Bürger (2018)

A hybrid approach

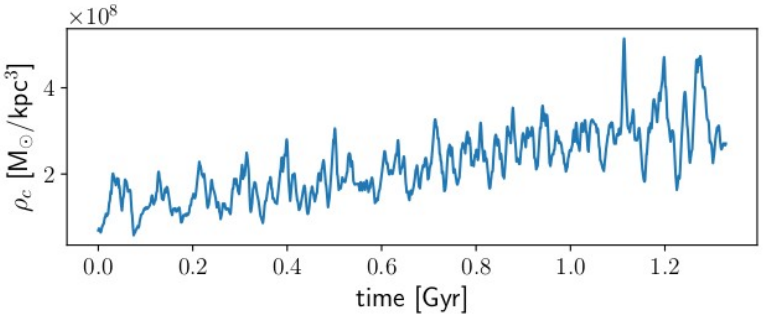


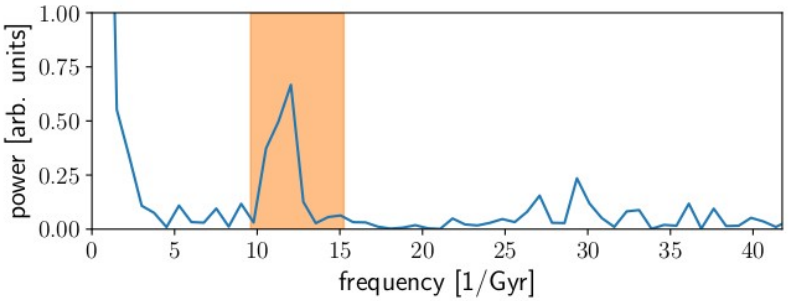
combining particle-based and grid-based methods

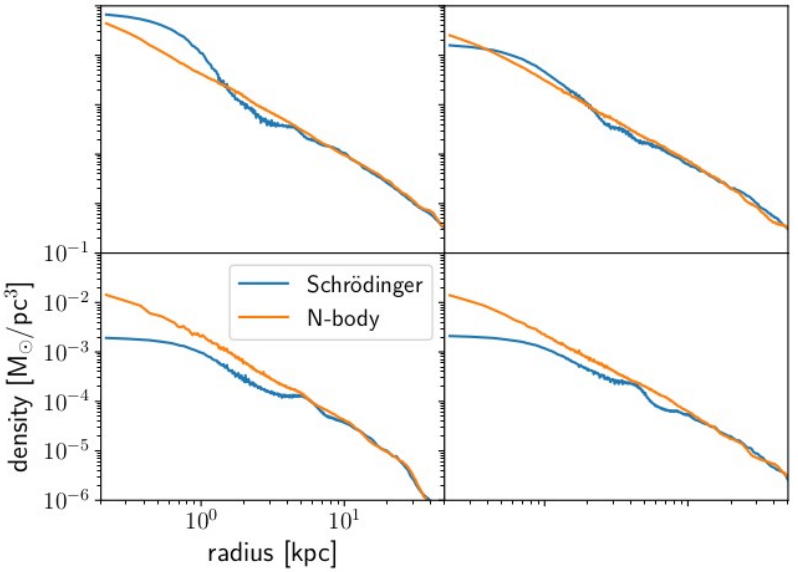


Veltmaat, Niemeyer, Schwabe (2018)

- How big are the cores and how do they evolve?
- How and why do they form?
- How much does Ultralight Axion Dark Matter differ from standard Cold Dark Matter?
- What are the properties of the granules?







Veltmaat, Niemeyer, Schwabe (2018)