Simulations of cosmological models beyond $\Lambda$CDM

Marco Baldi (see also poster Nr. 2)


We defined theoretical requirements (i.e. a selected list of cosmological models and relative parametrizations) for the EUCLID N-body simulations programme.

The programme is aimed at providing mock data for alternative cosmologies and should be homogeneous in terms of cosmological parameters normalization and numerical requirements.

We selected 8 classes of models according to their implementation requirements.
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1. Quintessence and Early Dark Energy
including dynamic scalar field models and phenomenological parametrizations
Simulations for this class have already been carried out by e.g. Grossi & Springel 2009, Jennings et al. 2009
✔ N-body codes already available
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2. Inhomogeneous large-void models
   including LTB cosmologies parametrized by the structural properties of the density void, in particular of its radius $r_0$.
   Simulations for this class have already been carried out by Alonso et al 2010
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3. **Warm Dark Matter**
   including models with a thermal relic of particles with **mass in the range** \( m_{WDM}=[0.5,2.0] \) keV.
   Simulations for this class have already been carried out by e.g. Zavala et al. 2009, Lovell et al 2011, Viel et al. 2011
   ✔ N-body codes and Initial Conditions codes already available
Simulations of cosmological models beyond $\Lambda$CDM
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4. Non-Gaussian initial conditions
including Local, Equilateral, and Orthogonal types of non-Gaussianity in the primordial density field.
Simulations for this class have already been carried out by e.g. Grossi et al 2007, Pillepich et al 2008, LoVerde & Smith 2011, Sefusatti et al 2010, Wagner et al 2010.

✔ N-body codes already available
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5. Massive Neutrinos
including models with a cosmological fraction of massive neutrinos.
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6. Self-Interacting Dark Matter
including microscopic models of Dark Matter scattering and short-range scalar forces (Loeb & Weiner 2011).
Simulations for this class have already been carried out by e.g. Dave et al 2001.
✘ N-body codes yet to be developed and optimized
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  ✘ N-body codes yet to be developed and optimized

7. Linear spatial Dark Energy fluctuations
including Coupled Dark Energy, Extended Quintessence, and Clustering Dark Energy models.
Simulations for this class have already been carried out by e.g. Baldi et al. 2010, De Boni et al. 2011.
  ✔ N-body and Initial Conditions codes already available for Coupled Dark Energy and Extended Quintessence
  ✘ N-body codes yet to be developed for Clustering Dark Energy
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✓ N-body and Initial Conditions codes already available for Coupled Dark Energy and Extended Quintessence

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8. Non-linear spatial Dark Energy fluctuations
including Modified Gravity theories and massive coupled scalar field Dark Energy scenarios.
Simulations for this class have already been carried out by e.g. Oyaizu et al. 2008, Zhao et al. 2011.

✗ N-body codes yet to be developed and optimized
A first example for Coupled Dark Energy models

**CODECS**

**Coupled Dark Energy Cosmological Simulations**
A first example for Coupled Dark Energy models

**CoDECS**

**Coupled Dark Energy Cosmological Simulations**

The **CoDECS** project (MB, in prep.) includes different types of cDE:

- **Constant** coupling cDE
- **Variable** coupling cDE
- **Bouncing** cDE (MB, arXiv:1107.5049)

Numerical parameters:

**L-CoDECS**: 1 Gpc/h, 2x1024³ particles

**H-CoDECS**: 80 Mpc/h, 2x512³ particles, hydro

Available data:

- Nonlinear matter power spectra
- Halo and Subhalo catalogs
- Full Snapshots

**PUBLIC DATABASE**

[www.usm.lmu.de/people/mbaldi/CoDECS](http://www.usm.lmu.de/people/mbaldi/CoDECS)
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