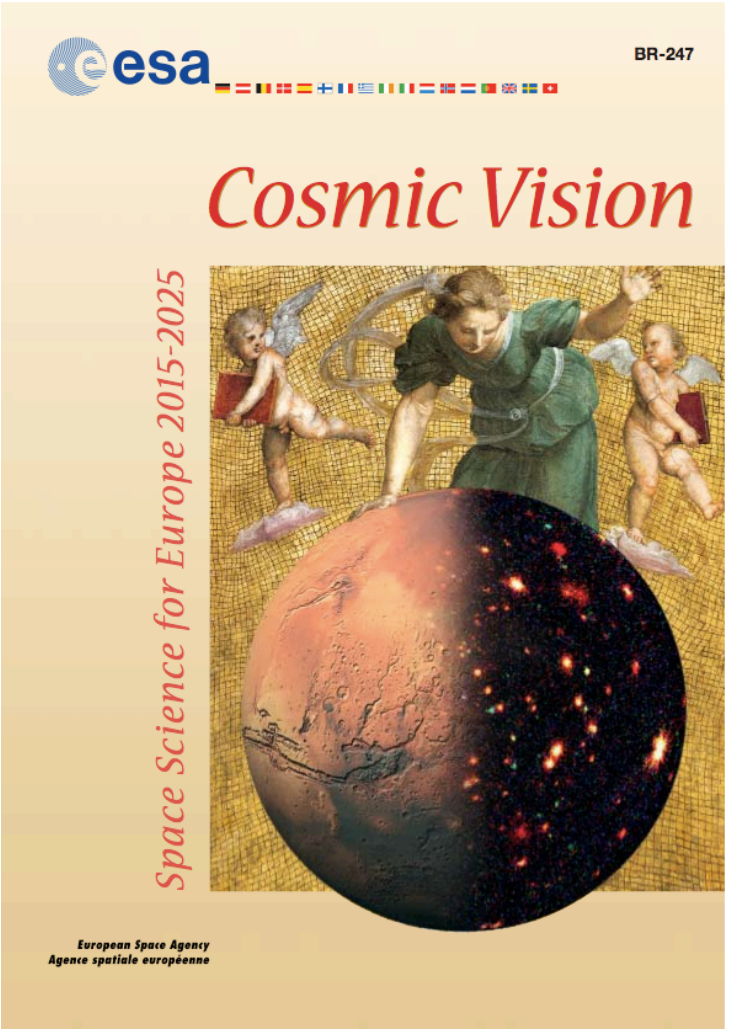
Dark energy report

UniverseNet, Lecce, 18 September 2010

P. Binétruy

Recent developments in the world outside the Universe…Net



Early 2010, EUCLID was selected to be among the three missions selected to compete for M1 (launch 2017) and M2 (lauch 2018) missions of ESA

Final selection: June 2011

Release of the results of the US Decadal Survey in astrophysics for the period 2012-2021.

In the category of large projects on the Ground, the winner is…

LSST

dark energy

In the category of large space projects, the winner is…

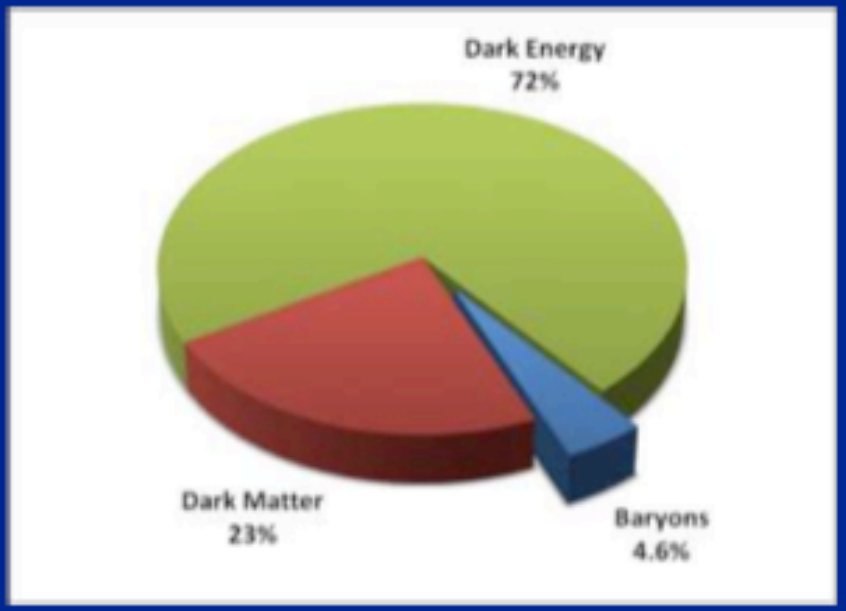
WFIRST

dark energy

Transparency of R. Blandford, chair of the decadal survey

Physics of the Universe

Understanding Scientific Principles



- Determine properties of dark energy, responsible for perplexing acceleration of present-day universe
- Reveal nature of mysterious dark matter, likely composed of new types of elementary particles
- Explore epoch of inflation, earliest instants when seeds of structure in the universe were sown
- Test Einstein's general theory of relativity in new important ways by observing black hole systems and detecting mergers

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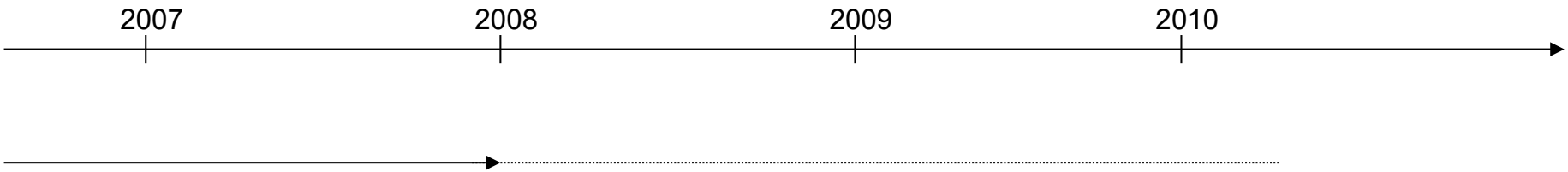
Back to the Universe…Net

General trends over 4 years

About 25 research papers and reviews around 100 papers!



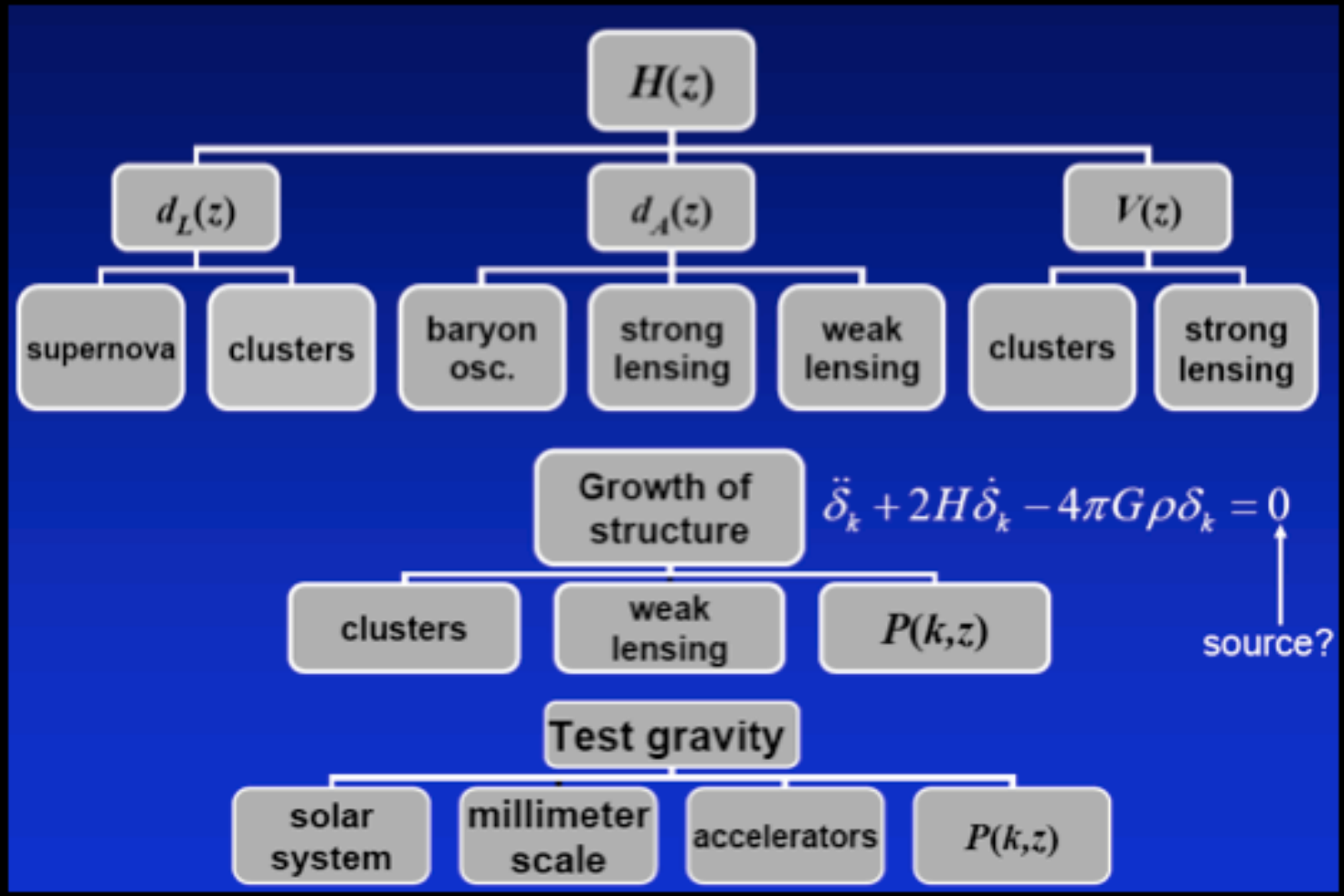
Do we interpret the data properly?

Models for dark energy

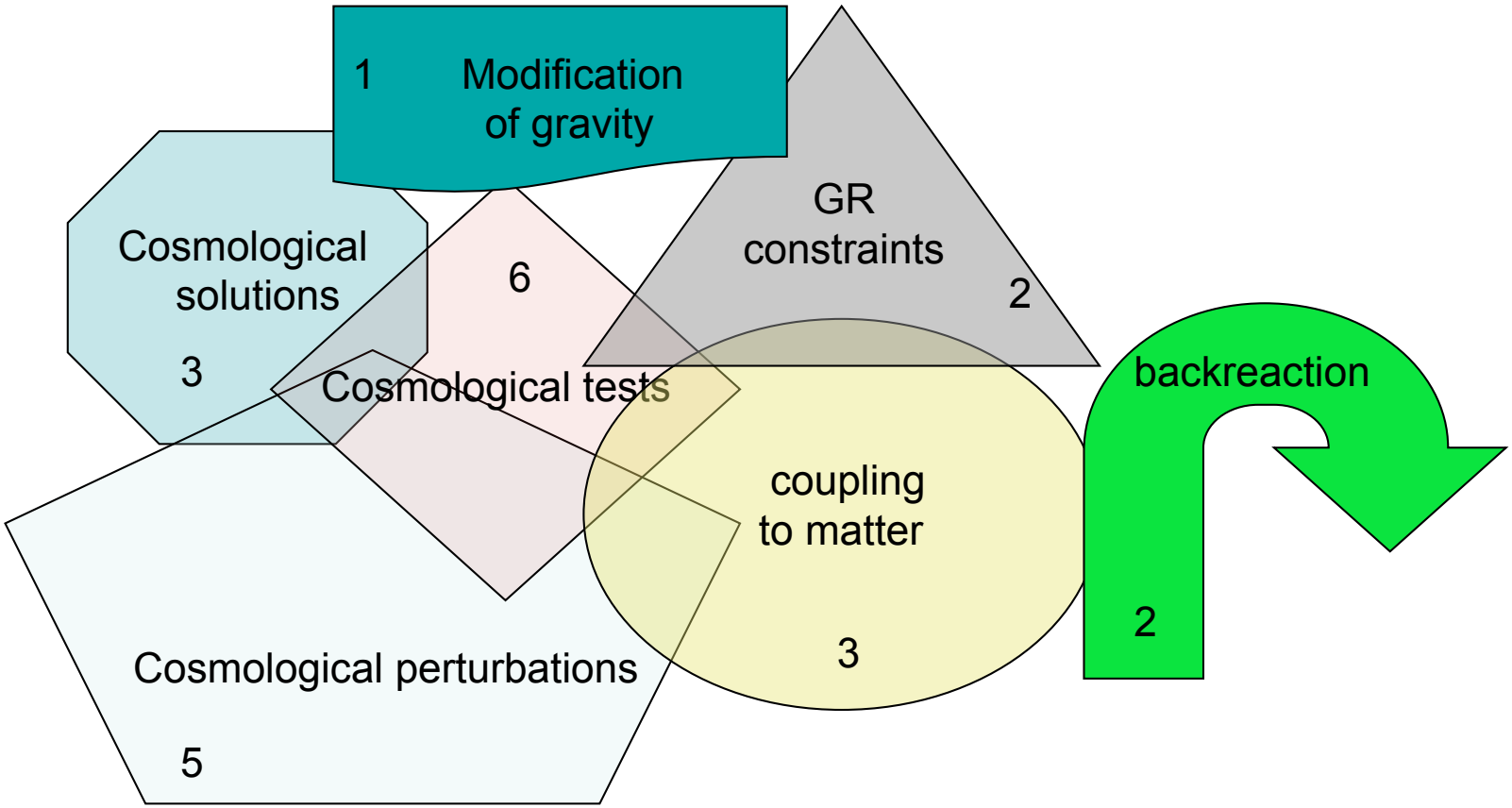
How to test dark energy?

Observational strategy

Transparency of A. Riotto at Oxford 2008



Nothing has really changed…

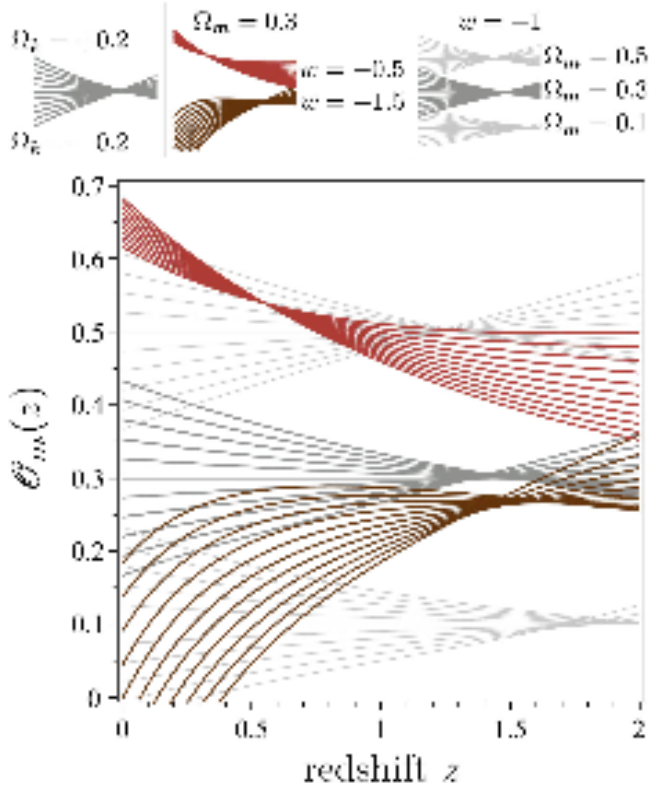


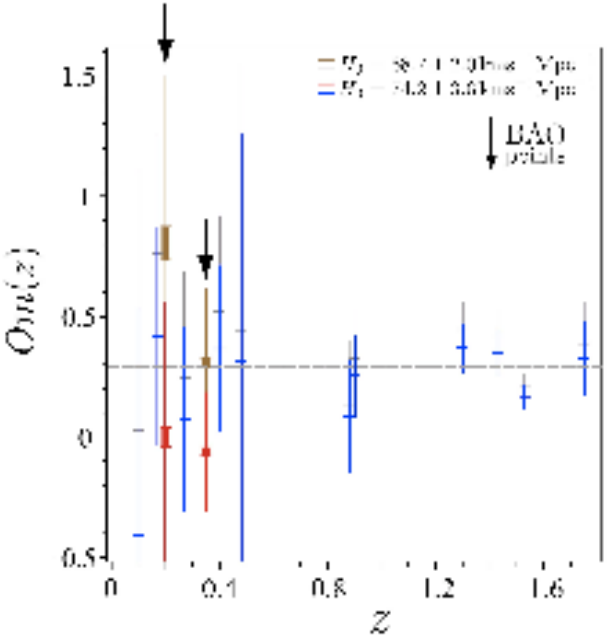
Very little work on explicit realizations within realistic models

Model independent tests of the standard cosmological model

Arman Shafieloo and Chris Clarkson 0911.4858

$$O_m(z) = \frac{h^2(z)-1}{(1+z)^3 - 1}$$



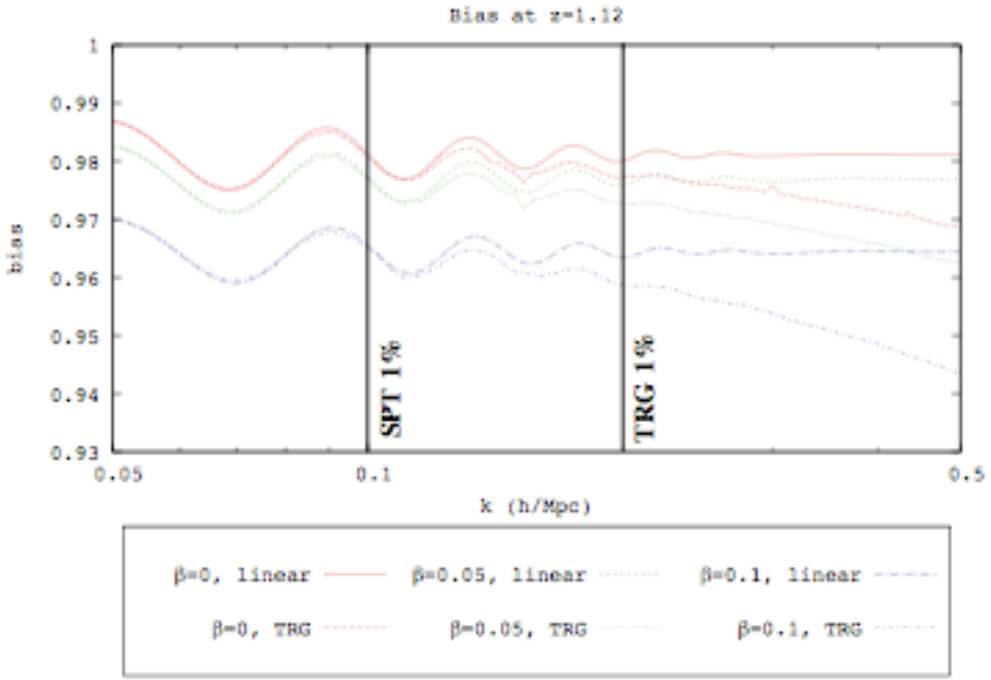


$O_m(z) = \Omega_m$ for ΛCDM

Coupling dark energy with dark matter

DM-DE coupling

$$\text{Bias} = \sqrt{\frac{P_{BM}(k)}{P_{CDM}(k)}}$$



Non-linear matter spectra in coupled quintessence

F. Saracco, M. Pietroni, N. Tetradis, V. Pettorino, G. Robbers 0911.5396

An important quantity: the speed of sound

$$c_S^2 = \frac{\partial p}{\partial \rho}$$

$c_s^2 \sim 1$

pressure overcomes gravitational clustering

diffuse dark energy

$c_s^2 \ll 1$

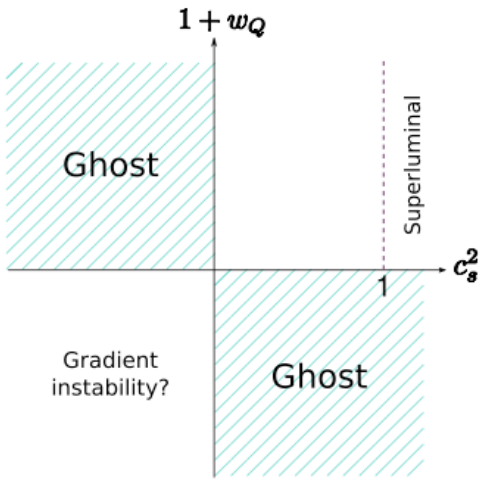
pressure does not prevent gravitational clustering

dark energy follows dark matter during collapse

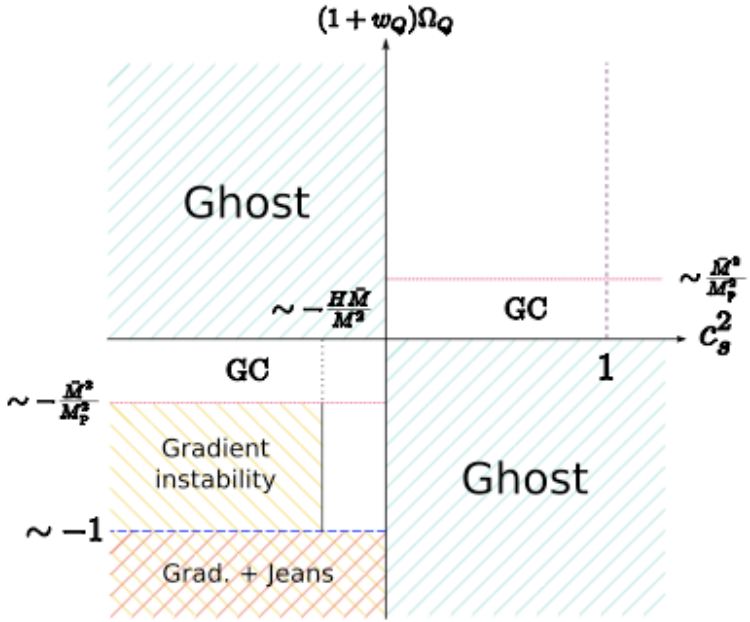
P. Creminelli, G. D'Amico, J. Noreña (Trieste), F. Vernizzi (IPhT) The effective theory of quintessence: the w<-1 side unveiled 0811.0827 [astro-ph]

The dark side of quintessence : w<-1

the gradient instabilities for w < –1 can be made harmless by higher derivative operators



k-essence



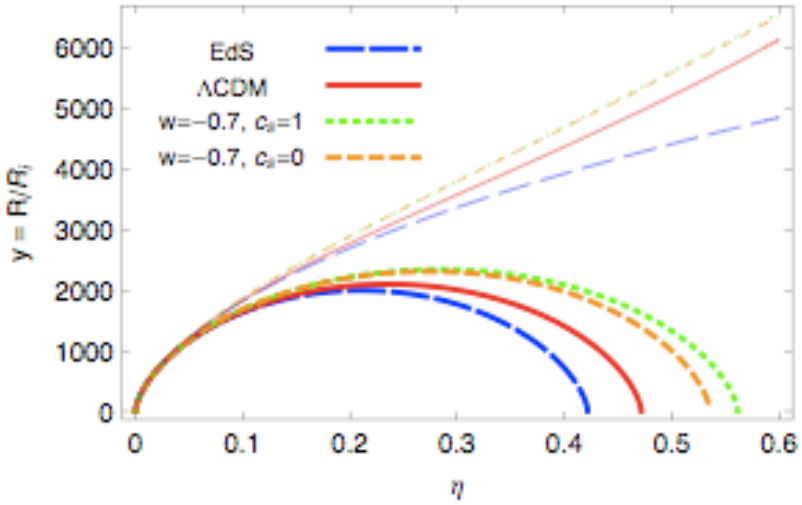
e.g. $\mathcal{L}_{\bar{M}} = -\frac{\bar{M}^2}{2}(\Box\phi + 3H(\phi))^2 \,.$

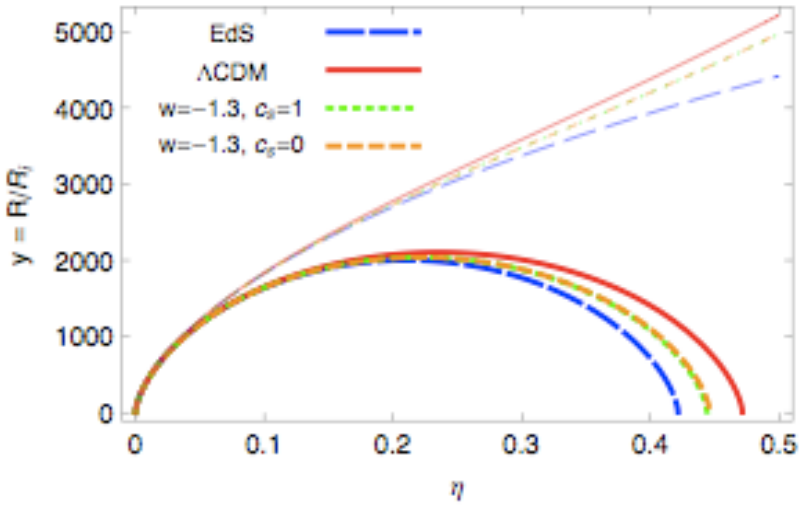
Ghost condensate

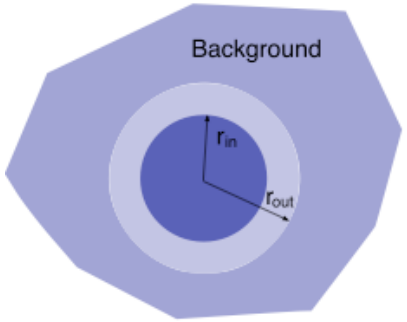
Requirement: $c_s < 10^{-15}$

Spherical collapse in quintessence models with zero speed of sound

P. Creminelli, G. D'Amico, J. Noreña, L. Senatore and F. Vernizzi 0911.2701



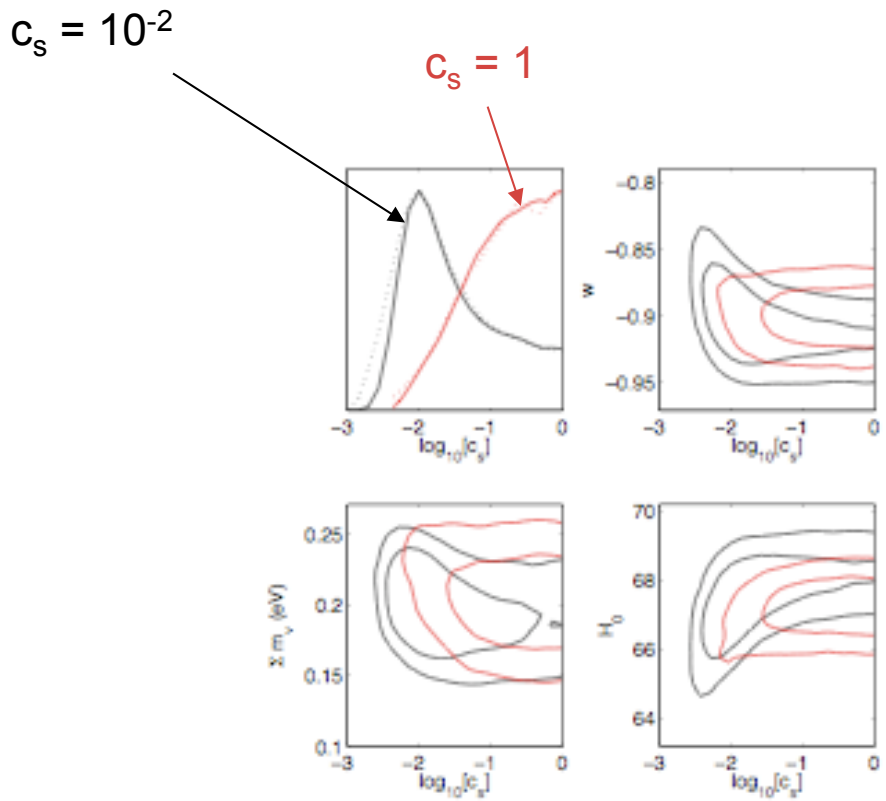




Time evolution of the radius for spherical collapse

Dark energy with non-adiabatic sound speed: initial conditions and detectability

G. Ballesteros and J. Lesgourgues 1004.5509



Marginalized posterior probability distribution of $\log_{10} c_s$ for Planck +LSST

Same conclusion as last year

Despite all the good work, we will need more than one UniverseNet to get out of the dark ages!