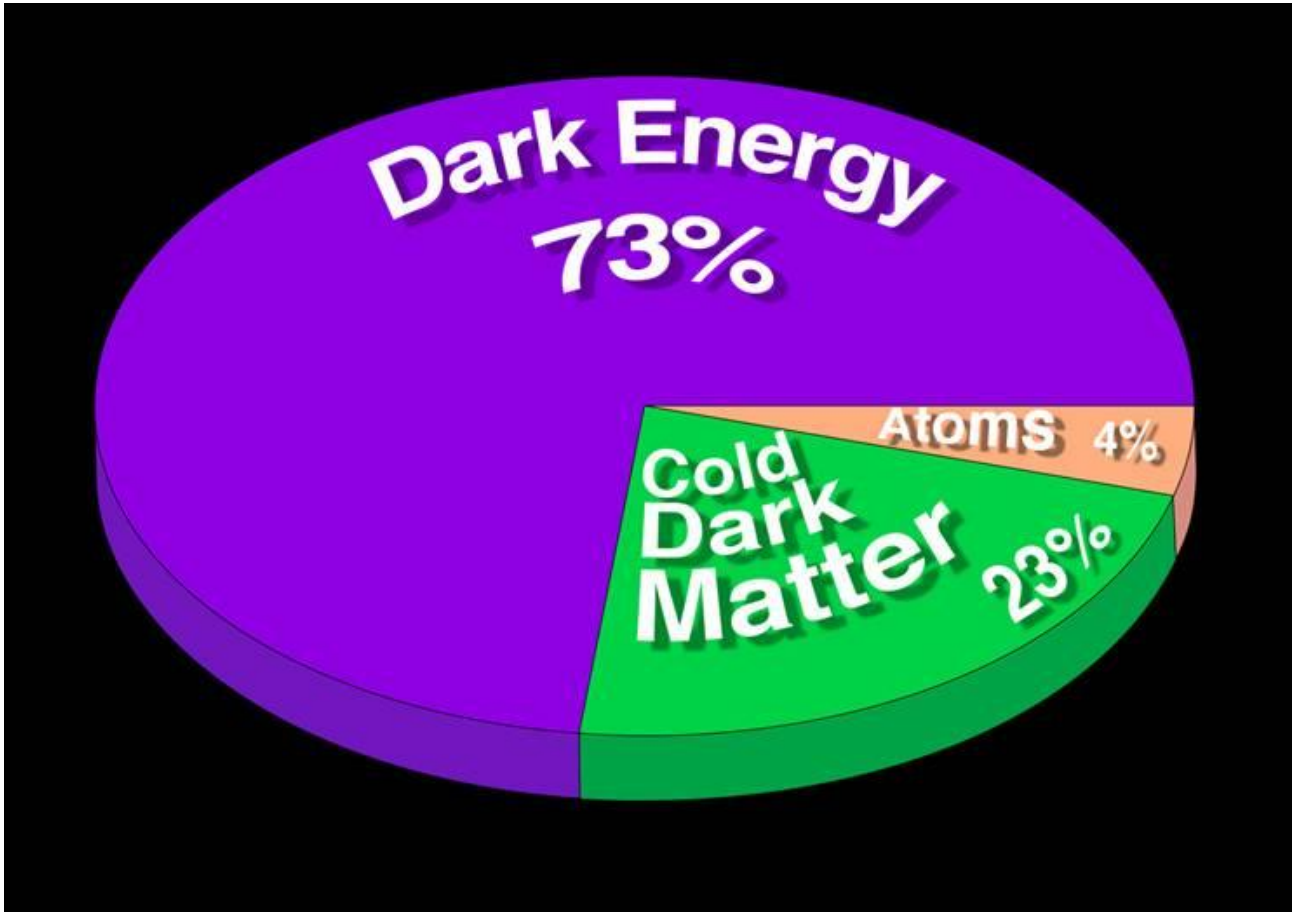
Does Dark Energy Exist?

CERN Theory Retreat, 4th November 2010.

Timothy Clifton

The ‘Observed’ Cosmic Cocktail



Methodology in Cosmology

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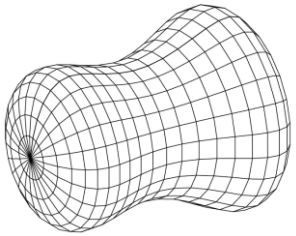

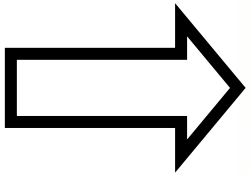

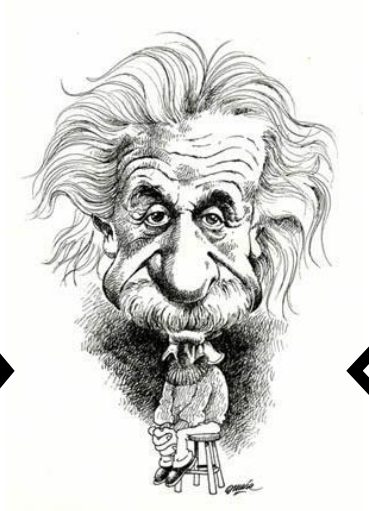

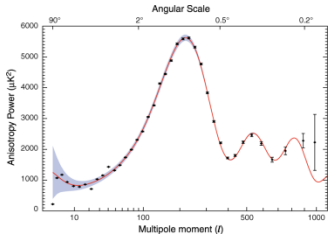

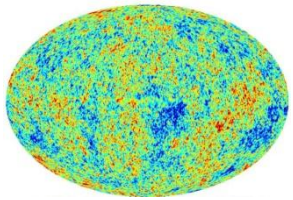

Choose some matter fields and
Choose some space-time symmetries

Solve Einstein's equations

Compare to observations

Methodology in Cosmology

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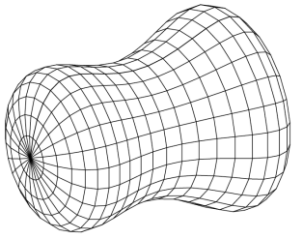

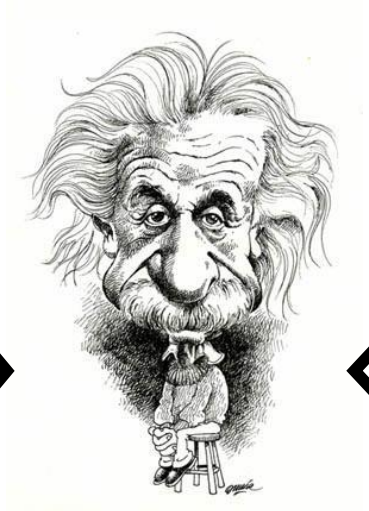

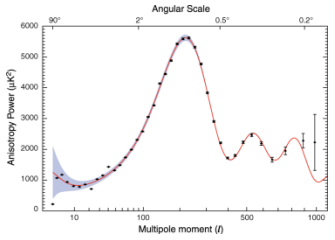

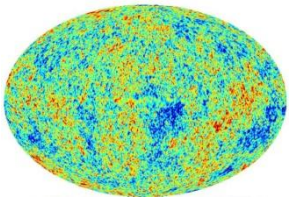

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DARK ENERGY!

Dark Energy exists if...

- General Relativity is correct on cosmological scales
- The Copernican Principle is true
- Matter/CMB observations are sufficiently isotropic & slowly varying
- Linear perturbation theory can adequately describe the late Universe
- ...

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- New behaviour
  - Non-perturbative gravity can become important
  - Theorems of GR are no longer valid
  - Approach to the initial singularity can change

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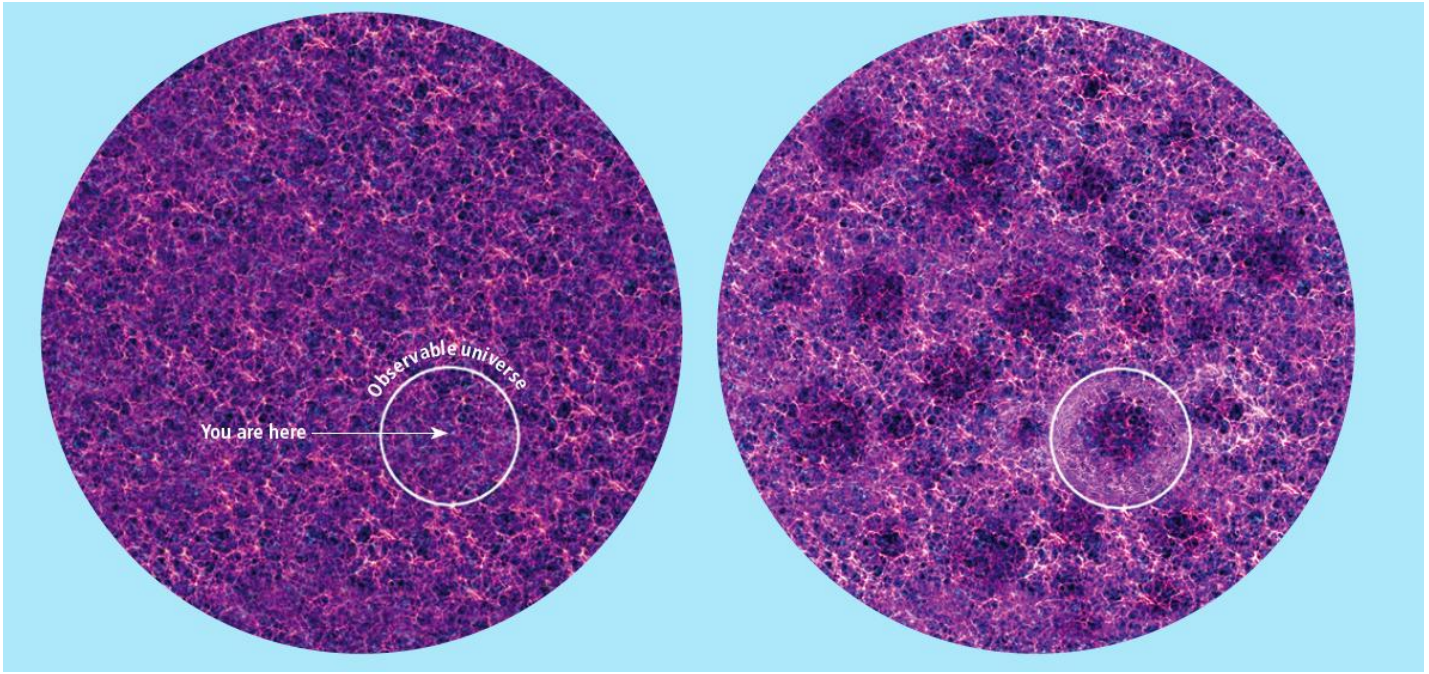

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- The first three terms in a series expansion of luminosity distance as a function of redshift are all isotropic, and the Universe is expanding.
  (Hass & Perlick)

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- All gravitational fields are well modelled by linear order potentials.
  - But are the backgrounds of all gravitating systems the same?
- Background expansion is not affected by perturbations.
  - Assumes a well defined, covariant, unique way of averaging in general relativity that we can straightforwardly apply.

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So... the existence of DE must also be considered unclear.