

Smooth Dark Energy

- Physical model of cosmic acceleration must specify 2 scalar closure relations + energy-momentum conservation [Hu (1998) - see also Martin Kunz talk]
- Density and anisotropic stress (or Newton G, slip)
<http://camb.info/ppf> Fang, Hu, Lewis (2009)
- Quintessence: no linear anisotropic stress, sound speed $c_s=1$
- K-essence: variable sound speed
- Below sound horizon dark energy density fluctuations negligible compared with dark matter
[caution! not true for momentum fluctuation in all gauges]
- Impact on structure formation comes purely from effect on background expansion
- Smooth dark energy hypothesis highly falsifiable

Falsifiability of Smooth Dark Energy

- With the **smoothness assumption**, dark energy only affects **gravitational growth of structure** through changing the **expansion rate**
- Hence **geometric** measurements of the expansion rate **predict** the **growth** of structure
 - Hubble Constant
 - Supernovae
 - Baryon Acoustic Oscillations
- **Growth of structure** measurements can therefore **falsify** the whole smooth dark energy paradigm
 - Cluster Abundance
 - Weak Lensing
 - Velocity Field (Redshift Space Distortion)