DISCUSSIONS
(with controversies if possible...)

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astrophysique & planétologie

Benasque, August 10, 2012

Université de Toulouse

IUF

Everybody knows
that we are living in
an accelerated Universe...

Nobel Prize in Physics 2011

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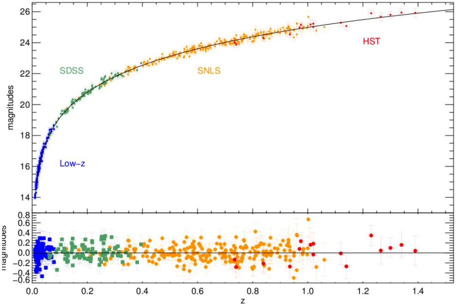
S.Perlmuter, A.Riess, B.Schmidt

SNIa Hubble diagramm (2012)

SNLS



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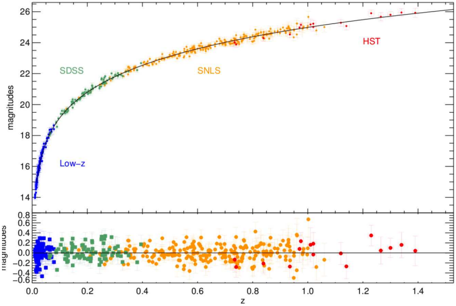

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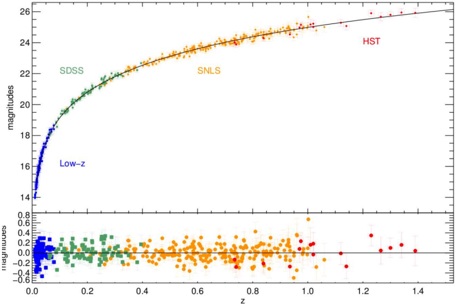

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Main constraint on $w(z)$...

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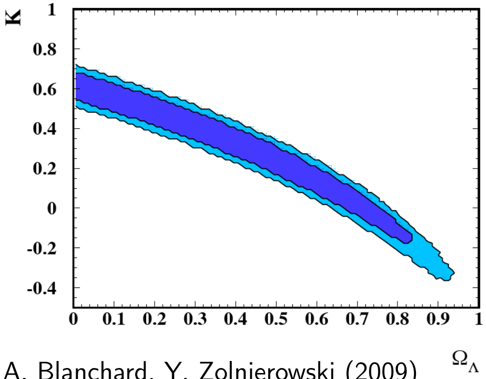

L. Ferramacho, A. Blanchard, Y. Zolnierowski (2009)

Cosmic microwave radiation fluctuations

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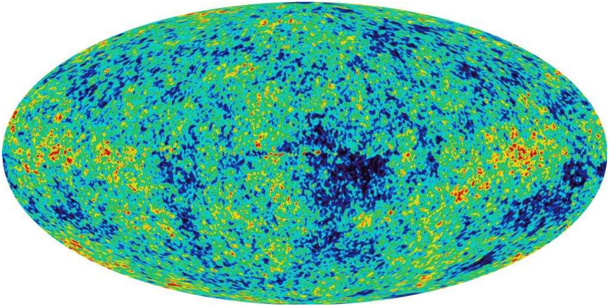
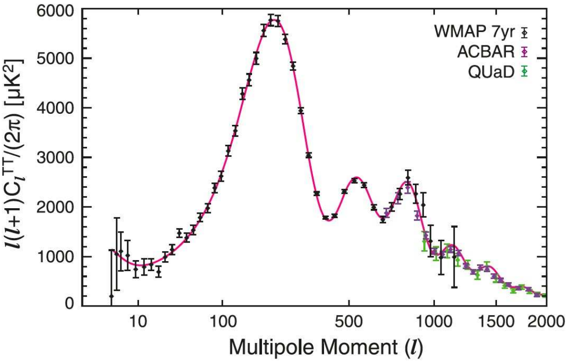


WMAP 1, 3, 5, 7,...

Cosmic microwave radiation fluctuations



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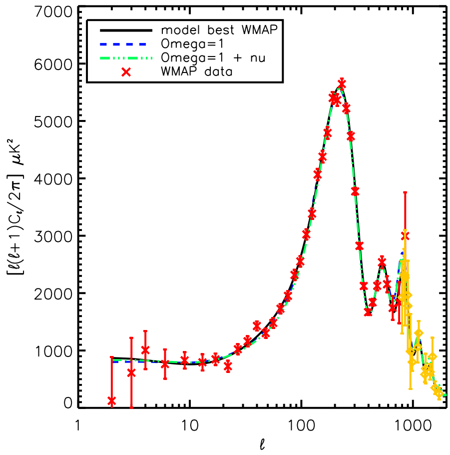

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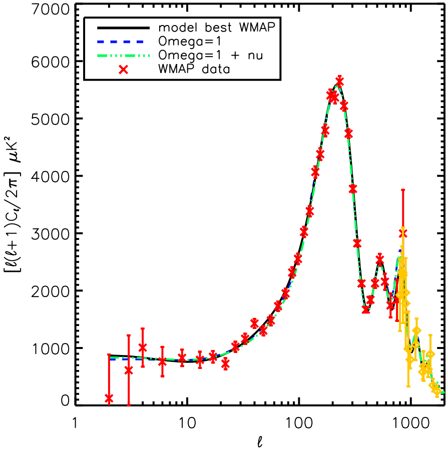

Degeneracy in parameters allows to reproduce the C_l

Blanchard et al., 2003

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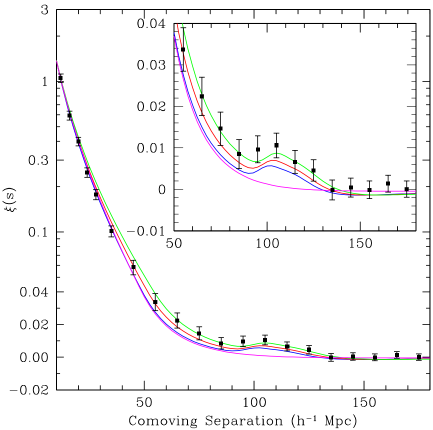

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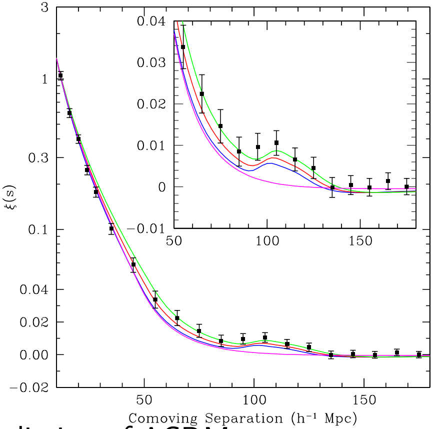

This was a prediction of ΛCDM

(Very) Positive point for ΛCDM

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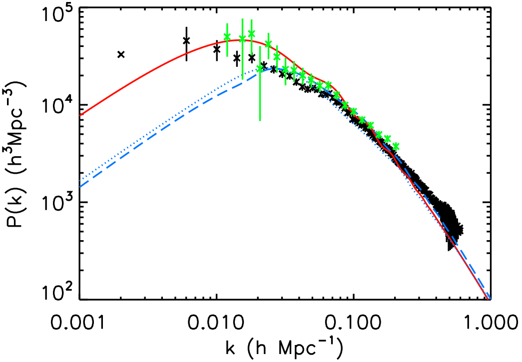

Standard Cosmological model: ΛCDM

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SNIa, CMB, P(k)

$$\Omega_m = 0.271 \pm 0.015$$

$$\Omega_k = -0.002 \pm 0.006$$

$$w = -1.069 \pm 0.091$$

Sullivan et al. (2011)

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So that the gravity strength is repulsive and proportional to R

...

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Can we really understand the origin of acceleration ?

Quantum vacuum as the source of the acceleration

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Arnaud Dupays (LCAR), Brahim Lamine (LKB) & AB

In progress.

Historical aspects

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So is this the origin of the acceleration ?

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The Vacuum catastroph (Weinberg, 1989):

$$\rho_v = \langle 0 | T^{00} | 0 \rangle = \frac{1}{2(2\pi)^3} \int_0^{+\infty} k \, \mathrm{d}^3\mathbf{k}$$

highly divergent.

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highly divergent :

$$\rho_v(k_c) \propto \frac{k_c^4}{16\pi^2}$$

Equation of state

The pressure:

$$p_v = (\mathbf{1/3}) \sum_i \langle 0 | T^{ii} | 0 \rangle = \frac{1}{3} \frac{1}{2(2\pi)^3} \int_0^{+\infty} k \, \mathrm{d}^3 \mathbf{k}$$

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i.e. eq. (1) + eq. (2) leads to :

$$p_v = \rho_v = 0$$

Equation of state

The density and pressure can be computed by dimensional regularization. Still diverging... but finite terms remain with the correct equation of state:

$$\rho_v = \frac{m^4}{64\pi^2} \log\left(\frac{m^2}{\mu^2}\right)$$

So is zero for a massless field.
(cf J.Martin 2012)

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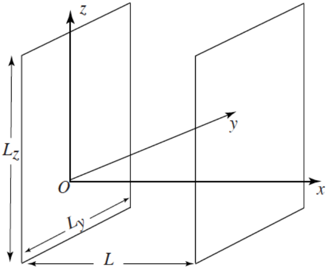

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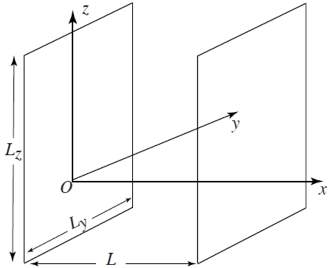

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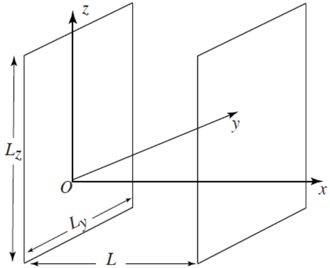

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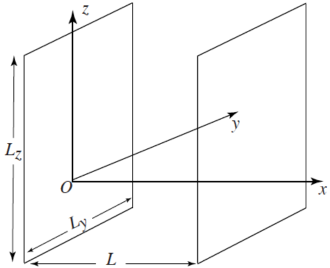

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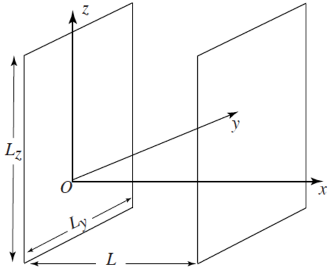

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Brown & Maclay (1968)

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Cosmology: at high energy, only modes with λ smaller than ct have to be taken into account i.e.:

$$\rho_v = \frac{5\hbar c}{8\pi^3 R} \int_{\omega > \omega_H}^{\infty} k^2 \mathrm{d}k \left[\sum_{n=-\infty}^{\infty} \left(k^2 + \frac{n^2}{R^2} \right)^{1/2} \right]$$

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However, as long as $ct \ll 2\pi R$ vacuum should be that of a massless field in a 4+1D space time i.e.:

$$\rho_v = 0$$

Isotropy ends...

when $\omega_H \sim \frac{1}{R}$, this is the last time at which symetries ensure $\rho_v = 0$. Then

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Later, when $ct \gg 2\pi R$ i.e. $\omega_H \sim 0$

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The condition :

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$R \sim 25\mu\mathrm{m}$ fits data. Corresponding to $E \sim 1\,TeV$

Conclusion

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This would be the simplest explanation...