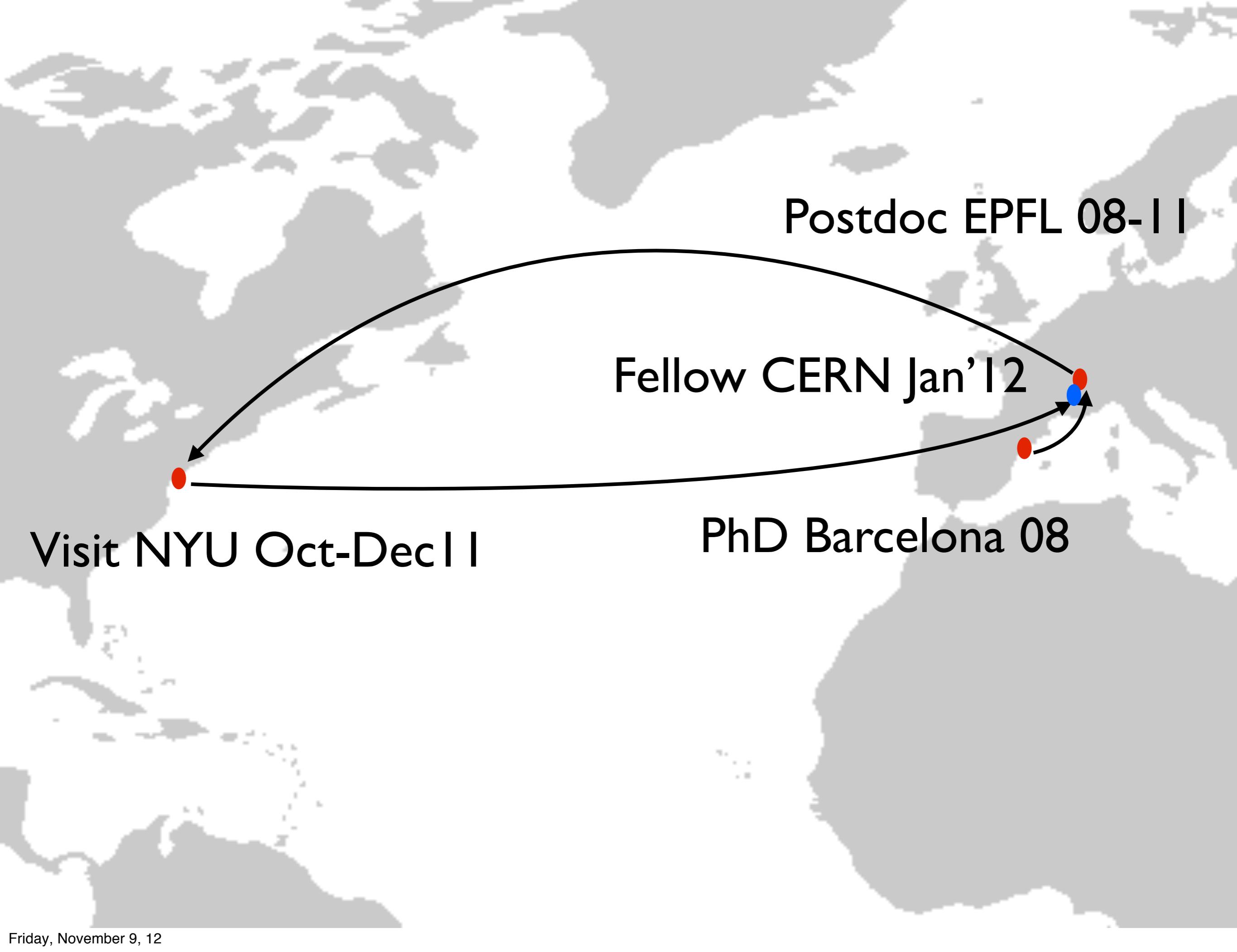


# Understanding Gravity at all scales

new approaches in quantum gravity and cosmology

Diego Blas



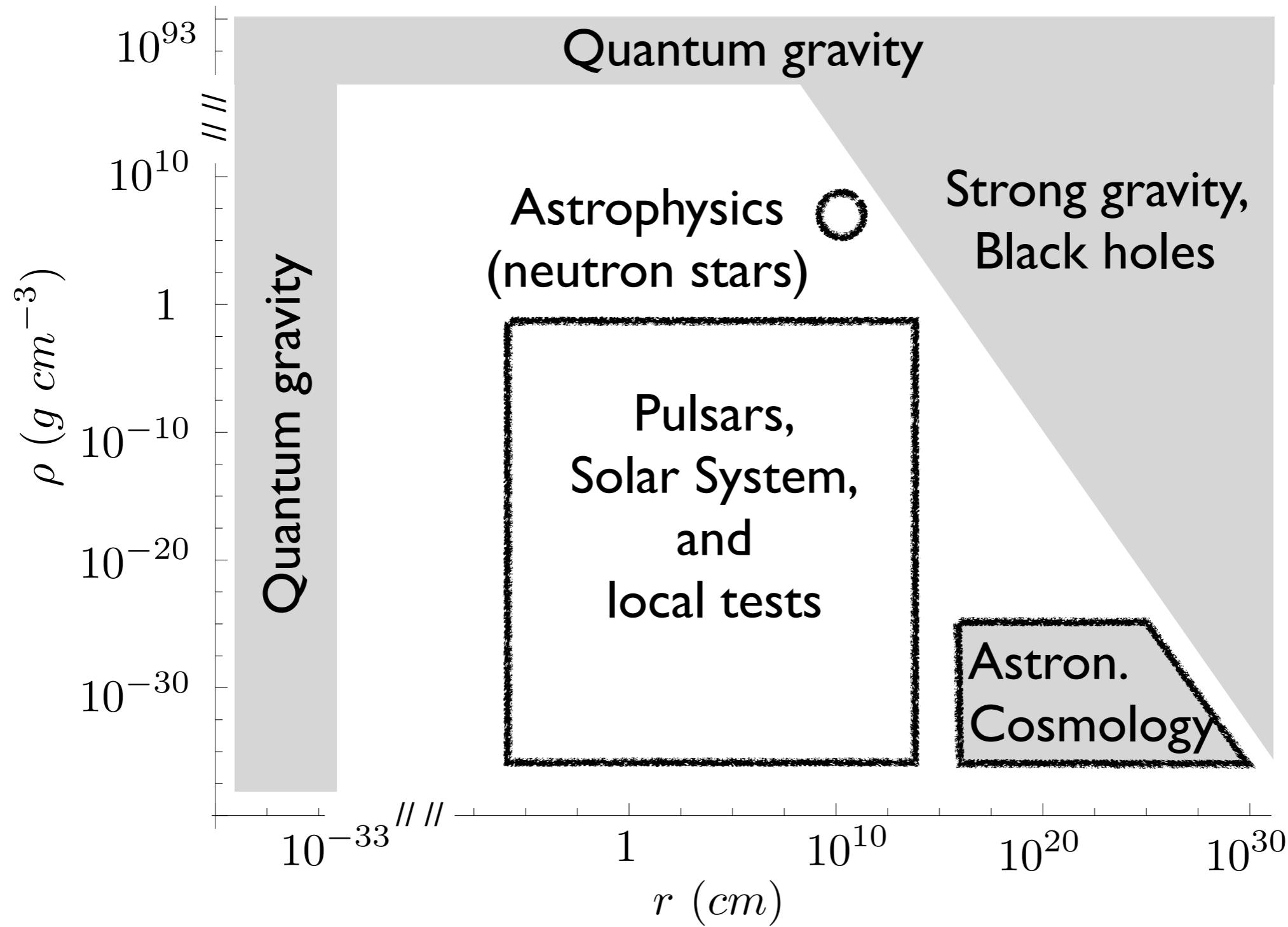


Postdoc EPFL 08-11

Fellow CERN Jan'12

Visit NYU Oct-Dec 11

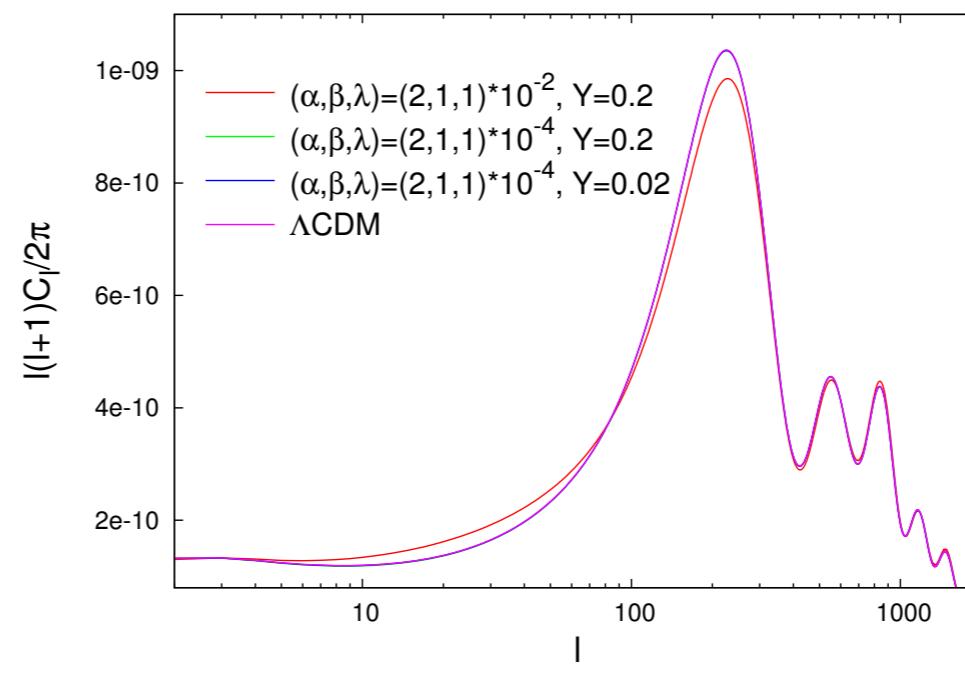
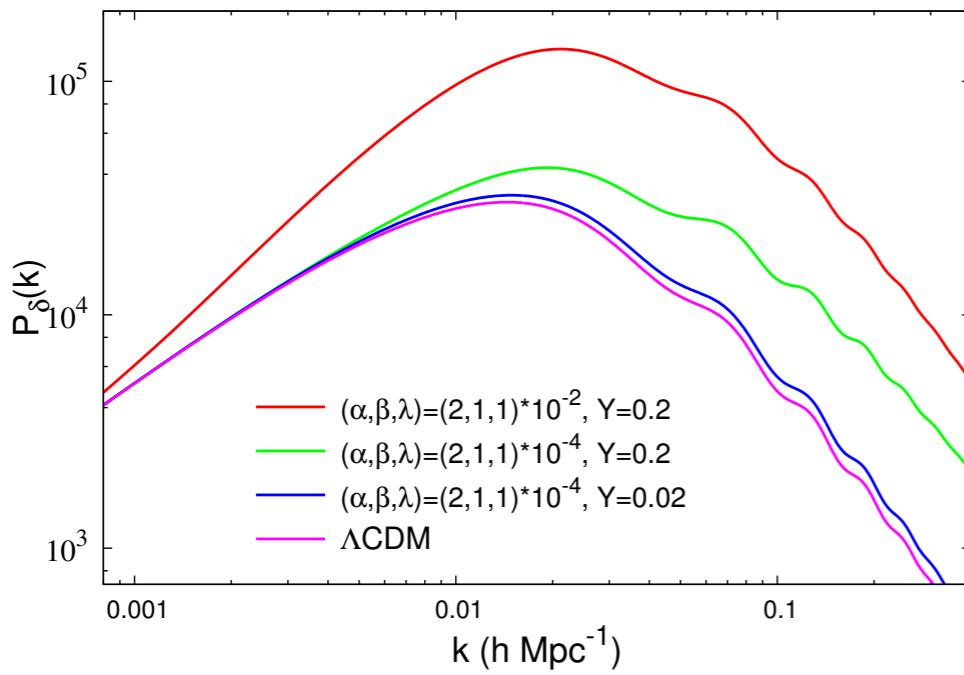
PhD Barcelona 08



**Past:** Dark matter, black holes, gravity waves, dark energy, post-Newtonian physics, next to leading order  $\Lambda$ CDM, scale invariant alternatives to GR, quantum gravity (Hořava), massive gravity, unimodular gravity

# Cosmology: Lorentz breaking effects

- Testing Lorentz invariance of the dark sector:  
effects in CMB and distribution of matter (PS)
    - \* Motivation: quantum gravity/phenomenological
    - \* Consequences (highlights):
      - > UV insensitive candidate for dark energy/quintessence
      - > enhanced clustering of dark matter
- broken gauge symmetry  $\longleftrightarrow$  new degree of freedom

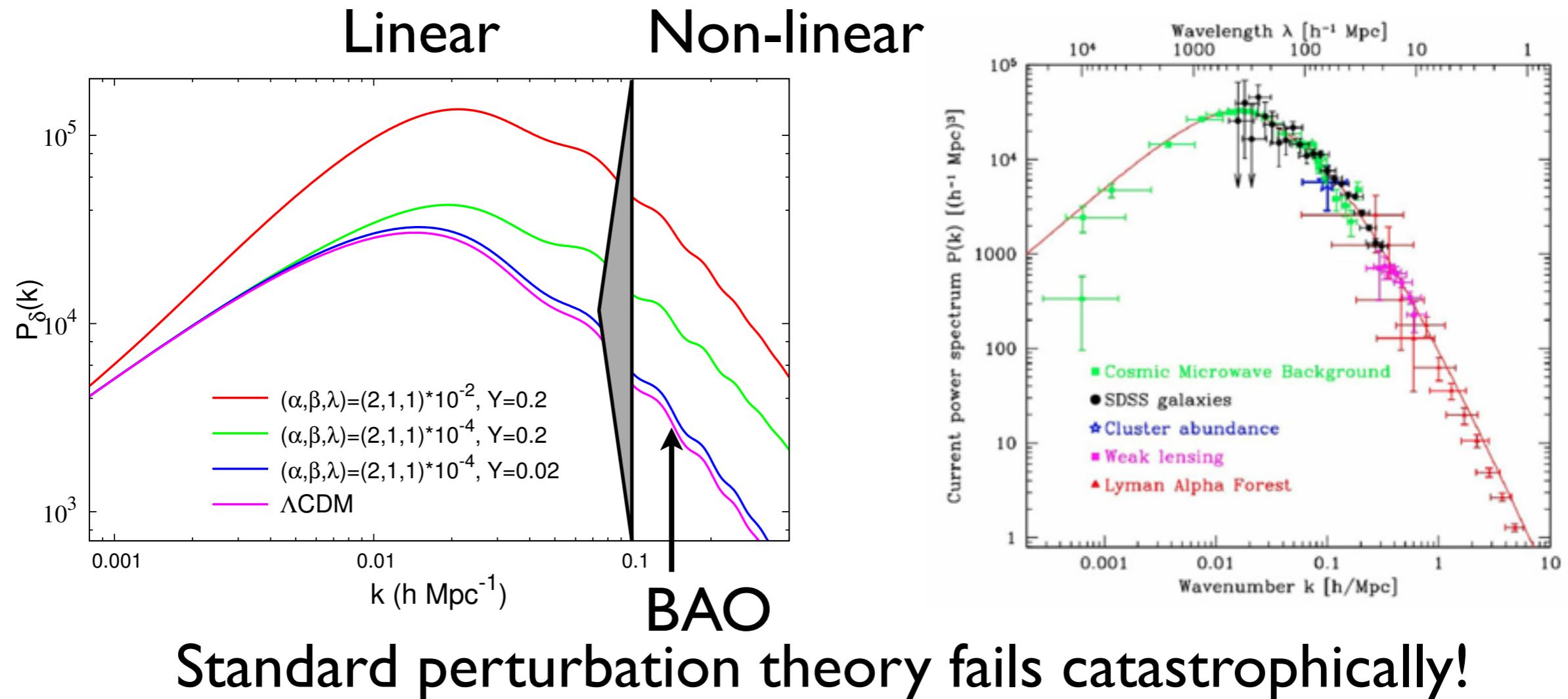


$$DM_{LB} < 10^{-2}$$

$$SM_{LB} < 10^{-20}$$

# Cosmology: beyond perturbation theory

- Non-perturbative techniques in cosmology



Standard perturbation theory fails catastrophically!

- \* **EFT:** use PT with an effective theory matched to simulations
- \* **Resummations:** reorganization of PT for better convergence  
Several approaches in the market. Effects of the bulk flows.

# Quantum gravity: Hořava Gravity

- Beyond power counting

**Hořava's:** pQFT for gravity without Lorentz invariance

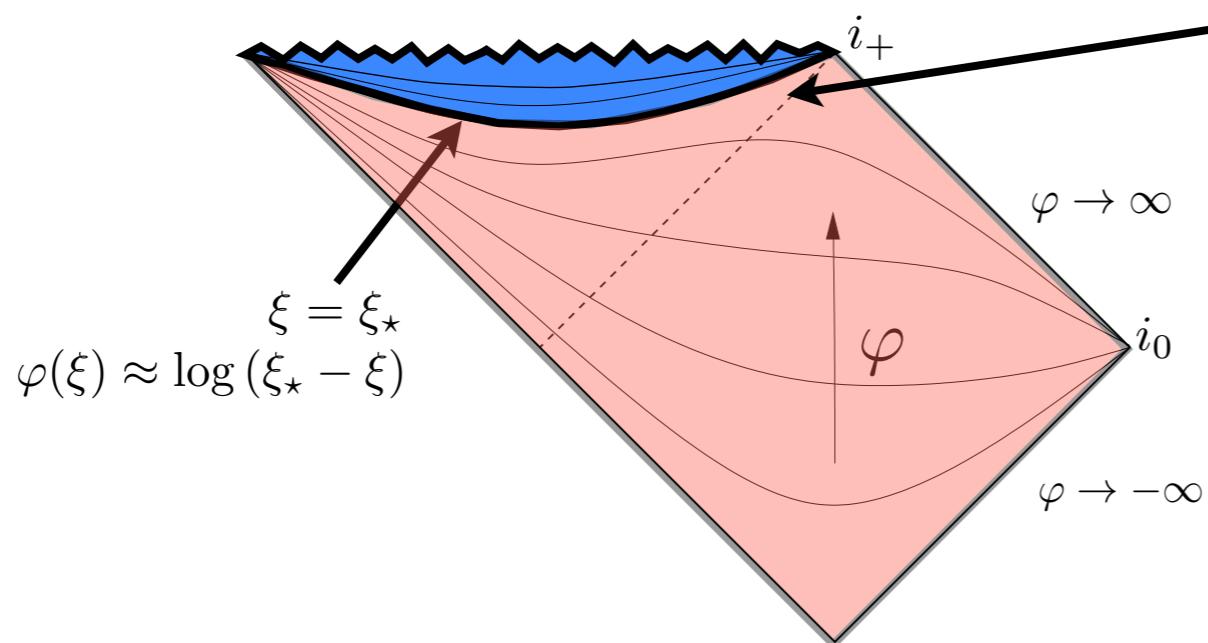
Power counting

$$G \sim \frac{1}{\omega^2 - k^2 \left( (1 + \left( \frac{k}{M_*} \right)^4) \right)}$$

One-loop/amplitudes



- Black hole physics



Singularity at large distance

different ‘vacuum’ state than  
the one of Hawking radiation

Fireball??