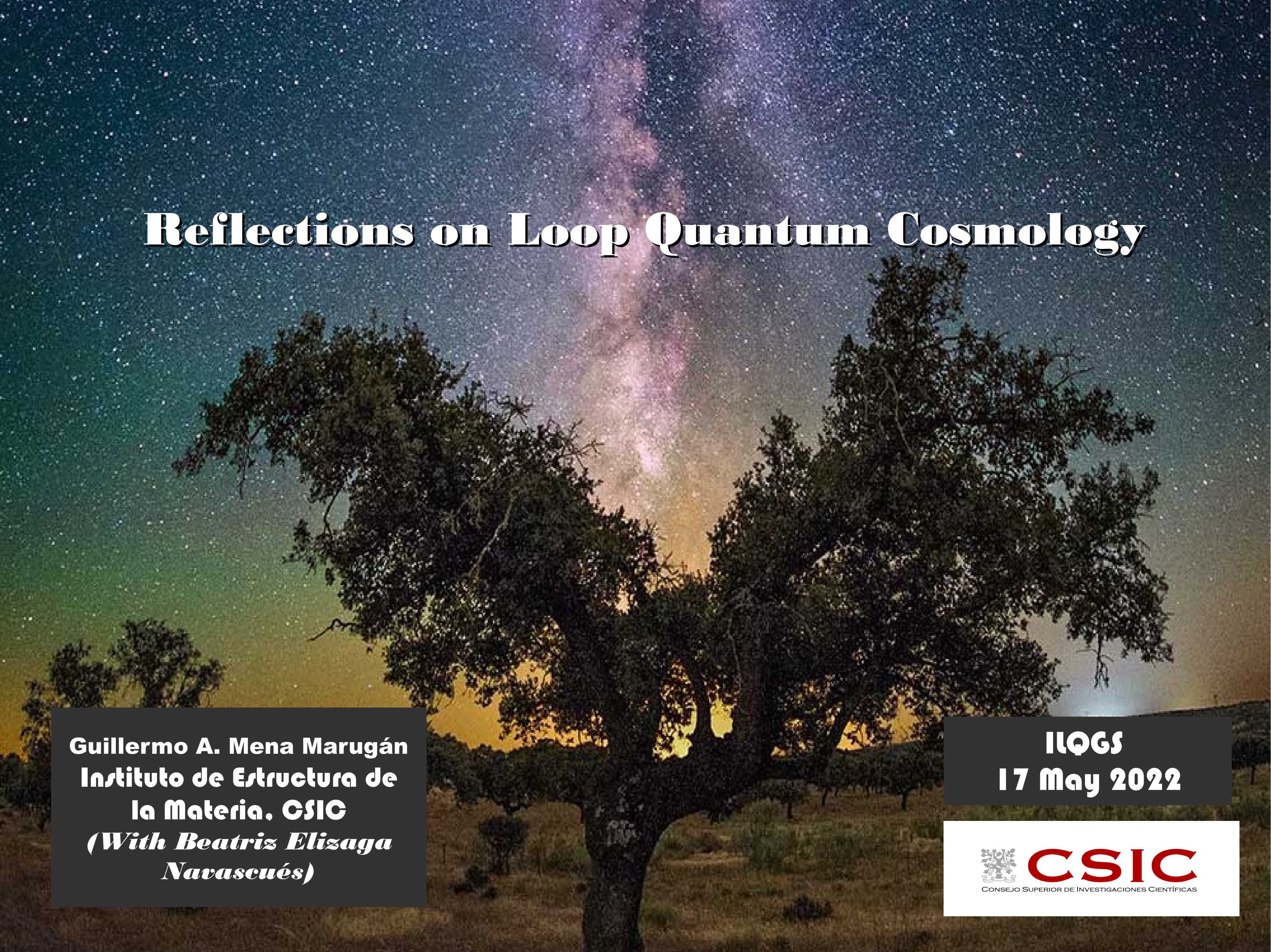

Reflections on Loop Quantum Cosmology

Guillermo A. Mena Marugán
Instituto de Estructura de la Materia, CSIC
(With Beatriz Elizaga Navascués)

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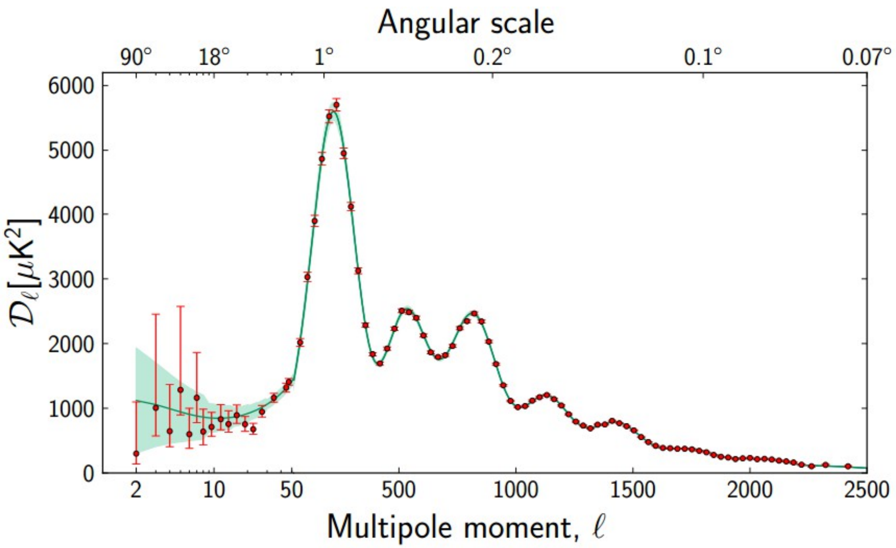
Consejo Superior de Investigaciones Científicas

Why Cosmology?

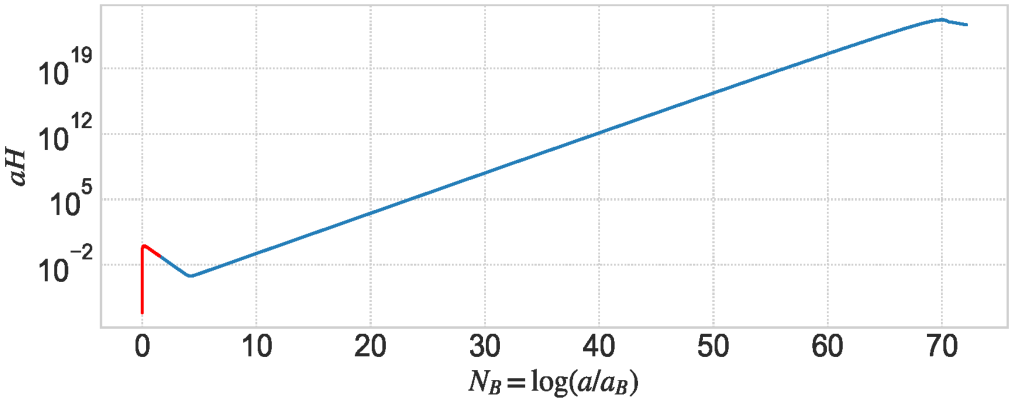
- Cosmology provides a testbed and a context to extract predictions.
- The Big Bang brings to the scene the fate of singularities.
- The Very Early Universe experienced large curvatures.
- The behavior during inflation and post-inflation appears very classical.
- In this sense, cosmology is a field where UV meets IR naturally.

- Observations display anomalies that might indicate new physics.
- A challenge is to make the scale invariance compatible with a quantum scale.



Cosmological perturbations in LQC

- What do we mean by LQC? ⟶ LQG methods in cosmological scenarios.
- Ambiguities?
- LQC must co-exist with the successful standard cosmological model.
- Quantum effects ⟶ From Pandora's box to question their observability.
- Departures of homogeneity and isotropy are viewed as perturbations.
- We consider quantum backgrounds that behave effectively, with (negligibly) small backreaction.



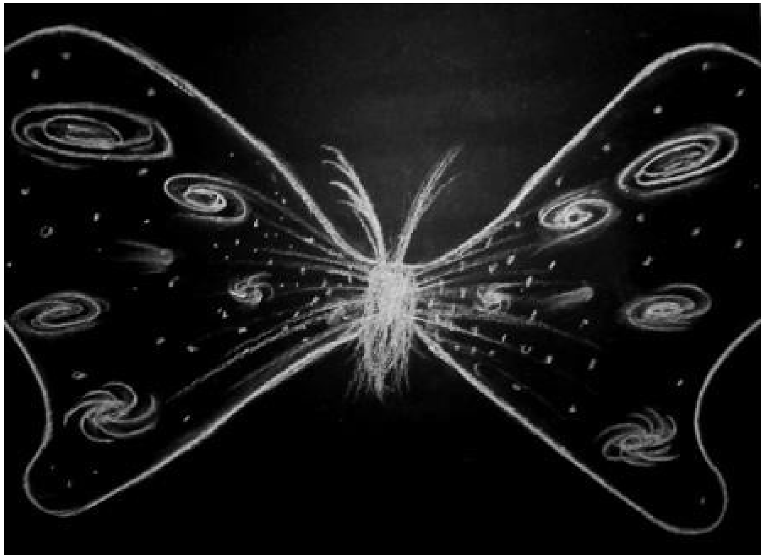
- The backgrounds studied in LQC present a bounce.
- Does this affect the perturbations?

Routes to QFT in (quantum) CST

- Two possible routes: dressed metric and hybrid LQC.

  A) Hybrid LQC:
  - Compact spatial sections.
  - Up to quadratic perturbations in the action.
  - Constrained truncated system.
  - Continuous non-compact limit.

  B) Dressed metric:
  - Negligible backreaction.
  - Effective dressed metric.
  - “Mean-field” approximation.



- Dynamics of the perturbations:

  - Background: effective regime of LQC.
  - Pertubations: Fock quantization of (classical) gauge invariants.
  - (Fourier) modes: oscillators with background dependent mass.

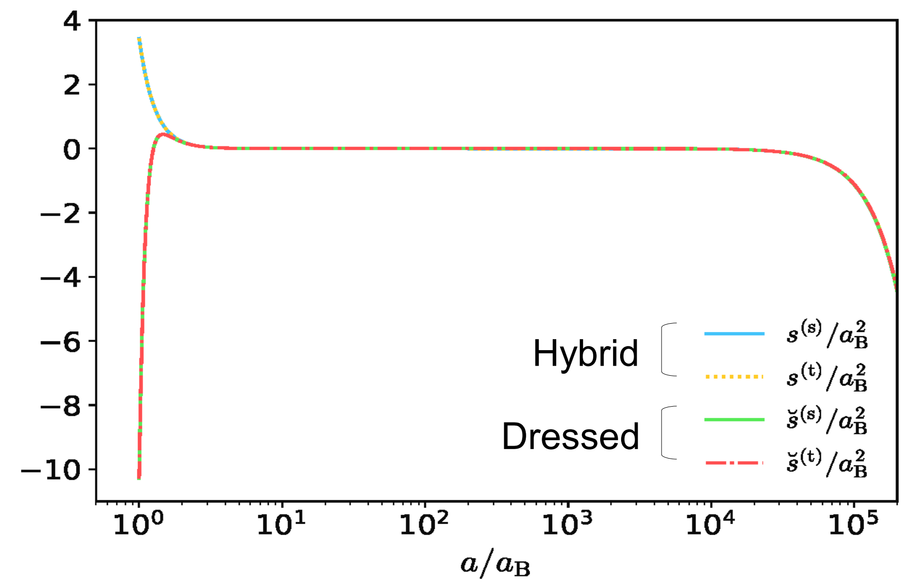
Hybrid LQC/Dressed metric

- Redefinition of the canonical set (backreaction?) / Homogeneous LQC x Fock gauge invariants.

- Totally constrained system (backreaction?) / Constrained background.

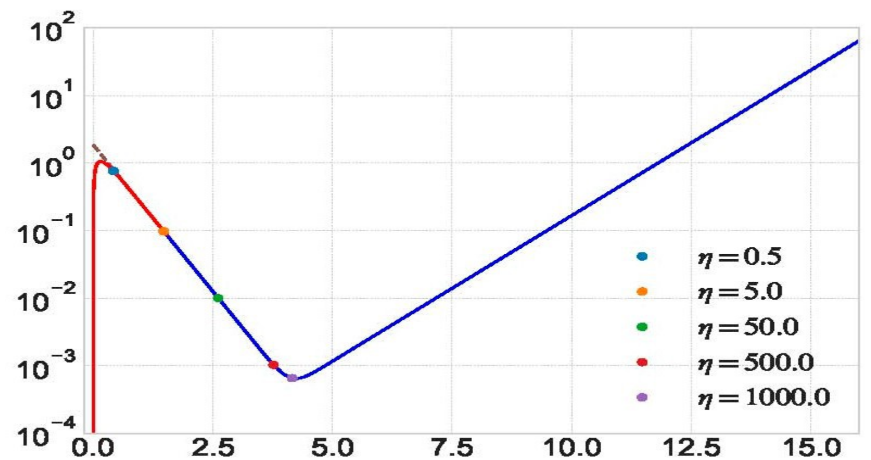
- “Canonical” description of the background dependent **mass** / Description on effective trajectories of LQC.

Differences only near the bounce.

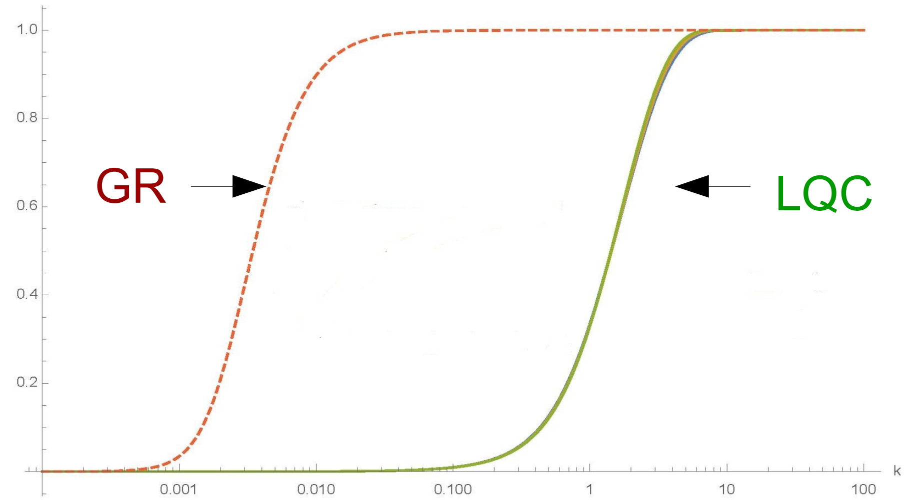


LQC/General Relativity

- Let us consider kinetically dominated regimes accompanied by short lived inflation.
- This is the case in LQC for effective solutions of phenomenological interest / In GR, this modifies the results of slow roll inflation.

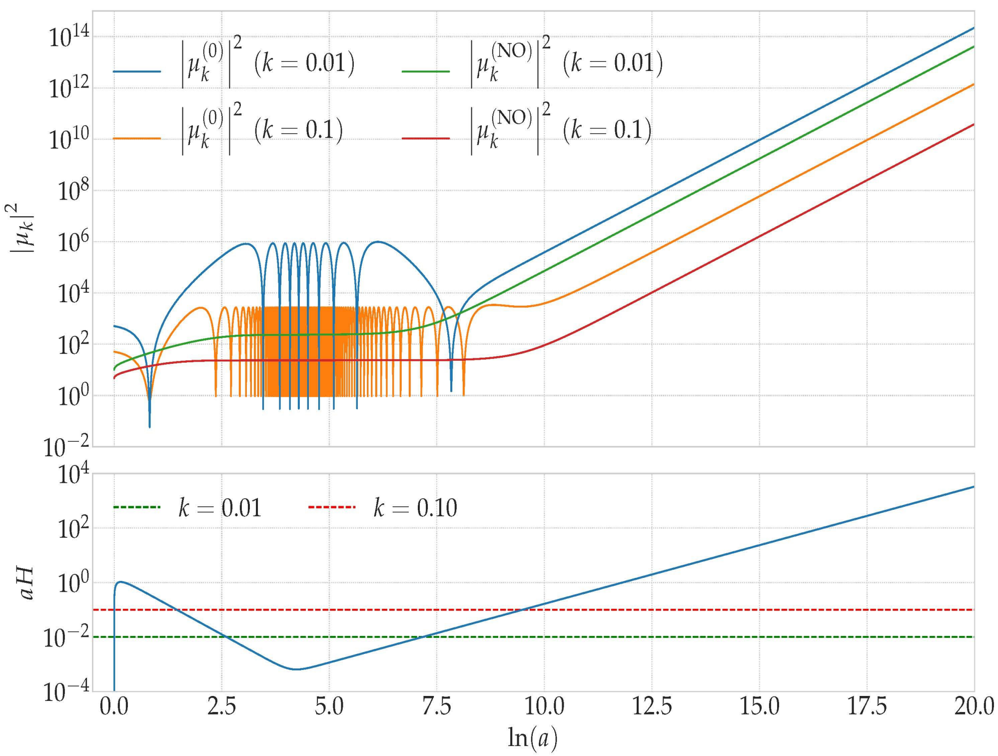


- Do these effects dominate over quantum corrections?
- How do they affect scale invariance?



Vacuum state

- The predictions depend **strongly** on the choice of vacuum state.
- The freedom can be used, e.g., to select a Fock quantization with improved properties of the Hamiltonian of the perturbations: domain of n-particle states, regularization…
- Proposals:



i. Adiabatic states.
Meaning in quantum regimes?

ii. Non-Oscillating (NO) state.
Oscillations enhance the power.
Analytic characterizations...
In which regimes?

iii. AG-state.
Precise definition.
Definition in GR?

Life beyond *horror vacui*

We expect that the vacuum state should:

- Lead only to small changes with respect to the Bunch-Davies state.
- Be motivated by first principles.
- Be optimally adapted to the dynamics (i.e., the background dependent mass).
- Be sensitive to the model scales.