

Research project for an M2 stage:
Primordial black holes and non-perturbative contributions to
primordial fluctuations

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1 Status of the field

Primordial inflation is believed to be responsible for seeding cosmological fluctuations. Indeed, there are clear strong resemblances between such a predicted spectrum and what we see in the sky. However, it is not still very clear how to make sense of the number and size of black holes that seem to populate the universe. Black holes millions times more massive than the sun are found in the center of most galaxies. Moreover, among the first gravitational wave events that we are detecting with LIGO/VIRGO are inspirals of black holes whose masses are so large that were generally believed to be very rare objects.

In [1] an interesting association has been hinted, relating the production of primordial black holes with certain non-perturbative aspects of the mechanism that allows the production of primordial perturbations during inflation.

2 Background and acquired expertise.

This subject represents an important opportunity to learn *i)* the basics of inflationary physics *ii)* some aspects of non-perturbative quantum field theory and *iii)* the basics of quantum cosmology and cosmological applications of tunneling effects. Reading and digesting Ref. [1] will be a first important step for the candidate to get into the matter. The observational aspects related with primordial black holes and their abundances are also of much relevance these days.

3 Aim of the research

The broad aim of this research is to find mechanisms alternative to those discussed in [1] (e.g. slightly different inflationary scenarios) and/or alternative frameworks to which the technique described in this reference can be applied (e.g. quantum phase transitions, possible other quantum aspects of cosmology).

References

- [1] M. Celia, P. Creminelli, G. Tambalo and V. Yingcharoenrat, “Beyond perturbation theory in inflation,” JCAP **06** (2021), 051 doi:10.1088/1475-7516/2021/06/051 [arXiv:2103.09244 [hep-th]].