Internship in ESA's Advanced Concepts Team

on

Signal processing techniques in QFT

Topic description

In relativistic quantum field theory, the vacuum depends on the observer. This has strong consequences, such as the Unruh effect: an observer uniformly accelerated in the vacuum will see a thermal state [1]. Those effect have been studied in details for stationary situations, but the exploration of realistic non-stationary situations is recent [2]. This is enabled by the use of tools from signal processing and especially time-frequency analysis. However, the analysis carried in [2] only concerns single-detection events for 1+1D motions.

The goal of this internship would be to extend the analysis to general motions (e.g. circular for a finite amount of time), and provide a numerical tool for a general 3+1D trajectory. If time allows, we will also explore the correlations between different detection events, by analyzing higher-order correlation functions, as well as the case of a non-flat spacetime.

Candidate's tasks

- Analyzing quantum field theory in general frames,
- Provide a numerical tool to address the case of general 3+1D trajectories,
- Extend this problem for higher-order correlation functions,
- Extend this problem in the presence of a background gravitational field.

The ideal candidate

Mandatory:

- Background in Quantum Field Theory,
- Programming skills in Python or C/C++ (numerical integration).

Desirable:

- Background in signal processing methods.

References

[1] Unruh, W. G. (1976). "Notes on black-hole evaporation". *Physical Review D.* 14 (4): 870–892.

[2] Roussel, B., and A. Feller. 2019. "Time-Frequency Approach to Relativistic Correlations in Quantum Field Theory." *Phys. Rev. D* 100 (4): 045016