Parameter estimation of gravitational waves with a quantum metropolis algorithm

Gabriel Escrig Mas
Roberto Campos, Pablo A M Casares, and M A Martin-Delgado

Universidad Complutense de Madrid, Departamento de Física Teórica I, Facultad de Ciencias Físicas, Plaza de Ciencias 1, 28040, Madrid, Spain

gescrig@ucm.es

Abstract

After the first detection of a gravitational wave in 2015, the number of successes achieved by this innovative way of looking through the Universe has not stopped growing. However, the current techniques for analysing this type of events present a serious bottleneck due to the high computational power they require.
In this talk, we explore how recent techniques based on quantum algorithms could surpass this obstacle [1]. For this purpose, we propose a quantization of the classical algorithms used in the literature for the inference of gravitational wave parameters [2] based on the well-known quantum walks technique applied to a Metropolis–Hastings algorithm. Finally, we develop a quantum environment on classical hardware, implementing a metric [3] to compare quantum versus classical algorithms in a fair way. We further test all these developments in the real inference of several sets of parameters of all the events of the first detection period GWTC-1 [4] and we expose a polynomial advantage in the quantum algorithms, thus setting a first starting point for future algorithms.

References

[1] Gabriel Escrig *et al*, *Class. Quantum Grav.*, 40 (2023) 045001
[2] Christensen N and Meyer R, *Rev. Mod. Phys.*, 94 (2022) 025001
[3] Lemieux J, Heim B, Poulin D, Svore K and Troyer M, Quantum, 4 (2020) 287
[4] Alexander Nitz et al, arXiv pre-print, (2021)

Figures

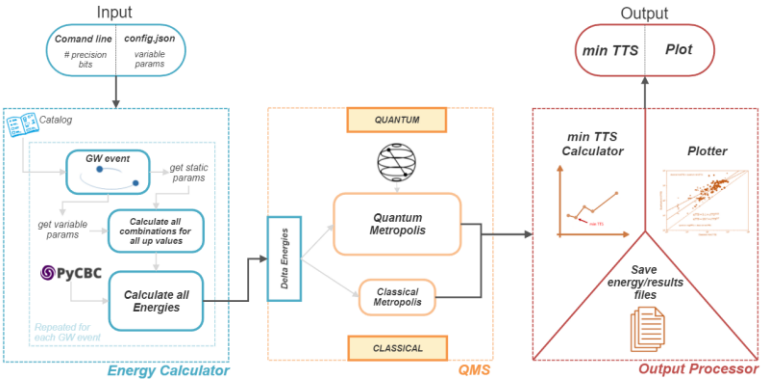

Figure 1: Flowchart of the algorithm implemented.

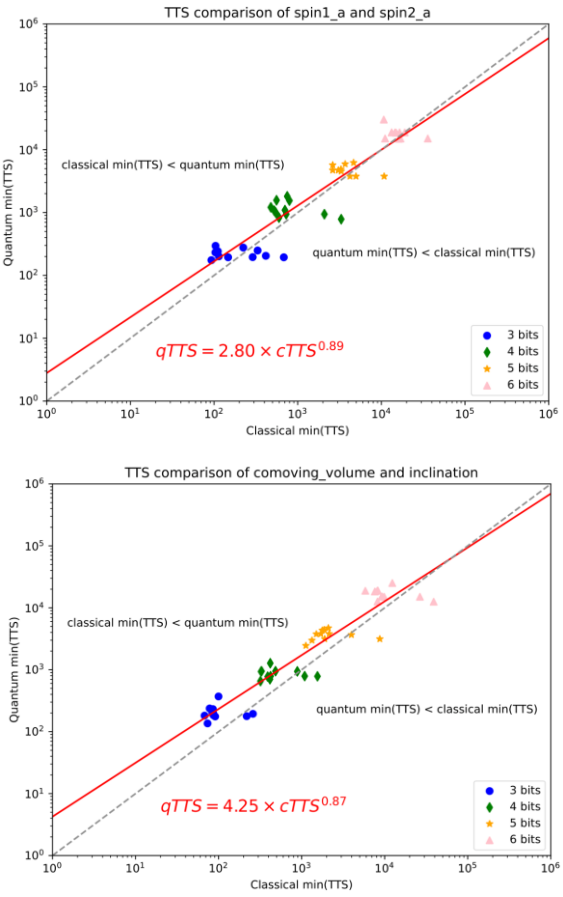

Figure 2: Comparison of the metric for 2-parameter inference simulation for quantum vs classical algorithms, achieving a quantum advantage.