

# Digital quantum computing for collective neutrino oscillations

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Studies of neutrinos from astrophysical environments such as core-collapse supernovae, neutron star mergers and the early universe provide a large amount of information about various phenomena occurring in them. The description of the flavor oscillation is a crucial aspect for such studies, since the physics of matter under extreme conditions is strongly flavor-dependents. The neutrino flavor changes under the effect of 3 contributions: the vacuum oscillation, the interaction with the electrons of the surrounding matter, and the collective oscillations due to interactions between different neutrinos. This last effect adds a non-linear contribution to the equations of motion, making the exact simulation of such a system inaccessible from any current classical computational resource.

Our goal is to describe the real time evolution of a system of many neutrinos by implementing the unitary propagator  $U(t) = e^{-iHt}$  using quantum computation and paying attention to the fact that the flavor Hamiltonian, in the presence of neutrino-neutrino term, presents an all-to-all interaction that makes the implementation of  $U(t)$ , into a quantum algorithm, strongly dependent on the qubit topology. In this contribution we present an efficient way to simulate the coherent collective oscillations of a system of  $N$  neutrinos motivating the benefits of full-qubit connectivity which allows for more freedom in gate decomposition and a smaller number of quantum gates making simulation on near-term quantum devices more feasible. We present the results obtained from a real quantum simulation on a trapped-ions based quantum machine.

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