Contribution ID: **18** Type: **Short talk (10' +5')**

Simulation of two flavor neutrino oscillations on a quantum processor

Thursday 17 July 2025 15:35 (20 minutes)

Classical simulations of neutrino oscillations faces multiple computational challenges such as simulating collective neutrino systems (e.g. inside of core collapse supernovae) and incorporating complex quantum effects (matter effects, quantum decoherence in a dense medium). These challenges can be overcome using quantum simulation as these can emulate different quantum systems rather than calculating their associated probabilities. In this talk, its presented the emulation of a two flavor neutrino oscillation system using a quantum processor. First, following the methodology presented in [1], a U3-gate is used to represent the basis change (Mass-Flavor) and then a S-gate to make the system evolve in time. Once the circuit is designed, its parameters are adjusted to fit the conditions for different situations/experiments (DUNE, KamLAND). Finally a comparison between theoretical solutions, an IBM Qiskit simulation (AerSimulator) and an IBM quantum processor (ibm_sherbrooke) is shown. The comparison shows a maximum porcentual error of 7\%.

[1] Argüelles, C. A., Jones, B. J. P. (2019).
Neutrino oscillations in a quantum processor.
Physical Review Research, 1(3).

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Track Classification: Neutrinos