Nonlinear dynamics as a ground-state solution on quantum computers

For the solution of time-dependent nonlinear differential equations, we present variational quantum algorithms (VQAs) that encode both space and time in qubit register. We obtain the entire time evolution by computing the ground state of a modified Feynman—Kitaev Hamiltonian [1,2]. We describe a general procedure to construct efficient quantum circuits for the cost function evaluation and an adaptive optimisation strategy to mitigate barren plateaus. We illustrate the approach using the nonlinear Burgers equation, showing that the IBMQ Ehningen machine can accurately reproduce the ground-state solution.

[1] McClean, J. et al. PNAS 110, E3901

[2] Barison, S. et al. Phys. Rev. Res. 4, 043161