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A Quantum Algorithm for a Class of Nonlinear Differential Equations[1] HERMAN OIE KOLDEN, Norwegian University of Science and Technology, JIN-PENG LIU, University of Maryland, NUNO LOUREIRO, Massachusetts Institute of Technology, ANDREW CHILDS, KONSTANTINA TRIVISA, University of Maryland, HARI KROVI, Raytheon BBN Technologies, PAOLA CAPPELLARO, Massachusetts Institute of Technology — With modern plasma simulations requiring large computational resources, there has been a recent interest in exploring whether computational plasma physics can benefit from the specialized efficiency of quantum computers. However, the nonlinearity commonly found in plasma dynamics is an obstacle for the linear nature of quantum mechanics. Recent proposals have suggested embedding the nonlinear system in a larger and linear one, with a computational cost scaling linearly with the dimension of the original equation. Our method is based on Carleman linearization, and it scales only polylogarithmically with the dimension. Using existing quantum algorithms for linear equations, we solve a truncation of an infinite-dimensional system and output a state vector encoding the solution. We prove that the method achieves arbitrary accuracy for ODEs whose nonlinearity is sufficiently weak in a specific sense, and we find numerical evidence that the method also works for the discretization of certain dissipative nonlinear PDEs.

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