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Solving the Navier-Stokes governing equations through quantum computing FRANK GAITAN, Laboratory for Physical Sciences — We present a quantum algorithm that solves an arbitrary set of coupled non-linear partial differential equations and show how it can be used to solve the governing equations for a Navier-Stokes fluid. To test the algorithm we examine the problem of inviscid, compressible flow through a convergent-divergent nozzle. We numerically simulate application of the algorithm to find the steady-state flow when a shock-wave is and is not present in the divergent part of the nozzle. In each case excellent agreement is found between the output of the quantum simulation and the exact analytical solution, with the simulation successfully capturing the shock-wave in the latter case. We compare the computational cost of this quantum algorithm to that of deterministic and random classical algorithms; discuss future applications, as well as the potential long-term significance of quantum computing for the fluid dynamics community.

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