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Dedalus: A spectral solver for PDEs with diverse applications to CFD KEATON J BURNS, Massachusetts Institute of Technology, GEOFFREY M VASIL, University of Sydney, JEFFREY S OISHI, Bates College, DANIEL LECOANET, Princeton University, BENJAMIN P BROWN, University of Colorado Boulder — Dedalus is an open-source framework for solving general partial differential equations with spectral methods. It is designed for maximum flexibility and incorporates features such as symbolic equation entry, custom domain construction, and automatic MPI parallelization. We will briefly describe key algorithmic features of the code, including our sparse discretization and multidimensional domain distribution. We will then discuss implementations of incompressible and compressible hydrodynamics using the Dedalus framework. For incompressible flow, we simultaneously solve for the pressure as a Lagrange multiplier enforcing the divergence-free constraint as we implicitly evolve the velocity field. This avoids operator splitting and allows for the use of high-order DAE timestepping methods. For compressible flows, we implement a mixed implicit-explicit formulation that allows us to implicitly timestep sound waves and efficiently simulate low-Mach-number but large-scale flows prevalent in astrophysics and atmospheric science.

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