Sparse global spectral methods for curvilinear domains with Dedalus

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Dedalus is an open-source Python framework for solving general PDEs at scale with modern spectral methods. Here we present a new version of the code which includes vector-invariant equation specification and new global bases for curvilinear domains. Our new bases allow for the sparse discretization of generic tensor calculus operations in polar and spherical coordinates. These additions enable the symbolic specification and efficient solution of broad ranges of equations with spectral accuracy. In this talk, we will detail our interface for the coordinate-free entry and discretization of systems of PDEs, including prognostic equations and algebraic constraints. This system allows the inclusion of general boundary conditions, including nonlocal conditions, via generalized tau corrections that can also be specified symbolically. We will also discuss the fast direct solvers that allow for the implicit integration of the linear part of the PDE system and the enforcement of generic linear constraints. Finally, we will describe ongoing extensions of this framework to support high-order spectral elements and direct couplings with other PDE and BIE solvers.

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