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Discretely conservative, non-dissipative, and stable collocated method for solving the incompressible Navier-Stokes equations REETESH RANJAN, CARLOS PANTANO, University of Illinois at Urbana-Champaign — We present a new method for solving the incompressible Navier-Stokes equations. The method utilizes a collocated arrangement of all variables in space. It uses centered second-order accurate finite-difference approximations for all spatial derivatives and a third-order IMEX approach for time integration. The proposed method ensures discrete conservation of mass and momentum by discretizing the conservative form of the equations from the outset and never relying on continuum relations afterward. This ensures uniform high order of accuracy in time for all fields, including pressure. The pressure-momentum coupled equations can be easily segregated and solved sequentially, as in the pressure projection method but without a splitting error. In this approach there are no spurious kernel modes, checkerboard, in the embedded elliptic pressure problem. The method has been applied to different canonical problems, including a fully periodic box, a periodic channel, an inflow-outflow channel and a lid-driven cavity flow. Near wall boundaries, spatial derivatives are obtained using the weak form of the conservation equations, similar to a finite element approach. The results from some of the sample cases will be presented to illustrate the features of the method.

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