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Angular Momentum in Fluids ROBERT CLOSE, Clark College — Classical mechanics features three prominent independent conserved quantities: energy, momentum, and angular momentum. However, only the first two of these conservation laws are routinely applied to analysis of fluid motion. Conservation of angular momentum is neglected because no local representation of the conservation law has been available ($\mathbf{r} \times \mathbf{p}$ is non-local). However, it has recently been shown that spin density, the field whose curl is equal to twice the momentum density, provides a local representation of angular momentum density. Spin density is uniquely defined as twice the vector potential resulting from Helmholtz decomposition of momentum density. Previous analysis of spin density in an ideal elastic solid yields the Dirac equation and all of the dynamical operators of relativistic quantum mechanics, including spin and orbital angular momentum. When applied to fluid dynamics, the spin density equation provides an independent constraint on the motion in addition to the Navier-Stokes momentum density equation. The equation of evolution of spin density completely determines incompressible motion, thereby simplifying calculation of the evolution of fluid motion from initial conditions.

Robert Close
Clark College

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