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Invariant subgrid-scale closure schemes for turbulence modeling

The understanding and modeling of turbulence is one of the remaining great challenges in classical physics. In numerical simulations of turbulent flows one generally faces the problem of not being able to resolve all the scales that are relevant for the accurate prediction of the flow. Thus, a subgrid-scale closure scheme has to be introduced that mimics the effects of the unresolved scales. The use of an artificial subgrid-scale closure model bears the risk of destroying the geometric properties of the differential equations describing the fluid, which ultimately can lead to spurious effects in the computed numerical solutions.

In this talk we will focus on the systematic construction of turbulence models that preserve the Lie symmetries of the incompressible Euler or Navier-Stokes equations. The method we introduce relies on equivariant moving frames, which can be used to send an existing non-invariant subgrid-scale model to an invariant closure scheme. Numerical examples will be given in order to demonstrate that invariant turbulence models can yield realistic results in turbulence simulations.