Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

General Theory of Reynolds Stress T.-W. LEE, Arizona State University — Starting from a few years back, I formalized a Lagrangian transport equation for the Reynolds shear stress in canonical flows. This approach is generalized for the full tensor including the streamwise, lateral and shear stress components, and validated using available DNS (direct numerical simulation) data for channel, jet, and zero-pressure gradient boundary layer flows. Next level of flow effects such as adverse pressure gradient and swirl are considered, showing similar level of agreement between theory and DNS data. When viewed from this Lagrangian perspective, i.e. moving with the mean flow, the Reynolds stress is seen to follow the basic momentum principle, illustrating the intricate but intuitive balance of flux, pressure and viscous effects of turbulence momentum and energy. This formalism allows for dynamic explanations of the turbulence structure, and also a solution algorithm for simple geometries. The uniqueness of the solution to the Reynolds-averaged Navier-Stokes equation, and the lognormal form of the turbulence energy spectra, are also briefly philosophized in the context of the maximum entropy principle.

T.-W. Lee
Arizona State University

Date submitted: 13 Jul 2020 Electronic form version 1.4