Some Studies on the 3D Prandtl Layer Equations

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The talk presents some recent works on the 3D Prandtl boundary layer equations derived from both the incompressible and the compressible Navier-Stokes equations and shows the difference from 2D models. Firstly, a well-posedness of the 3D classical Prandtl layer equations both locally and globally in time under some constraint on its flow structure is given and it reveals the classical Burgers equation plays an important role in the analysis. The linear stability of this structured flow is justified. And then we will show that if a background state violates this constraint on the structure, the Prandtl equations are both linearly and nonlinearly instable in the Sobolev framework.

Motivated by the study on the 2D inviscid Prandtl system by Hong-Huneter, a semi-explicit formula of solution to the boundary layer system for the thermal layer derived from the compressible Navier-Stokes equations is given. Furthermore, the time asymptotic stability of the linearized system around a shear flow is studied that shows the asymptotic stability depends on whether the direction of tangential velocity field of the shear flow is invariant in the normal direction respective to the boundary.

This is a joint work with Chengjie Liu and Yaguang Wang.