Stability of Three-dimensional Prandtl Boundary Layers

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In this talk, we shall study the stability of the Prandtl boundary layer equations in three space variables. First, we obtain a well-posedness result of the three-dimensional Prandtl equations under some constraint on its flow structure. It reveals that the classical Burgers equation plays an important role in determining this type of flow with special structure, that avoids the appearance of the complicated secondary flow in the three-dimensional Prandtl boundary layers. Second, we give an instability criterion for the Prandtl equations in three space variables, which shows that the monotonicity condition of tangential velocity fields is not sufficient for the well-posedness of the three dimensional Prandtl equations, in contrast to the classical well-posedness theory of the Prandtl equations in two space variables under the Oleinik monotonicity assumption of the tangential velocity. Both of linear stability and nonlinear stability are considered. This criterion shows that the monotonic shear flow is linear stable for the three dimensional Prandtl equations if and only if the tangential velocity field direction is invariant with respect to the normal variable, which is an exact complement to our above well-posedness result for a special flow.