Effects of buoyancy on the lower branch modes on a Blasius boundary layer

Abstract

The effect of thermal buoyancy on the stability properties of lower branch Tollmien-Schlichting waves are investigated. At moderate values of thermal buoyancy the standard triple deck structure, which describes the evolution of such short wavelength instabilities in a buoyant boundary layer, is unaltered. The leading order eigenrelation is now a function of thermal buoyancy and from it we can derive the new dominant length-and time-scales for the instability in the case when the boundary layer is strongly buoyant. These new scales demonstrate that, in the case of strong wall cooling the lower branch structure is identical to the upper branch structure, thus suggesting that the curve of neutral stability may become closed at some large value of a Reynolds number. In the alternate limit of strong wall heating the evolution of a fixed frequency disturbance is governed by the linearized interactive boundary-layer equations; in this case wave-like disturbances cannot be described by any form of the quasi-parallel approximation theory.