The evolution of a localized finite amplitude vortex disturbance in uniform shear flow

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The purpose of the present research is to explain the generation of hairpin vortices in turbulent boundary layers. In previous investigations it was assumed that the generation of hairpin vortices is caused by the instability of streamwise vortices. In the present research we focus on the development of hairpin vortices initiated by finite amplitude vortex disturbances embedded in plane Couette flow without pressure gradient. Here we only concentrate on the interaction between the base shear and the disturbance and do not take into account other effects such as the presence of the wall or the non-uniformity of the shear.

The research examines the effects of the disturbance amplitude, it's geometry, and the viscosity and the shear of the base flow. Preliminary results show that there is a threshold amplitude, above which, the evolution of the disturbance is similar to that of a hairpin vortex in a turbulent boundary layer. Increasing the disturbance aspect ratio leads to the generation of more than one vortices. Decreasing the shear of the base flow has the same effect as that of increasing the amplitude of the initial disturbance. However, below a certain shear, the disturbance just spreads in space but does not grow.

For the present investigation commercial FLUENT CFD code is used. In our case this software is used to solve the 3D and unsteady flow by the finite volumes method.