THE DESTRUCTION OF ISOTROPY AND THE INITIAL-VALUE PROBLEM OF PARALLEL SHEAR FLOW

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ABSTRACT

The classical eigen analysis of parallel shear flow cannot solve the problem of transcient evolution of a localized perturbation. Yet the basic mechanism of Rayleigh equation consists only two simple effects; the inhomogeneous advection and the bending. The isotropy would be destructed by these two effects but the phase lines can be titled either along or orthogonal to the wind profile. Since the inhomogeneous advection and bending are connected through the Arnold constraint, it is expected that not only a full description of the development of anisotropy has to include both, but also some light can be shed while the evolution being interpretated in terms of the cascade process of eddy energy and enstrophy spectrum.

In this study a sine jet with periodic boundary condition was chosen as the basic state. The flow itself is exponentially stable but not necessarily conserving perturbation energy. The deformation of an isotropic vortex was scrutinized by the analytic and numerical methods. We found that inhomogeneous advection, acting on the perturbed vorticity field like on the passive tracer, would tilt the phase lines along the wind shear and henceforth, lead to the up-gradient transport of momentum flux. On the other hand the bending of mean vorticity gradient made the phase lines became perpendicular to the sine profile, a down-gradient transport of vorticity flux proved to be the source of instability.

We also showed that the statistically isotropic initial state had the minimum level of energy and enstrophy. Naturally the perturbation energy would start to increase. The further study will focus on the asymptotie behavior of WKB solution.

Keywords: Isotropy, Initial-value problem, Parallel shear flow, Continuous spectrum.