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Singularity of Navier-Stokes Equations Leading to Turbulent Transition HUA-SHU DOU[1], Zhejiang Sci-Tech University, FLUID MECHANICS RESEARCH TEAM — As is well known, there is discontinuity during the transition from laminar flow to turbulence in the time-averaged Navier-Stokes equations. In other words, singularity may implicitly exist in the Navier-Stokes equations. Transition of a laminar flow to turbulence must be implemented via the singularity. However, how the singularity of Navier-Stokes equations is related to the turbulent transition is not understood. In this study, the singularity possibly hidden in the Navier-Stokes equation is exactly derived by mathematical treatment. Then, it is found that for pressure driven flows, the singularity of Navier-Stokes equations corresponds to the inflection point on the velocity profile. Since the rate of amplification to a disturbance at the inflection point is infinite, the laminar flow is able to involve into turbulence at this point firstly at a sufficient high Reynolds number. This is the reason why turbulent spot is formed at the location of inflection point. It is further demonstrated that the existence of the singularity in the time-averaged Navier-Stokes equations is the necessary and sufficient condition for the turbulent transition in pressure driven flows. These results agrees well with the findings from the recent proposed energy gradient method.

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