About the Prospects to Enter the Instability

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The difference in nature of observed instability and numerically simulated instability is elucidated on the phenomenon of vortex shedding. Vortex shedding behind bluff bodies has been studied systematically at least since the days of Strouhal. Vortex shedding is an unavoidable, well-defined instability-development mode, which is fairly extended along the Reynolds scale. The direct numerical integration of the Navier-Stokes equations for unstable flows became feasible only recent twenty-five years. Numerical simulation was performed both in 2D problems on flow past a circular cylinder, past a flat plate and so on, and in 3D problems on flow past a sphere, past a disk and so on. However, passed years gave no numerical experiments in which stability loss results in a periodic vortex shedding modes. The direct numerical integration of the Navier-Stokes equations finds several stable stationary solutions, and the only stable limiting cycle in all the problems. Experiment finds its own stable flow for every of stable stationary solution, and the stable central type flow without vortex shedding for the stable limiting cycle in all the problems. Apart from these flows, experiment records several different vortex shedding modes (six modes for problem on flow around a sphere). Attempts at putting the stable limiting cycle in correspondence to the stable central type flow together with vortex shedding modes, are the only chance of reproducing experimental results in calculations. The attraction of the stable limiting cycle to interpret a vortex shedding seems initially to have no prospects. And really, it turns out there are no numerical experiments in which the calculated flow pictures represented by streamlines contain vortex streets. .In this situation, the conclusion of agreement between calculation results and experiment is based in some numerical experiments on a comparison of the calculated vorticity distributions with visual observation results. Other simulations explain the absence of vortex streets in the calculated streamline flow pictures by an ability of uniform motion of a coordinate system to mask the vortex structure which, in reality, exists. However, the analysis [1] demonstrates that these explanations do not eliminate the discrepancy between calculation and experiment. In [1,2], the responsibility for simulation failure was laid on the Navier-Stokes equations themselves. According to interpretation [1,2], solutions to the classic hydrodynamics equations successfully attain the boundary of unstable field. However, classic solutions are not able to cross this boundary. The possibility to enter the unstable field is searched along the direction of increasing of hydrodynamic values number when constructing hydrodynamics equations [1,2].

References

[1] I.V. Lebed and S.Y. Umanskii , "The Appearance and Development of Turbulence in a Flow Past a Sphere: Problems and the Existing Approaches to Their Solution", RJ of Physical Chemistry B, Vol. **1**, pp. 52-73, (2007).

[2] I.V. Lebed and S.Y. Umanskii , "About the Possibility to Improve the Hydrodynamics Equations by Means of Increasing of the Hydrodynamic Values Number", RJ of Physical Chemistry B, Vol. **4**, (2011), (to be published)