# SEPARABLE NON-PARALLEL AND UNSTEADY FLOW STABILITY PROBLEMS

GEORGY I. BURDE and ALEXANDER ZHALIJ

*Ben-Gurion University, Jacob Blaustein Institute for Desert Research*
*Sede-Boker Campus, 84990, Israel*

*Institute of Mathematics of the Academy of Sciences of Ukraine*
*Tereshchenkivska Street 3, 01601 Kyiv-4, Ukraine*

**Abstract.** The governing equations of the hydrodynamic stability theory are separable only with the parallel steady-state flow assumption, when they can be reduced to an ordinary differential equation, the Orr-Sommerfeld equation. For nonparallel flows, a basic flow and the equations for disturbance flow are dependent on the downstream coordinate so that the corresponding operator does not separate unless certain terms are ignored. If the basic flow is non-steady, this brings about great difficulties in theoretical studies of the instability since the normal modes containing an exponential time factor $\exp t$ are not applicable here. The objective of this work was to obtain new results in the problem of linear stability of non-parallel and unsteady flows by applying the recently developed symmetry-based approach to the separation of variables in PDEs with variable coefficients.

## 1. Introduction

Problems of hydrodynamic stability are of great theoretical and practical interest, as evidenced by the number of publications devoted to this subject. The prediction of the location of transition from a laminar flow to a turbulent one plays a fundamental role in the analysis of the flow field around most configurations of engineering interest. The flow stability problem has also many applications in meteorology and oceanography, and in astrophysics and geophysics.

The underlying notion is that transition from one type of flow to another results from spontaneous amplification of disturbances present in the original flow. Because of the mathematical simplifications associated with linearization, the stability theory has largely been developed with the restriction of infinitesimal disturbances. Infinitesimal disturbances are always present, even in the most carefully