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Dynamics of flows induced by a motionless or uniformly moving thin strip in a continuously stratified fluid

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Dynamics and a fine structure of a flow formed in a continuously stratified fluid are studied analytically, numerically and experimentally in the laboratory equipped with sensitive schlieren instruments. Selection of the governing equations set was done on results of analysis of symmetries of different widely used systems by theoretical-groups method. The set of fundamental equations including differential equations of continuity and balance of momentum, energy and concentration is characterized by family of point ten-parametric groups corresponding to "first principles" of mechanics and Galilelian transformations. Comparisons of calculated infinitesimal symmetries have shown that approximate or constitutive models have extended or reduced family of groups (examples are given). The set of governing equations with physically based boundary conditions that are no-slip for velocity and no-flux for density was analyzed as a coupled system that satisfies the condition of compatibility defining its order. In analytical study methods of singular perturbations were applied. In numerical investigations the size of the cell mesh was selected from condition of resolvability of the finest flow components governed by diffusion effects. The condition of the all flow components observation including the largest ones that are internal waves, wakes and vortices and the finest interfaces was selected as criteria for development of laboratory techniques. Different schlieren instruments, markers and conductivity probes were used in laboratory studies. At the beginning formation of diffusion induced flows on a horizontal and sloping strip was studied in details in vicinity and far from the obstacle. Fields of different parameters that are density, pressure, momentum, streamlines, vorticity and rate of baroclinic generation of vorticity in the flow were analyzed and compared with known solutions of stationary and transient problems. Comparison with laboratory visualization of diffusion induced flows inside and outside different hollow bodies is presented. Beginning of strip motion violated the flow pattern symmetry and created new flow components of both large and small scales. Flow patterns in different physical parameters was calculated and compared with laboratory schlieren visualization. Ranges of parameters where strong difference between calculated and observed flow patterns was observed are indicated. Forces and moments acting on moving strip were calculated in a wide range of flow parameters corresponding to laminar and transient flow regimes in a the free space and on different distances from underlined plane to estimate the ground effect. Extrapolation on practically important ranges of flow parameters is speculated. Experiments were performed on facilities USU "HPC IPMec RAS" under support of Ministry of Education and Science RF (Goscontract No. 16.518.11.7059).