Structure of Microfluidic Flows around Impermeable Obstacles in a Non-homogeneous Environment

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The environmental systems are mostly non-homogeneous in space and variable in time due to non-uniform distributions of dissolved or suspended matters, gas bubbles, temperature, medium compressibility and the influence of external forces. Combined effects of a medium non-homogeneity and the Earth's gravitation lead to formation of a stable stratification which gives rise to fluid motions even in the absence of purely mechanical reasons. Among such phenomena are convective flows driven by spatial variations in fluid density or the so-called diffusion-induced flows on topography. The study of such flows has received much attention in laboratory studies and numerical and analytical modeling because there are abundant instances of the phenomena in environmental systems [1].

The numerical study of diffusion-induced flows on an impermeable obstacle reveals a system of jet-like flows formed along its sloping boundaries and a complicated structure of circulation cells attached to the surface of the obstacle [2]. The most intensive structures are clearly registered experimentally by Schlieren techniques in form of horizontally extended high gradient interfaces attached to extreme points of an obstacle. With increase of typical velocities these structures do not disappear but are transformed into a complicated system of thin interfaces separating different kinds of disturbances, e.g. internal waves and a vortex sheet.

The calculated flow patterns are compared with the results on exact solution of the analogous linearized problem and the Schlieren images of stratified flows around both motionless and moving obstacles.

[1] Ia. V. Zagumennyi, Yu. D. Chashechkin, Fine structure of unsteady diffusion-induced flow over a fixed plate, Fluid Dynamics, **48(3)** (2013), p. 374–388.

[2] Ia. Zagumennyi, Yu. Chashechkin, Diffusion induced flows on a strip: theoretical, numerical and laboratory modeling, Procedia IUTAM, **8** (2013), p. 257–266.