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Adequate mathematical modelling of environmental processes

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In environmental observations and laboratory visualization both large scale flow components like currents, jets, vortices, waves and a fine structure are registered (different examples are given). The conventional mathematical modeling both analytical and numerical is directed mostly on description of energetically important flow components. The role of a fine structures is still remains obscured. A variety of existing models makes it difficult to choose the most adequate and to estimate mutual assessment of their degree of correspondence. The goal of the talk is to give scrutiny analysis of kinematics and dynamics of flows. A difference between the concept of "motion" as transformation of vector space into itself with a distance conservation and the concept of "flow" as displacement and rotation of deformable "fluid particles" is underlined. Basic physical quantities of the flow that are density, momentum, energy (entropy) and admixture concentration are selected as physical parameters defined by the fundamental set which includes differential D'Alembert, Navier-Stokes, Fourier's and/or Fick's equations and closing equation of state. All of them are observable and independent. Calculations of continuous Lie groups shown that only the fundamental set is characterized by the ten-parametric Galilelian groups reflecting based principles of mechanics. Presented analysis demonstrates that conventionally used approximations dramatically change the symmetries of the governing equations sets which leads to their incompatibility or even degeneration. The fundamental set is analyzed taking into account condition of compatibility. A high order of the set indicated on complex structure of complete solutions corresponding to physical structure of real flows. Analytical solutions of a number problems including flows induced by diffusion on topography, generation of the periodic internal waves a compact sources in week-dissipative media as well as numerical solutions of the same problems are constructed. They include regular perturbed function describing large scale component and a rich family of singular perturbed function corresponding to fine flow components. Solutions are compared with data of laboratory experiments performed on facilities USU "HPC IPMec RAS" under support of Ministry of Education and Science RF (Goscontract No. 16.518.11.7059). Related problems of completeness and accuracy of laboratory and environmental measurements are discussed.