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Modeling Biological Systems as nonequilibrium relaxation structures by means of the kinetic equation

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The kinetic approach is used to describe a biological system as a nonequilibrium spatial structure. The underlying theoretical preposition is the Boltzmann kinetic equation and kinetic models in the form of the relaxation equations applied for simulating liquid flows with chemical reactions. This allows us to treat global thermodynamic and kinetic properties of organisms in the case for which the methods of the thermodynamics of the irreversible processes with a local equilibrium are invalid. We assume that a biological object is an open system formed by joint transport (related, e.g. to a flow of blood) and reactions (related, e.g. to biochemical reactions introduced by genome). Then we consider a mathematical formulation of the so-called spatial relaxation problem. It is possible to understand important fundamental characteristics of biological systems by investigating simple models and to include more and more complex elements of the kinetic description. Thus, first 1D relaxation structure has been considered for a simple medium, and interesting nonclassical properties have been found. On the other hand, this model of the advection + the counteraction of particles (molecules) can explain some properties of the biological objects concerning the sizes of mammals. Using the statistical notion of entropy we can translate into quantitative terms the claim that the entropy of a biological object is smaller than the entropy of an inorganic object with the same mass. The properties of a green leaf can be described by solving 2D nonuniform relaxation problem. Generally, it is possible to simulate 3D biological system as a structure shaped by the processes of synthesis and degradation in the flow of a nonequilibrium medium.

Biography

Prof. Vladimir Aristov defended his Ph.D thesis and Dr.Sci. thesis devoted to mathematical methods for solving the Boltzmann and other kinetic equations with application for studying nonequilibrium flows. He is the head of the subdivision of Kinetic theory of gases in Dorodnicyn Computing Centre of Russian Academy of Sciences. He has published more than 40 papers in reputed journals, he is also an author of a monograph on mention topics published in Kluwer Academic Publishers.