

An Energetic Variational Approach for Ionic Fluids and Ion Channels

(Talk #7)

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The interactions of ions flowing through biological systems have been a central topic in biology for more than 100 years. Flows of ions produce signaling in the nervous system, initiation of contraction in muscle, coordinating the pumping of the heart and regulating the flow of water through kidney and intestine.

Ion concentrations inside cells are controlled by ion channel proteins through the lipid membranes. In this talk, a continuum model is derived from the energetic variational approach which include the coupling between the electrostatic forces, the hydrodynamics, diffusion and crowding (due to the finite size effects). The model provides some basic understanding of some important properties of proteins, such as the ion selectivity and sensor mechanism.

Transport of charged particles and ions in biological environments is by nature a multiscale and multiphysics problem. I will also discuss the roles of other important ingredients such as those of nonlocal diffusion and also the connection between kinetic description and continuum approaches.