Bioinspired Super-wettability System and Beyond Quantum-confined Superfluid: Energy Conversion, Chemical Reaction and Biological Information Transfer

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Biological ionic/molecular channels embedded in plasma membranes play important roles in a wide spectrum of physiological processes such as energy conversion, bioinformation transformation and biochemical reaction etc. On the basis of biological channels, signals can be transmitted from the nerves to brain in the process of vision, smell, audition and tactility. Those crucial functions highly depend on their selective protein-based gatekeepers that allow extremely rapid transit (10^7 ions per channel in one second). This ultrafast mass transfer stems from the special features of the biological channels, e.g., small size, unique structure and surface charge distribution, which lead to peculiar properties, inducing ultrafast ion and molecule transmission in the form of single strand. From the viewpoint of classical thermodynamics, mass transport across nanometer-scale channel with chemical selectivity should be very slow. In the living system, however, the fast transit of ions and molecules is precisely the state of ultrafast fluid caused by a quantized flow. Biological ion channels show that ultrafast ions and molecules transmission are in a quantum way of single molecular or ionic chain with a certain number of molecules or ions, and we define it as “quantum-confined superfluid” (QSF). The biomimetic systems also exhibit QSF phenomena, such as ultrafast ions transport in artificial ion channels, and ultrahigh water flux in artificial water channels. The introduction of QSF into the fields of energy, chemistry and biology would have significant impact. As a challenge to the traditional theory, the concept of QSF will open up a new field of quantum ionics and promote the development and application of energy conversion materials. The development of QSF reactions will expand the application of nanochannels (even sub nanochannels), promote the development of interfacial catalytic chemistry theory, and open up a new way for the future development of chemistry, chemical engineering and synthetic biology. The introduction of quantum ionics into the field of bioinformatics will provide new technical means for the study of neural signals, overturn the understanding of neural signal transmission in neuroscience and brain science, and expand the development of biophysics, bioinformatics and biomedicine.