Possible role of quantum diffusion in ontogenesis of nervous tissue

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A complete neglect of one fundamental feature of charge transport through any conductor, namely, the existence of temporary charged layer on its boundary accompanied by external electric field, led in the particular case of transfer of electric signals via nervous fibres to a rather bizarre but generally accepted theory. For example, for the description of transfer of electric signals by nerves, the non-adequate concept of "conduction velocity" is used, for myelinated axons with Ranvier's nodes an obscure idea of "saltatory propagation of action potential" through the surrounding tissue appears (e.g. [1]). Reconsidering this theory and relevant experimental data, we have concluded that the transfer of electric signals by nerve fibres has an overall character of diffusion. We further have shown that the build-up of charged boundary layer necessary for the electric transport through axon is very likely locally controlled by quantum diffusion of Na^+ and K^+ ions with Fürth's limiting diffusion constant $D_Q = h/2M$ (h is Planck's constant, M ionic mass) [2]. Finally, we have formulated a hypothesis that the ontogenesis of Ranvier's nodes interrupting myelin coat of nerve fibres is triggered by periodic self-organised reactions promoted just by the above mentioned ionic quantum diffusion.

[1] B. Hille: Ion Channels of Excitable Membranes. Sinauer Assocites Inc., Sunderland MA, 2001.

[2] J.J. Mareš, J. Stávek, J. Šesták: Quantum aspects of self-organized periodic chemical reactions. J. Chem. Phys. 121 (2004) 1499-1503.