

Ephaptic Coupling Study Based on the Conditional PNP Equation

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Abstract

In this note the authors propose the use of the conditional Poisson Nernst Planck equation instead of the traditional model, in order to simulate the dynamics of ephaptic coupling in a tract of axons.

In the paper by Bob Eisenberg et. al. [1], the authors derive a modified Nernst-Planck equation which includes self-force as a term and conditional charge densities. Herein we propose to use their formulation instead of the traditional Nernst equation for calculating the electrochemical gradients across a membrane. This would impact the dynamics of the m, n, h, p activation and inactivation variables which enter into the nodal Hodgkin Huxley equation. In general, a deeper quantum-based investigation of ion dynamics at the pore level should inform large scale action potential coupling effects. This has implications for diseases such as multiple sclerosis where accurate modeling can impact physician conclusions and hence patient outcomes.

References

- [1] Z Schuss, B Nadler, and RS Eisenberg. Derivation of poisson and nernst-planck equations in a bath and channel from a molecular model. *Physical Review E*, 64(3):036116, 2001.