166. Time-Independent Solution of the Poisson-Nerst-Planck System of Equations for Neurological Applications

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Electromagnetic brain stimulation has been shown to benefit medical patients with a variety of brain diseases. The molecular mechanisms by which these therapies operate are still largely unknown; nevertheless, these treatments are electromagnetic in nature, and so we hypothesize that they must have a direct influence on the distribution of ionic species adjacent to neural cells and their transfer between extracellular and intracellular spaces in neural tissue. We implement a finite element solution to the steady-state Poisson-Nerst-Planck system of partial differential equations to investigate these questions. To solve this system, we employ a variety of numerical methods including a Gauss-Siedal decoupling method and a weighted iterative Gummel scheme to facilitate numerical convergence. Implementation is performed using FEniCS on a biologically-inspired domain constructed in GMSH. We present our numerical simulation results which show the influence of an electric field on ionic distributions, and in addition, present numerical method convergence metrics which gauge simulation efficiency and accuracy.