1171-39-210 **Hailiang Liu*** (hliu@iastate.edu), Carver Hall 434, Iowa State University, Ames, 50011, and **Wumaier Maimaitiyiming**. *Efficient, positive, and energy stable schemes for multi-D Poisson-Nernst-Planck systems.*

In this paper, we design, analyze, and numerically validate positive and energy-dissipating schemes for solving the time-dependent multi-dimensional system of Poisson-Nernst-Planck (PNP) equations, which has found much use in the modeling of biological membrane channels and semiconductor devices. The semi-implicit time discretization based on a reformulation of the system gives a well-posed elliptic system, which is shown to preserve solution positivity for arbitrary time steps. The first order (in time) fully-discrete scheme is shown to preserve solution positivity and mass conservation unconditionally, and energy dissipation with only a mild O(1) time step restriction. The scheme is also shown to preserve the steady-state. For the fully second order (in both time and space) scheme with large time steps, solution positivity is restored by a local scaling limiter, which is shown to maintain the spatial accuracy. These schemes are easy to implement. Several three-dimensional numerical examples verify our theoretical findings and demonstrate the accuracy, efficiency, and robustness of the proposed schemes, as well as the fast approach to steady states. (Received August 11, 2021)