Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Electrostatics and Rheology in Semidilute Polyelectrolyte Solutions GUANG CHEN, ANTONIO PERAZZO, HOWARD STONE, Princeton University — Polyelectrolyte (PE) solutions, which are charged polymers in aqueous solvents, have been studied from many perspectives in the past century. However, the effect of added salt on semidilute PE solutions remains unclear. To understand the electrostatic interactions among the polyions and electrolyte ions, we use a mean-field approach to determine the electrostatic energy of a PE solution at various polymer concentration n_p and salt concentration n_s. We derive asymptotic approximations for the potential and ion distributions in nano-confined charged systems by probing the Poisson-Boltzmann equation within and beyond the Debye-Hückel linearization, and obtain distinct scaling laws for the electrostatic energy and viscosity for PE solutions at different regimes of n_p/n_s. One of our predictions coincides with the empirical Fuoss law for viscosity $\eta \sim n_p^{0.5}$ under the same assumption $n_s \propto n_p$ as in de Gennes scaling theory. Our theory also captures an unexplained empirical observation $\eta \propto n_p^{0.68}$ for salt-free PE solutions [1], and provides more physical insights on the effects of salt and charge fraction on the properties of PE solutions.
[1] C. G. Lopez, R. H. Colby, P. Graham and J. T. Cabral, Macromolecules, 50, 332 (2017)

Guang Chen
Princeton University

Date submitted: 29 Jul 2019 Electronic form version 1.4