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Approximate Time-Dependent Current-Voltage Relations for Currents Exceeding the Diffusion Limit YOAV GREEN, Ben-Gurion University of the Negev — In the limit of an infinitesimally thin Debye length and sufficiently large voltages, the steady-state current transported through a permselective membrane/nanochannel is predicted to saturate to a limiting value. In practice, the Debye lengths are finite and the current exceeds the predicted diffusion-limited value [1]. This peculiar steady-state response has been investigated for four decades [1,2]. However, the time-dependent response has yet to be resolved. Leveraging the steady-state approach of Yariv [2], I derive three separate expressions for the potential drop for short, intermediate, and long times for currents exceeding the diffusion limit [3]. I will demonstrate that the potential drop correlates to the time-evolution of the non-equilibrium space-charge-layer adjacent to the permselective interface. These approximations are compared to numerical simulations and show remarkable correspondence. [1] Rubinstein and Shtilman, J. Chem. Soc., Faraday Trans. 275, 231 (1979). [2] Yariv, Phys. Rev. E, 80, 051201 (2009). [3] Green, Phys. Rev. E, 101, 043113 (2020).

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