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Entropy driven insulator-metal crossover in ion channels and water filled nanopores JINGSHAN ZHANG, ALEX KAMENEV, BORIS SHKLOVSKII, ANATONY LARKIN[1], University of Minnesota — We consider ion transport of an ion channel in a lipid membrane or a water filled nanopore in silicon films [1]. It is known that due to the large ratio of dielectric constants of water (80) and lipid (2), the electric lines of an ion in the channel are squeezed. This should lead to a large electrostatic self-energy barrier for Ohmic resistance [2]. Nevertheless biological channels are well transparent at least for some selected ions. To address this paradox, we study reduction of the electrostatic barrier by a finite concentration of salt in water and/or by immobile charges on the internal channel walls. We show that both types of charges reduce the barrier, leading to insulator-metal crossover resembling metal-insulator transition in excited gas or in doped semiconductors. But here entropy plays the role of quantum mechanics. Evolution of ion channels took into account biological concentration of monovalent salt, and more importantly, made some channels charged from inside to reduce electrostatic barrier for a given sign of ions (cation/anion selectivity). We also show that in the channel with negative wall charges fractionalization of divalent Ca ions into monovalent excitations leads to good Ca-Vs.-Na selectivity of Ca channels. [1] A. Kamenev, J. Zhang, A. I. Larkin, B. I. Shklovskii, Physica A 359, 129 (2006); J. Zhang, A. Kamenev, B. I. Shklovskii, Phys. Rev. Lett. 95, 148101 (2005); cond-mat/0510327. [2] A. Parsegian, Nature 221, 844 (1969).

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