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Mass and charge transport in arbitrarily shaped microchannels
HENRIK BRUUS, NIELS ASGER MORTENSEN, FRIDOLIN OKKELS, LAURITS HOEJGAARD OLESEN, Department of Micro and Nanotechnology, Technical University of Denmark — We consider laminar flow of incompressible electrolytes in long, straight channels driven by pressure and electro-osmosis. We use a Hilbert space eigenfunction expansion to address the problem of arbitrarily shaped cross sections and obtain general results in linear-response theory for the mass and charge transport coefficients which satisfy Onsager relations [1,2]. In the limit of non-overlapping Debye layers the transport coefficients are simply expressed in terms of parameters of the electrolyte as well as half the hydraulic diameter $\mathcal{R} = 2\mathcal{A}/\mathcal{P}$ with $\mathcal{A}$ and $\mathcal{P}$ being the cross- sectional area and perimeter, respectively. In particular, we consider the limits of thin non-overlapping as well as strongly overlapping Debye layers, respectively, and calculate the corrections to the hydraulic resistance due to electro- hydrodynamic interactions.

[1] N. A. Mortensen, F. Okkels, and H. Bruus, Phys. Rev. E **71**, 057301 (2005)
[2] N. A. Mortensen, L. H. Olesen, and H. Bruus, New J. Phys. **8**, 37 (2006)

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