Abstract Submitted
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Connecting the classical limits: the Graetz-Nusselt problem for partial, homogeneous slip[1] ROB LAMMERTINK, SANDER HAASE, University of Twente, JON CHAPMAN, University of Oxford, PEICHUN TSAI, DETLEF LOHSE, University of Twente — The classical Graetz-Nusselt problem concerns the transport of heat between a hydrodynamically fully developed flow and the wall of a cylindrical pipe at constant temperature. In the thermally developing regime, the Nusselt number scales as $\mathrm{Nu} \propto \mathrm{Gz}^{-\beta}$, where $\mathrm{Gz} = \mathrm{RePr}D/L$ is the Graetz number. In case of a non-slippery wall $\beta = 1/3$, whereas for no-shear surfaces $\beta = 1/2$. The generally assumed no-slip boundary condition does not always hold. Intrinsic slip lengths in micro- and nanofluidic systems vary from nearly zero to almost infinity. Here we studied the Graetz-Nusselt problem for partial slip. We present a solution for the Graetz-Nusselt problem for partial slip, connecting the two classical solutions. We show numerically and analytically that for surfaces displaying partial slip, β gradually changes from 1/3 to 1/2. Also the developed Nusselt number Nu_∞ slowly changes value from 3.66 to 5.78. We provide a mathematical and physical explanation for these two transitions points, which are separated more than one decade apart for β and Nu_∞.

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