Hydrodynamic electrons in Graphene: a viscous boundary-layer description.

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The hydrodynamic regime of charge transport in graphene has been studied in the past years and recently observed [1][2]. Some authors have committed their analysis to a highly viscous regime leading to a Poiseuille-like flow [3]. However, for such a flow to develop, the channel width must be smaller than the boundary layer of the fluid [4], and the flow quasi-stationary. These conditions might not be met in some technological applications, e.g. graphene nano-antennae operating at THz [5][6]. Thus, the assessment of the boundary layer thickness [4] for the electronic flow is of central importance for study of the hydrodynamic models of conduction in graphene. Solving numerically the fluid equations, one finds that for wide enough samples the velocity profile is not convex (Fig. 1) leading to a velocity peak near the edges at the boundary layer transition. We derive an analytic description of the velocity profile that shows fair agreement with the numerical simulations, reproducing the non-convex behaviour, and from which the boundary layer thickness can be retrieved.

References

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Figures

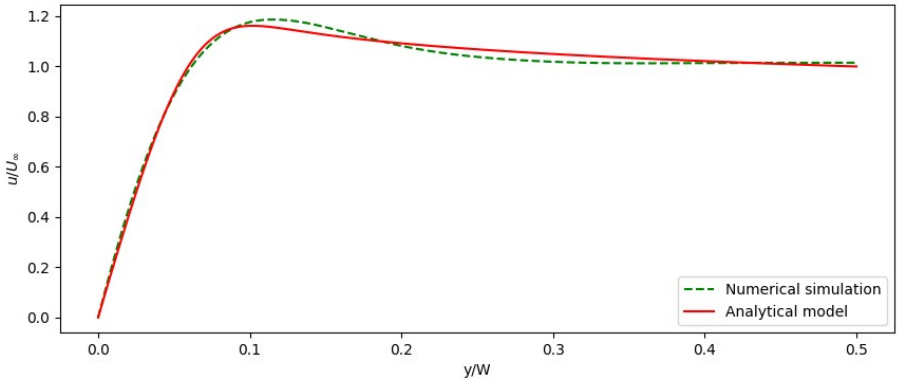

Figure 1: Non-convex velocity profile for aspect ratio of sample L/W=0.3. Comparison between numerical simulation of hydrodynamic model and boundary layer model.