Comparing kinetic and hydrodynamical models, for electron transport in monolayer graphene

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ABSTRACT

Graphene is a gapless semiconductor made of a sheet composed of a single layer of carbon atoms arranged into a honeycomb hexagonal lattice. In view of application in graphene-based electron devices, it is crucial to understand the basic transport properties of this material. A physically accurate model is given by a semi-classical transport equation whose scattering terms have been deeply analysed in the last decade [1,2,3]. Due to the computational difficulties, the most part of the available solutions have been obtained with direct Monte Carlo simulations [4,5]. A different approach based on a finite difference scheme has been employed in [6]. Macroscopic models can be found in [7,8].

The aim of this work is to compare, in monolayer grapheme, solutions of the electron Boltzmann equation, obtained with both stochastic and deterministic discontinuous Galerkin methods [9], with those of the hydrodynamical model of [8].

REFERENCES

[1] A. H. Castro Neto, F. Guinea, N. M. R. Peres, K. S. Novoselov, A. K. Geim, *Rev. of Mod. Phis.,* Vol. **81**, pp. 109-162 (2009).

[2] S. Piscanec, M. Lazzeri, J. Robertson, A. C. Ferrari and F. Mauri, *Phys. Rev., B,* Vol. **75**, 035427 (2007).

[3] A. Tomadin, D. Brida, G. Cerullo, A. C. Ferrari, and M. Polini, *Phys. Rev. B,* Vol. **88**, 035430 (2013).

[4] T. Fang, A. Konar, H. Xing, and D. Jena, *Phys. Rev. B,* Vol. **84**, 125450 (2011).

[5] K.M. Borysenko, J. T. Mullen, E. A. Barry, S. Paul, Y. G. Semenov, J. M. Zavada, M. Buongiorno Nardelli, and K. W. Kim, *Phys. Rev. B,* Vol. **11**, 121412(R) (2010).

[6] P. Lichtenberger, O. Morandi, and F. Schuerrer, *Physical Review B,* Vol. **84**, 045406 (2011).

[7] N. Zamponi, L. Barletti, *Math. Methods Appl. Sci.*, Vol. **34**, 807818 (2011).

[8] V.D.Camiola, and V.Romano, "Hydrodynamical model for charge transport in grapheme", *Journal of Statistical Physics*, online (2014).

[9] Y. Cheng, I. M. Gamba, A. Majorana, C.-W. Shu, *Computer Methods in Applied Mechanics and Engineering,* Vol. **198** (37-40), pp. 3130-3150, (2009).