Transmission through silicene quantum barriers

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Silicene is a monolayer of silicon atoms that form a two-dimensional honeycomb lattice similar to graphene's. It has attracted considerable attention due to its exotic electronic structure and its compatibility with current silicon-based electronic technology. The low-energy physics of silicene is described by Dirac electrons with relative large spin-orbit interaction, $\lambda = 3.9\, meV$, due to its buckled structure[1] with $l = 2.3 \times 10^{-2}\, nm$ the half distance between the A and B sublattices. Its band structure can be controlled externally by an electric field $E_z = 300\, meV/nm$. We theoretically explore resonant features in the electronic transmission T through barriers in silicene by studying T as a function of the electron's energy E (meV) and its angle of incidence θ. The incident electrons are assumed spin polarized and the barriers are formed by contact potentials. Our results show that the applied electric field can result in spin-resolved transmission channels. In addition, we critically compare the results with those through barriers in graphene. Important differences from the graphene's case[2] show up and are highlighted in the transmission $T^{\uparrow}$ and polarization $P = |T^{\uparrow} - T^{\downarrow}|/|T^{\uparrow} + T^{\downarrow}|$. A (E,θ) contour plot of T, for incident *spin-up electrons*, through a silicene barrier of length L=110 nm and height V=100 meV, is shown in Fig. 1(a). Notice the periodicity along the E axis for large θ. Figure 1(b) is the same contour as in Fig. 1(a) but for the values $\lambda = 0\, meV$ and $E_z = 0$ which pertain to a barrier on suspended graphene. Notice the absence of the transmission channel below 20 meV shown in Fig. 1(a). The contour plot in Fig. 1(c) shows the spin polarization P for a barrier on silicene. P increases strongly for energies near the top of the barrier and also for $E_+ = (\lambda + l * E_z)$ and $E_- = -(\lambda - l * E_z)$.--- This work is sup-ported by CAPES, CNPq, and FAPESP, Brazil, and the NSERC grant OGP012756, Canada.

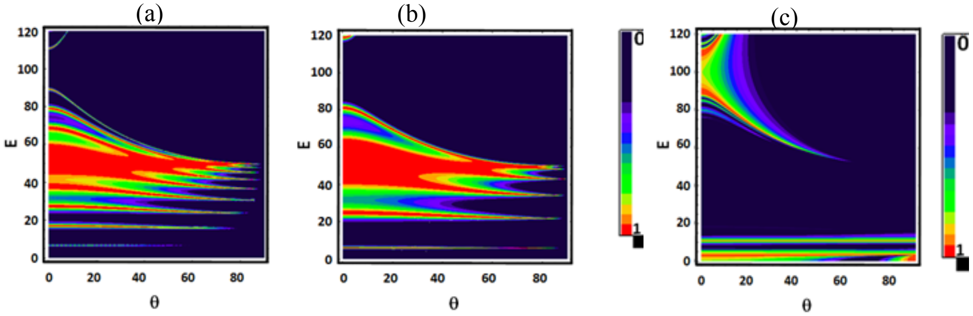

Figure 1. (a) (E,θ) contour plot of the transmission through a silicene barrier. (b) As in (a) for a barrier on suspended graphene. (c) (E,θ) contour plot of the polarization for a silicene barrier.

[1] Motohiko Ezawa, Phys. Rev. Lett. **109**, 055502 (2012).
[2] J. Milton Pereira Jr. *et al.,* Appl. Phys. Lett. **90,** 132122 (2007).