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Novel electronic and transport properties of graphene superlattices[1]

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Charge carriers in graphene show linear and isotropic energy dispersion relation and chiral behavior, like massless neutrinos in particle physics. Because of these novel properties, many interesting and unconventional phenomena occur in graphene. On the other hand, since the 1970's, metallic and semiconducting superlattice structures – man-made crystals – have been extensively studied regarding to their fundamental electronic and optical properties as well as many applications. In this talk, I will present calculations on the properties of charge carriers in graphene under an external periodic potential (graphene superlattices) which are found to be greatly different from those of conventional two-dimensional electron gases in similar conditions [1-3]. I will discuss the anisotropies in the group velocity around the Dirac point and in the gap opening at the supercell Brillouin zone boundary [1]. Next, I will focus on the special cases where the group velocity along one direction becomes zero [1,2], emphasizing the phenomena of pseudospin collapse and possible electron beam supercollimation effects in these systems [2]. Finally, I will discuss the properties of a new generation of massless Dirac fermions at the supercell Brillouin zone boundaries and their experimental implications [3].

[1] C. -H. Park, L. Yang, Y. -W. Son, M. L. Cohen, and S. G. Louie, Nature Phys. 4, 870 (2008).
[2] C. -H. Park, Y. -W. Son, L. Yang, M. L. Cohen, and S. G. Louie, Nano Lett. 8, 2920 (2008).
[3] C. -H. Park, L. Yang, Y. -W. Son, M. L. Cohen, and S. G. Louie, Phys. Rev. Lett. 101, 126804 (2008).

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