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Inspired by photonics - unconventional electron flow across 2-D P-N junctions

Avik Ghosh
University of Virginia, USA

With the current slow-down of Moore's law and the abolition of the ITRS roadmap, there is a pressing need to explore various materials, architectural and physical solutions for low-power electronics, ranging from spintronics to 2D materials to sub-thermal switching that beats the fundamental Boltzmann limit. Graphene and other 2D materials have been widely studied because of their photon-like band structure and high mobility. However, their gaplessness compromises their ability to switch under gate bias. I will discuss how using a sequence of gated PN junctions, we can make electron flow in graphene resemble optics-with unconventional equivalents of Snell's law for trajectories, Fresnel equation for transmission, Malus' law for polarization and cut-off modes of a waveguide. These equivalents (negative index, Klein tunneling and Veselago focusing) can be used to filter electrons and engineer a gate-tunable transport gap that allows us to turn off the electron flow abruptly without hurting the mobility of the on current. This novel switching has implications for both digital devices and high speed analog RF applications. Extended to 3D topological insulators, the unconventional switching allows us to filter the spins, amplifying their torque at an injecting ferromagnetic by giving us a gate-tunable giant spin hall angle.

Biography

Avik Ghosh is Professor of Electrical and Computer Engineering and Professor of Physics at the University of Virginia. He has over 100 refereed papers and book chapters and 2 upcoming books in the areas of computational nano-electronics and low power devices including 2D materials, molecular electronics, low-power devices, nano-magnetism, photodetectors and nanoscale heat flow. Ghosh did his PhD in physics from the Ohio State University and Postdoctoral Fellowship in Electrical Engineering at Purdue University. He is a Fellow of the Institute of Physics (IOP), senior member of the IEEE, and has received the IBM Faculty Award, the NSF CAREER Award, a best paper award from the Army Research Office, the Charles Brown New Faculty Teaching Award and the UVA's all University Teaching Award. His group's research on observing negative index behavior in graphene was voted by Physics World as one of the top-10 Breakthroughs of 2016.

ag7rq@eservices.virginia.edu

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