On-demand conductivity for graphene nanoribbons

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Physicists have, for the first time, explored in detail the time evolution of the conductivity, as well as other quantum-level electron transport characteristics, of a graphene device subjected to periodic ultra-short pulses. To date, the majority of graphene studies have considered the dependency of transport properties on the characteristics of the external pulses, such as field strength, period or frequency.

The new findings have now been published in *European Physical Journal B* by Doniyor Babajanov from the Turin Polytechnic University in Tashkent, Uzbekistan, and colleagues. These results may help to develop graphene-based electronic devices that only become conductors when an

external ultra-short pulse is applied, and are otherwise insulators.

The authors' focus is on the transport in graphene nanoribbons driven by laser pulses, which were chosen for their ability to apply periodic kicks to the system. Babajanov and colleagues relied on driven quantum systems and quantum chaos theories to study transport characteristics within the nanoribbon. For a single kicking period, they obtained the exact solution of a mathematical equation, called the time-dependent Dirac equation. Then, by iterating this solution they were able to numerically and precisely compute the arbitrary characteristics of time-dependent quantum transport of electrons within the material.

They found that applying external driving force leads to enhancement of electronic transitions within what are referred to as valence and conduction bands. This study thus demonstrates that such transitions allow a dramatic increase in conductivity within a short time, making it possible to tune the electronic properties using short external pulses.

The next stage could be extending the test to the case of a time-dependent magnetic field, to strain-induced pseudo-magnetic fields, or to external monochromatic fields. Ultimately, this could lead to useful applications such as ultrafast electronic switches.

More information: Babajanov, D. et al. (2014). Particle Transport in Graphene Nanoribbon Driven by Ultrashort Pulses. *European Physical Journal B*. DOI: 10.1140/epjb/e2014-50610-6

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