Graphene mini-lab

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A team of physicists from Europe and South Africa showed that electrons moving randomly in graphene can mimic the dynamics of particles such as cosmic rays, despite travelling at a fraction of their speed, in a paper about to be published in the *European Physical Journal B*.

Andrey Pototsky and colleagues made use of their knowledge of graphene, which is made of a carbon layer, one atom thick, and packed in a honeycomb lattice pattern. In such material the interaction of electrons with atoms changes the effective mass of the electrons. As a result, the energy of electrons in graphene becomes similar to the photon energy.

Therefore, electrons in graphene can be regarded as behaving like cosmic rays, which belong to a family known as ultra-relativistic particles, even though their actual velocity is one hundred times lower than the speed of light.

The authors employed the classical equations used to describe random motion—so-called Brownian motion—to study the dynamics of electrons within the confines of their graphene mini-laboratory. They considered different graphene chip geometries and subjected them to changing conditions that affect the way these electrons diffuse through the material, such as temperature and electric field strength.

Going one step further, the authors were able to rectify electron fluctuations and to control the electron motion itself, from an unusual chaotic type of motion to a periodic movement, by varying the electric field.

Future work would experimentally demonstrate how variation of the temperature can be used positively to enhance the performance of graphene chips by gaining a greater control over electron transport. Such graphene mini-labs could also ultimately help us to understand the dynamics of matter and anti-matter in cosmic rays.

More information: A. Pototsky, F. Marchesoni, F. V. Kusmartsev, P. Hanggi, and S. E. Savel'ev, Relativistic Brownian motion on a graphene chip, *European Physical Journal B* (2012) 85: 356, DOI: 10.1140/epjb/e2012-30716-7

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