Nature Physics **advance online publication**, 5 October 2010
doi:10.1038/nphys1836

Research Highlights

Nobel Prize 2010: Geim and Novoselov

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The 2010 Nobel Prize in Physics has been awarded to Andre Geim and Konstantin Novoselov, "for groundbreaking experiments regarding the two-dimensional material graphene".

It's a sheet of carbon that looks like chicken-wire, just one atom thick. The charge carriers that conduct electricity through it move as if they had no rest mass, like photons, at just three-hundredths of the speed of light. Its in-plane strength exceeds that of diamond. And it has become the most active research subject in all of condensed-matter physics today. Now Andre Geim and Konstantin Novoselov have been awarded the 2010 Nobel Prize in Physics, for being the first to isolate and demonstrate the properties of this remarkable material, graphene.

The properties of graphene had been studied theoretically for decades, largely owing to the fact that it is the building block of both graphite and carbon nanotubes. But no one knew how to isolate a single sheet of the material. That changed in 2004, with Geim and Novoselov's demonstration of field-effect transistors built from flakes of graphite just a few atomic-layers thick[1] — flakes that had been peeled off a block of highly oriented pyrolytic graphite using adhesive tape. Geim and Novoselov found that several of the flakes they'd isolated using their technique were in fact only a single-carbon-atom thick, and, although they hadn't yet built a device from it, this challenged the widely held expectation that a single layer of graphene would be too fragile to exist as a isolated sheet.

A short while later, they succeeded in making single-layer graphene devices[2], and the electronic behaviour they observed in these devices was profound. Far beyond simple field-effect transistor action, they discovered an entirely new class of quantum Hall effect — dubbed the half-integer quantum Hall effect — and found that graphene's charge carriers exhibited behaviour similar to that of massless high-energy particles travelling at relativistic speeds.

Since then all manner of strange and exotic phenomena have been observed in graphene and its variants. These include: the Klein effect, in which charge carriers are able to pass right through high potential barriers as if they weren't there; the survival of the half-integer quantum Hall effect at room temperature; and another class of unconventional quantum Hall effect in bilayer graphene.

Yet the reason for much of the excitement about graphene is its potential for new technology. The speed and ease with which charge carriers move in graphene make it an obvious candidate to succeed silicon in high-speed computer chips. Its combination of high conductivity, inherent flexibility and near-perfect optical transparency make it attractive for solar cells, touch-screen displays and similar large-area devices. And its mechanical properties could enable a new generation of high-strength composites.

REFERENCES

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