The 4th Dvořák Lecture

By Professor Allan H. MacDonald, University of Texas at Austin, USA

Graphene Ten Years Later

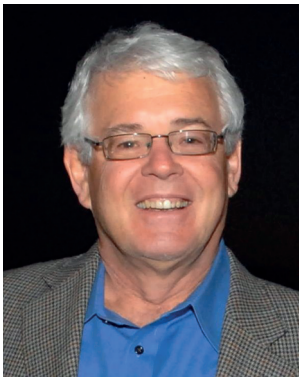
June 6, 2012 at 3:00 pm

Institute of Physics of the AS CR, v. v. i., *Na Slovance 2, CZ-182 21 Praha 8, Czech Republic*

Annotation

Graphene is an atomically two-dimensional material which was first isolated for electronic property studies by Novoselov, Geim and collaborators from the University of Manchester about ten years ago. It is a gapless semiconductor formed entirely from carbon atoms and can be viewed as a giant aromatic molecule. Graphene's honeycomb lattice structure is bipartite; atoms on one sublattice have three nearest neighbors all on the other sublattice. Its conduction and valence band states are both formed from graphene π-bands and differ only in the phase difference between their sublattice projections. Because it is two-dimensional, its carrier density can be tuned over a broad range without introducing dopants.

I will briefly review the present status of efforts to exploit the unusual properties of graphene sheets in electrical and optical devices, and then turn to some of the completely unanticipated unusual electron-interaction physics that can be studied in high quality single-layer and especially bilayer graphene samples. Bilayer states can be described using a pseudospin language in which conduction and valence band states are characterized by a layer pseudospin with zero polar angle, corresponding to symmetric occupation of the two layers, and an azimuthal angle that specifies the momentum-dependent interlayer phase difference. Bilayer graphene has a broken symmetry state in which a core is formed in this momentum space vortex structure, turning the ground state into a type of Chern insulator. I will discuss what we can learn about these states from recent experiments, and comment briefly on the potential for pseudospin order in other graphene-based two-dimensional electron systems.



Allan H. MacDonald

Born 1951, educated in Canada, receiving his B.Sc. in physics from St. Francis Xavier University in Nova Scotia, and his Ph.D. from the University of Toronto. He was a research scientist at the National Research Council of Canada from 1978 to 1987, Professor of Physics at Indiana University from 1987 to 2000, and has held visiting positions at the Max Planck Institute for Solid State Research, the University of California at Berkeley, the University of California at Santa Barbara, and the California Institute of Technology. In 2000 he joined the University of Texas at Austin as the Sid W. Richardson Professor of Physics. He has authored more than 300 research articles in recognized journals on a wide variety of different topics in the theory of condensed matter, including the quantum Hall effect, magnetic semiconductors, and graphene sheets. Professor MacDonald was awarded the Herzberg Medal in 1987 and the Buckley Prize in 2005, and is a member of the American Academy of Arts and Science and the United States National Academy of Sciences.

Vladimír Dvořák (1934–2007)

Solid state physicist, the most prominent Czech scientist in the theory of ferroelectricity and structural phase transitions, for the whole productive life affiliated with the Institute of Physics, Acad. Sci. Czech Rep. in Prague, its director in 1993-2001, member of the Learned Society since 1995. The main protagonist of the revolutionary reforms in the Institute of Physics after 1989.

His personality has strongly influenced the scientific program and development in the Department of Dielectrics of the Institute since the late sixties up to present. Brilliant lecturer and most respected director of the Institute.

To commemorate his work and personality, the Institute of Physics of the Academy of Sciences of the Czech Republic decided to organize an annual festive Dvořák lecture, given by prominent internationally renowned scientists in the field related to the research pursued at the Institute of Physics.

Fyzikální ústav
Akademie věd ČR, v. v. i.