Theory of the Electronic, Transport and Optical Properties of Nanotubes

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Abstract

Nanotubes are a fascinating new class of materials with highly unusual properties. In additional to the multi-wall carbon nanotubes first discovered in the synthesis of fullerenes, single-walled carbon nanotubes and various hybrid structures including junctions and peapods, as well as noncarbon nanotubes (such as the BN nanotubes), have been synthesized and studied. In this talk, I will discuss some of our theoretical understanding of their unusual electronic, transport, and optical properties. For examples, the metallic carbon tubes behave as quantum wires at low temperature and some are superconductors. The band gap of the BN nanotubes may be tuned by transverse electric fields via a giant Stark effect. The optical spectra of the small diameter carbon nanotubes exhibit dramatic excitonic effects. Electronic device elements based on the nanotubes have been theoretically predicted and experimentally realized. Because of their nanometer dimensions, structures formed from the nanotubes can have novel properties and yield unusual scientific phenomena.