Bringing Research to LIFE

In Brief

Millions for research

The Manitoba government announced that it has awarded the University of Manitoba more than $2.3 million in funding to support research projects relating to health, the environment and advanced technologies.

The announcement was made by Science, Technology, Energy and Mines Minister Jim Rondeau. The funding is provided through the Manitoba Research and Innovation Fund.

The principle investigators who received funding include: Cindy Ellison, pathology; Olanrewaju Ojo, mechanical and manufacturing engineering; Jennifer Wijngaarden, chemistry; Michael Gericke, physics and astronomy; Davinder Jassal, internal medicine; Andrey Bekker, geological science; Wen Zhong, textile science; Jitender Sareen, psychiatry; Frank Schweizer and Scott Kroeker, chemistry; Feiyue Wang, environment and geography, and chemistry; Torsten Hegmann and Michael Freund, chemistry; Warren Cariou, English, Film and Theatre; David Barber, environment and geography; and Bruce Ford and Robert Roughley, biological sciences.

Upcoming

Public Lecture

Making Every Kernel Count

By Digvir Jayas

Tuesday, February 3, 2009

8:00 PM

343 Drake Centre

For more information:

Phone: (204) 474-6915

Speaker Series

When Family is Business and Business is Family

By Reg Litz

Wednesday, February 25, 2009

7:00 PM

Robert B. Schultz Lecture Theatre,

St. John's College

For more information:

Phone: (204) 474-9020

Finding a nano puzzle piece

BY SEAN MOORE

Take a carbon nanotube, snip it open, lay it flat, and you have graphene, one of the most rigid materials known, and one full of strange properties that were first predicted in 1947 by Canadian physicist Philip Wallace.

Judging by the thousands of papers written about graphene since 2005 (when Wallace's predictions about electrons behaving relativistically in graphene were verified experimentally), it's safe to say that this puzzle has plenty of pieces – and two University of Manitoba researchers have just found a big one hiding, as they sometimes do, in an advanced theory.

Their findings will be published in the prestigious journal *Physical Review Letters*.

Tapash Chakraborty, Canada Research Chair in Nanoscale Physics, and his post-doctoral researcher David Abergel, have developed a theory which explains why bilayer graphene displays strange properties when placed in a magnetic field. Their explanation has implications for industries hoping to make the next generation of computer chips.

But let's take a step back for a moment.

Monolayer graphene is one atom thick and looks, as other have written, like molecular chicken wire. Stack two monolayers and you get bilayer graphene.

Recently, researchers at Columbia University put this material in a magnetic field and shone specific wavelengths of light at it to see what was absorbed – measuring what's called the cyclotron resonance.

Photo by Sean Moore

David Abergel (left), and Tapash Chakraborty, from Physics and Astronomy

By doping graphene so that it has an overall positive charge in one experiment, and an overall negative charge in another, the researchers observed how much energy the cyclotron resonance absorbed.

Imagine an elevator in a building. It should take the same amount of energy to move it from the basement (negatively doped) to the main floor (no doping) as it does to go from the main floor to the first floor (positively doped). At least, that is what you would expect if you used the simple theory.

What the Columbia team found, however, was that it took less energy to move from the basement to the main floor than it did to move from the main to the first floor.

Simple theory ignores the interactions between electrons because when you account for these, the equations become very difficult to solve. But interacting theory does take them into account.

"Interacting theory is usually a very difficult thing to handle so people first try the simple approach to see if it fits the experimental result," Chakraborty said.

"So, what we've done in the more complicated theory is to take the fact that electrons repel each other into account and model the system in this much more complete way," Abergel said.

"And when you include these interactions, it does predict this difference in the energy that the experimentalists found. It's a fundamental addition to the whole jigsaw puzzle of knowledge about this material, and you have to include these interactions if you want an accurate theoretical description of graphene," he said.

It was, in short, an important discovery.

"I was telling David how lucky he is," Chakraborty said. "There are so many groups around the world studying the same thing, and that makes it all very exciting, although it makes it a challenge too. But we hit the right thing. We found the explanation."

Kinky nano engineering

BY SEAN MOORE

Kinks are rarely, if ever, a cause for celebration, unless that kink is propagating through a carbon nanotube.

"The kink propagation effect through a carbon nanotube, identified through my research, is exciting and enlightening to researchers in this field," Quan Wang, mechanical and manufacturing engineering professor, said.

As Canada Research Chair in Solid Mechanics, Wang has been characterizing the fundamental properties of carbon nanotubes (CNTs) and recently applied those findings to a practical research project: developing a way to transport atoms via CNTs.

His most recent findings are published in the January 2009, edition of the journal *NANO Letters* (Vol. 9, No. 1, pp 245-249). The paper discusses his simulation, using molecular dynamics, of helium atoms being transported through a single-walled CNT. The tube's diameter was 0.63 nanometres; a nanometer, to jog your memory, is 10^{-9} meters, which is so small that this comma, is half a million nanometers across.

The ability to transport molecules through nanotubes would be a boon to drug delivery systems. A doctor could, for example, direct a cancer drug to the exact spot where it will do the most good, thereby avoiding any collateral damage such drugs may cause to other healthy tissues. Other potential applications include nanorobotics, helium energetics, micropumps, microarrays, atom optics, chemical process control, and molecular medicine.

Photo by Sean Moore

Quan Wang, mechanical and manufacturing engineering, sits in front of his computer displaying a graphic of a kink pushing atoms out of a nanotube.

Some researchers have tried to transport atoms down the tube using waves (think of a cork bobbing ashore). Wang, however, has a good grasp of civil and mechanical engineering concepts and began testing whether instability itself – something disastrous in engineering structures – can move an atom along.

It can.

By applying torsion to the end of the tube, a kink, or instability, appears. The key point though is this kink travels the length of the tube pushing what's ahead of it out the other end. When the force is removed from the carbon nanotube it springs back to its original shape.

"I started my nano research in 2003 and most of it has been on fundamental and theoretical points so as to answer questions like whether civil and mechanical engineering principles can apply to nano science.

"Simulations verified the theories and uncovered new potential for carbon nanotubes. The results are very exciting."

Wang's future work will be aimed at finding the optimal operating temperature, applied force, and nanotube diameter. He will also begin using larger molecules.

To date, 128 international journal papers by Wang have received more than 770 SCI citations. He also serves on 12 journals' editorial boards and acts as a technical review for 34 international journals.

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