Profile

A physicist of many talents

His achievements include levitating a frog and discovering a brand new type of material just one atom thick. **Andre Geim** talks about his wide-ranging career to Edwin Cartlidge

Andre Geim
Not content with a narrow spectrum of research.

In person

Born: Sochi, Russia, 1958
Education: Moscow Technical University (degree in physics), Institute of Solid State Physics, Chernogolovka, Russia (PhD in condensed-matter physics)
Career: Associate professor at the University of Nijmegen, the Netherlands (1994–2000), honorary professor at Nottingham University (1998–2000), professor at Manchester University (2001–present), director of the Centre for Mesoscience and Nanotechnology, Manchester University (2002–present)
Outside interests: When not doing research, climbing mountains

When Andre Geim and other physicists working at the University of Nijmegen in the Netherlands published a photograph of a levitating frog in the April 1997 issue of *Physics World*, many of their colleagues congratulated them on an excellent April Fools' joke. But, in fact, the photograph was no prank. The researchers were able to suspend the frog and a host of other "non-magnetic" objects by exploiting the phenomenon of "diamagnetism", which is caused by electrons in the material adjusting their orbits in the presence of an external magnetic field.

Their colleagues knew of this effect but thought it was far too weak to levitate objects. However, by placing the frog in a powerful – 16 T – magnet and precisely adjusting the shape of the magnet's field, Geim and his co-workers showed they could create an upward magnetic force on the frog to balance the effect of gravity and so suspend the frog in midair.

Geim, now based at Manchester University in the UK, has carried out a wide spectrum of condensed-matter research, including the recent development of a material that could one day be used to make a new generation of ultrasmall electronic circuits. But none has captured the public's imagination as much as the frog experiment, which was reported in newspapers and on TV across the world. It elicited responses from a huge range of people, from prisoners to priests and one nine-year-old American girl who said she was very interested in his work and wanted to become a scientist.

Geim's research has also been appreciated by many scientists, among them Michael Berry of Bristol University, who developed a theory to explain the levitating effect and shared the 2000 "IgNobel prize" with Geim for their efforts. But not everyone has been so enthusiastic. "There are some physicists who think that if they're doing boring research they must be doing serious science," Geim says. "But in my experience, if people don't have a good sense of humour, they are usually not very good scientists either. They don't realize that science doesn't need to be boring to be good."

Flying high
This frog was one of a number of objects that Geim and co-workers suspended magnetically.

From east to west

Geim, 47, is no stranger to abuse. Growing up in Russia as the son of two German parents he says he was used to being called a fascist by some and a "bloody Jew" by others. After receiving a PhD from the Institute of Solid State Physics in Moscow in 1987 he took up a postdoc position at Nottingham University in the UK and says he was "flabbergasted" to be called a Russian for the first time in his life. He was also taken aback at how much science he was actually able to carry out in the UK. "It was a shocking experience that you could spend your time doing research rather than continually battling for resources and dealing with politics," he says.

At that point he realized he could not return to Russia, and became another in the now long line of scientists to quit the country since the fall of Communism. After further postdoc positions in Copenhagen and Bath, and, again, Nottingham, he moved to Nijmegen in 1994. There, in addition to his work on levitation, he also did work on mesoscopic superconductivity, shedding light on the unusual magnetic properties of micron-sized superconductors. He was offered professorships at Nijmegen and Eindhoven, but turned them down as he found the Dutch academic system too hierarchical and full of petty politicking. "This can be pretty unpleasant at times," he says. "It's not like the British system where every staff member is an equal quantity."

Instead he returned to the UK, taking up a chair at Manchester, where he says he now feels at home. His time there has certainly been productive. In 2003 he and his colleagues invented a new type of nanostructured sticky tape that mimics the adhesive properties of gecko feet. More recently, he was part of a team that made an important step in the creation of a material that can "negatively" refract visible light; such a material could be used to build a perfect lens that would focus an image with a resolution not restricted by the wavelength of light.

But what looks set to be his most important work was the discovery of stable crystals that are just one atom thick. In 2004 he and colleagues at Manchester and the Institute for Microelectronics Technology in Chernogolovka, Russia, showed how to make one such material, which they have called graphene. Last year they discovered that the electronic properties of this material, which consists of a single sheet of carbon atoms, are very different from all other materials (*Physics World* December 2005 p4). Electrons in graphene behave

Science doesn't need to be boring to be good

like relativistic particles with no rest mass and they can travel large distances (in atomic terms) with very little scattering.

According to Geim, the material is important scientifically, both for its own exotic behaviour and the fact that it can be used to make bench-top experiments to study the subtle physics of quantum electrodynamics. And technologically, the material could be used to make electronic devices with dimensions of just a few nanometres, a scale at which silicon no longer works reliably. Geim says that although graphene is still at a very early stage of development, it could be an alternative to carbon nanotubes in many potential applications. When high-quality graphene wafers eventually become available, complete circuits could be built from a single graphene sheet, he explains.

The lucky break

Geim is fairly exceptional in the range of research that he has undertaken, but he admits it has not been easy switching from one field to another. This, he says, involves learning an enormous amount of new science in order to avoid "reinventing the wheel", and adds that publishing papers in leading journals does not guarantee you instant visibility in a new field. "I've given invited talks at conferences, expecting people would know who I was," he says. "But people were asking 'who is this old postdoc?'."

Perhaps he will not have to go through that experience again, however. Having created a name for himself with the media and the general public through his levitation experiments, he has further enhanced his scientific reputation in the wake of the graphene discovery. He and his colleagues announced the discovery in *Science* in October 2004 (**306** 666), and there are now about 20 groups carrying out their own research on the material.

"In the different areas that I've worked in for the last 20 years I've been searching for something big," he says. "I think with graphene at last I've found it. Before I relied on professionalism or hard work but never had the luck. Now at last I think I've been lucky and that we've struck gold."

US research

California retains right to run Los Alamos

A consortium led by the University of California has won the race to manage the Los Alamos National Laboratory in New Mexico, the original home of the atomic bomb. Although the university has run Los Alamos since the lab was founded in 1943, a series of security lapses over the last six years had forced the US Department of Energy (DOE) to put the contract out to tender. The university retained the contract after joining forces with the engineering firm Bechtel National, the nuclear-management company BWX Technologies, and the US contractor Washington Group International.

In winning the race, the university fought off a rival bid from the University of Texas and aerospace firm Lockheed Martin. Many observers had believed that the Texas bid would win, particularly because Lockheed Martin already manages the Sandia National Laboratories, another US nuclear-weapons facility. The firm and the University of Texas also have close links with the Bush administration.

The University of California may have retained the contract because it chose Michael Anastasio as head of Los Alamos. Anastasio, who has a reputation as a manager who seeks consensus, is currently director of the Lawrence Livermore National Laboratory. He will take up his new post when the contract comes into force in July. The contract is worth a total of $512m and will run for seven years, although it could be extended for up to 20 years.

Hugh Gusterson, an anthropologist from the Massachusetts Institute of Technology who studies nuclear-weapons scientists, warns that Anastasio's job could become "a bureaucratic nightmare" as the various members of the consortium jockey for pieces of the overall responsibility for the institution. But he could obtain help from a proposal by New Mexico's two senators – Republican Pete Domenici and Democrat Jeff Bingaman – to increase the amount of science undertaken by Los Alamos.

The DOE is now looking for potential bidders to run the Livermore lab, which the University of California has also managed since 1952.

Peter Gwynne
Boston, MA

UK research

Mostly good, but some improvement needed

Researchers in the UK carry out internationally prominent work in astrophysics, particle physics and nuclear physics, according to a major review of physics and astronomy in the country. The review adds that the UK is strong in optics, lasers and condensed-matter physics, but it warns that improvements are needed in atomic physics and experimental quantum computing.

Nanoscience research is also criticized, with the report saying that "the UK lacks coherence and international visibility" in this field, and efforts in surface science are said to be "patchy". While praising "vibrant" research in soft matter and biophysics, the report expresses concern that most work in these fields takes place outside university physics departments, and that few physics students are taught about these topics.

Sponsored by the Institute of Physics, the Royal Astronomical Society and UK the research councils, the review was carried out by an international panel of 14 physicists led by Jürgen Mlynek, an optical and atomic physicist who is president of the Helmholtz Association of research centres in Germany. The review is intended to benchmark the UK's standing in world physics and pick out those fields that would benefit from more involvement.

ESO

Good for British research
The Very Large Telescope in Chile.

The panel says that investment in science has increased significantly since the first such review took place in 2000, with the government spending almost £3bn in 2005/6 – more than double the figure in 1997/8. The panel praised "the general improvement in the research environment" over that period. It has seen, for example, the UK joining the European Southern Observatory, which runs the Very Large Telescope in Chile.

The review welcomes the increased internationalization of physics research in the UK, but warns that physics is no longer carried out as a separate discipline in a number of universities, and says that physicists find it hard to compete for postdoctoral positions because PhD courses are relatively short.

Martin Griffiths