Brownian Motion Fluctuations Used to Measure Minute Torques on Optically Trapped Particle

Along with fundamental advances in quantum optics and special relativity, Albert Einstein's 1905 *annus mirabilis* included the first correct description of the long-puzzling Brownian motion of particles suspended in a liquid. The result of thermal molecular fluctuations, Brownian motion has since been used in applications such as molecular transport and the measurement of pico- to femto-Newton forces. Now G. Volpe and D. Petrov of the Institut de Ciencies Fotoniques in Barcelona have demonstrated the use of an analysis of Brownian motion to measure torques on the scale of 10^{-21} N m, smaller than any previous measurements.

As reported in the November 24, 2006 issue of *Physical Review Letters* (210603; DOI: 10.1103/PhysRevLett.97.210603), Volpe and Petrov used a cw laser at 785 nm to optically trap a 0.5-μm radius polystyrene sphere. They then passed a second laser at 532 nm through a holographic mask to produce a high-order Laguerre-Gaussian (LG) mode carrying a total flux of orbital angular momentum equal to 7.5×10^{-18} N m, and copropagated it with the trapping laser. Using a quadrant photodetector, the researchers tracked the spatial motion of the trapped sphere perpendicular to the trap axis for both low and high trapping laser power. In the case of the weak trapping laser, the sphere simply orbited the axis of the two laser beams, driven by the torque from the LG beam. In the strong-trapping limit, the sphere no longer showed a rotational motion, but the statistics of its Brownian motion were significantly altered by the presence of the torque. Using these statistics, the researchers extracted a value of 4×10^{-21} N m of torque exerted by the LG beam on the sphere, consistent with the total flux of angular momentum and the overlap factor of the LG beam and the sphere.

This value is smaller than any previously reported measurement of a torque, including those from DNA twist elasticity, bacterial flagellar motors, and the transfer of optical orbital and spin angular momentum. This Brownian motion technique is likely to improve the characterization of optical trapping potentials, and may one day become the standard method for the measurement of extremely small torques produced by biomolecules, the interactions between colloidal particles, or optical beams carrying orbital angular momentum.

COLIN MCCORMICK

News of MRS Members/Materials Researchers

Yeo Yee Chia of the National University of Singapore received the **Young Scientist Award 2006** in recognition of "his research on nanoelectronics and semiconductor devices." The award is organized by the Singapore National Academy of Science and supported by the Agency for Science, Technology, and Research.

Cathy A. Fleischer was promoted in November 2006 to president of NaturalNano Inc. (Rochester, New York). She was named chief technology officer of NaturalNano in July 2006 and will continue to serve in that position.

Adolf Goetzberger of the Fraunhofer Institute for Solar Energy Systems, Germany, has received the **Einstein Award** from SolarWorld AG in recognition of his lifetime achievements, particularly for his extensive scientific accomplishments as well as for founding the Fraunhofer ISE, a solar energy and independent research facility.

Peter Gregory will be joining Wiley-VCH as editorial director and a member of Wiley's Global STM Board. He will also be editor-in-chief of the journals *Advanced Materials* and *Advanced Functional Materials*. Gregory returns to Wiley-VCH, where he worked from 1989 to 2002, after four years as managing director of publishing at the Royal Society of Chemistry in Cambridge, United Kingdom.

Axel Herguth of the University of Constance, Germany, has received the **Einstein Junior Award** from SolarWorld AG in recognition of his work on degradation in crystalline silicon solar cells.

Oliver Schultz, a staff scientist at the Fraunhofer Institute for Solar Energy Systems, Germany, received the **Einstein Junior Award** from SolarWorld AG in recognition of his work in the area of process development of highly efficient multicrystalline silicon solar cells.

Han Yu of the Institute of Bioengineering and Nanotechnology in Singapore received the **Young Scientist Award 2006** in recognition of "his research on nanoporous materials and their biomedical applications." The award is organized by the Singapore National Academy of Science and supported by the Agency for Science, Technology, and Research.

Leo Christodoulou of DARPA Receives National Materials Advancement Award

Leo Christodoulou, program manager, materials, for the Defense Sciences Office of the Defense Advanced Research Projects Agency (DARPA), has received the National Materials Advancement Award from the Federation of Materials Societies.

The award recognizes individuals who have demonstrated their outstanding capabilities in advancing the effective and economic use of materials and the multidisciplinary field of materials science and engineering generally, and who contribute to the application of the materials profession to national problems and policy.

Christodoulou is being recognized as a national leader in conceiving and implementing programs that create collaborative efforts with industry and academia at the cutting edge of structural materials development.

During his years at DARPA, Christodoulou's work has significantly changed the frontiers of materials science by identifying new materials concepts and innovative synthesis and processing technologies. His research has been associated not just with advancing the technical state of the art but with promoting the beneficial societal and national applications of materials and structures research and development. One example is known as prognosis, an innovative approach to maintenance that incorporates materials modeling, unique diagnostic techniques, and environmental monitoring to predict the lifetime and remaining performance of critical materials structures such as aircraft wings and jet engine turbines. This new methodology will significantly increase the lifetime of both military and commercial systems. Christodoulou has been highly effective at integrating universities into these programs and supporting the research training of graduate students, thus contributing to the transformation of the future of materials science and engineering.

Linda Griffith of MIT Named MacArthur Fellow

Linda Griffith, a professor in the Departments of Biological and Mechanical Engineering and director of the Biotechnology Process Engineering Center, both at the Massachusetts Institute of Technology, was named a MacArthur Fellow in 2006 for her work in shaping the frontiers of tissue engineering and synthetic regenerative technologies by designing new methods for fabricating scaffolds on which cultured cells can adhere and grow. Her early work focused on designing novel substrates for liver cell cultures to allow pharmacologists to test *in vitro* the efficacy and toxicity of many potential drugs.

Griffith has designed several methods for fabricating scaffolds on which cultured cells can adhere and grow. An initial effort used linear polymer gels crosslinked by electron-beam radiation to form star-shaped structures. More recently, she developed a solid-phase method using L-lactic acid for precisely controlling the pore size and surface chemistry of three-dimensional substrates. Using this technique, she has explored the optimal conditions (e.g., pore size, growth media, cell density, and fluid dynamics) necessary for liver cells to live and organize into physiologically functional units.

With these results, Griffith is developing a powerful tool for exploring the normal function of the liver and the mechanisms of disease that attack it, offering the prospect of significant reduction in the need for future organ replacement or regeneration. Her latest experiments are expanding the use of 3D scaffolds for growing other cell types, such as blood-forming cells. As with the liver culture studies, these experiments lay the groundwork for building *in vitro* models of toxicity and cancer metastasis. At the intersection of materials science, cell surface chemistry, physiology, and anatomy, Griffith is extending the limits of biomedical engineering and its applications for diagnosing disease and regenerating damaged organs.

For more research news on Materials Science, access the Materials Research Society Web site:

ww.mrs.org/connections

News of MRS Corporate Affiliates/Materials Institutions

Arizona State University (Tempe, Ariz.) has created the School of Materials, with founding director **Subhash Mahajan**. The ASU School of Materials is designed as a transdisciplinary unit, combining faculty and resources from the university's College of Liberal Arts and Sciences and the Ira A. Fulton School of Engineering. It will be overseen by deans of both schools.

JEOL USA Inc. (Peabody, Mass.) received the **Omega NorthFace Award** from the Omega Management Group for the sixth consecutive year, in recognition of its commitment to exemplary service and for exceeding customer expectations. JEOL was rated on product reliability, service response time, call center assistance, and service expertise. JEOL manufactures, sells, and services electron microscopes and analytical instruments for high-end scientific and industrial research and development.

The engineering faculty at **McMaster University** opened the **Light Metal Casting Research Centre (LMCRC)** in October 2006. The research focus of the LMCRC is to develop lighter, stronger, and more fuel-efficient automobiles. Among the Centre's partners are Orlick Industries, General Motors, Burlington Technologies, Alcan International, and Magna Powertrain. **Sumanth Shankar**, the Braley-Orlick Chair in Advanced Manufacturing at McMaster University, is the founding director of LMCRC.

The **National High Magnetic Field Laboratory** (NHMFL), located at Los Alamos National Laboratory in New Mexico, has achieved fields above 85 T non-destructively and repetitively in its 100T Multi-Shot Magnet. The magnet is part of the NHMFL science user program supported by the National Science Foundation. Scientists and engineers from academia, government laboratories, and industry will have access to the magnet on a competitive basis.

A doctoral program in materials and nanotechnology at **North Dakota State University** (Fargo, N.D.) was approved by the State Board of Higher Education on June 15, 2006. The proposal called for four focus areas: microelectronics, biomaterials, nanomaterials, and general materials science, and was submitted by **Kalpana Katti**, associate professor of civil engineering and construction.

Oak Ridge National Laboratory (Oak Ridge, Tenn.) has completed its new nanoscience facility, the Center for Nanophase Materials Sciences (CNMS), directed by **Linda Horton**. Designated a user facility by the Department of Energy, CNMS integrates nanoscale science with neutron science, synthesis science, theory, modeling, and simulation.

The **University of Pittsburgh** (Pittsburgh, Pa.) has created a new department, to be known as the Department of Mechanical Engineering and Materials Science (MEMS), by combining the Departments of Mechanical Engineering (ME) and Materials Science and Engineering (MSE). **Minking Chyu**, the Leighton E. and Mary N. Orr Chair in Engineering and current ME chair, will serve as chair of the combined department, and current MSE professor and chair **John Barnard** will direct the department's Materials Science and Engineering program.

The **Weizmann Institute of Science** (Rehovot, Israel) has announced its Initiative for Research in Sustainable and Alternative Energy, a multidisciplinary program. The goal of this initiative is to significantly advance the search for solutions to the world's most pressing energy problems. □

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