by Nancy Forbes

Physics Applied at Columbia University

Columbia University, located on New York City's Upper West Side, is one of more than 40 academic institutions in the United States with separate departments of physics and applied physics. Although differences between the two disciplines can be subtle, applied physics generally focuses on "applicable" areas of physics, such as semiconductors, electro-optics, advanced materials, and microelectronics. It often fills a void created by physics departments, which tend to emphasize the science's fundamental areas, such as high-energy, nuclear, and condensed-matter physics.

Applied physics enables students to use their basic knowledge of physics to explore real-world problems and emerging technologies. In Columbia's case, a number of applied physics graduates have gone on to highly successful careers in industry (see p. 28) and some of them have even started their own innovative technology companies.

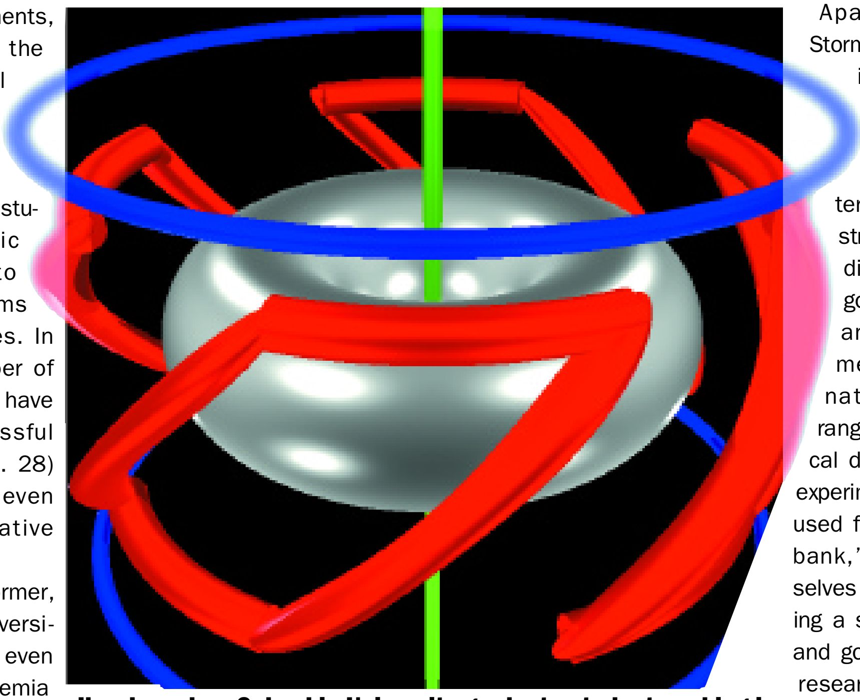
Nobel laureate Horst Stormer, a recent addition to the university's faculty, plans to forge even stronger ties between academia and industry. Stormer, who shared the 1998 Nobel Prize in Physics for his work on the fractional quantum Hall effect, holds a joint appointment in Columbia's department of physics and its department of applied physics and applied mathematics. He also serves as an adjunct director of physical sciences one day a week at Bell Laboratories (Murray Hill, NJ), a division of Lucent Technologies, Inc.

"One of the reasons I came to Columbia is to build a stronger bridge between Lucent Technologies and Columbia's research activities," Stormer says. "This is a two-way bridge: Lucent's technical capabilities and experience can provide tools and opportunities for student researchers, and talented young scientists at Columbia can become involved with scientific issues of practical interest to Lucent."

Blurred lines

In Stormer's view, the lines between applied and basic physics are not clear-cut, and they often change from one university to another. "For example, Stanford's applied physics department has a very strong condensed-matter physics emphasis, for historical reasons, while at Princeton, the electrical engineering department has a focus that's more fundamental than applied," he says. "Dan Tsui, who shared the Nobel Prize with me, is from the latter department. His work in condensed-matter physics can certainly be described as basic research. I think it's healthy not to have strong opinions about the differences between physics and applied physics. When this distinction becomes blurred, it becomes possible for physicists, applied physicists, and even engineers from industry to communicate with one another across the disciplines."

"In addition," he says, "our storehouse of physics knowledge has grown, and one can't do everything anymore in a given field. So the connections between physics, applied physics, and industry become important in the sense that people from each environment can contribute their different expertise to the overall research goal, and this of course includes the students."



Ilon Joseph, a Columbia University graduate student working in applied physics, developed this innovative magnetic-induction concept for use in sustaining high-temperature plasma rings.

Apart from the addition of Stormer and a tradition of producing successful alumni, Michael Mauel, professor of applied physics, cites several factors that characterize his field at Columbia: a strong spirit of discovery, a tradition of active research, and good rapport between faculty and students. "Our department is interdisciplinary in nature, and our efforts can range from the smallest technical detail of an applied physics experiment to applied mathematics used for operations research in a bank," he says. "We pride ourselves on our breadth, and on having a strong departmental identity and good communications across research areas and between the faculty and students."

The department, part of Columbia's Fu Foundation School of Engineering and Applied Science, was established in 1978 with the goal of creating a cooperative environment that encourages complementary and interdisciplinary research between applied physicists and applied mathematicians. An undergraduate can major in either applied physics or applied mathematics. Graduate students can earn a master's degree, Ph.D., or Eng. Sc.D. in either discipline or specialize in medical physics. At present, the department numbers 20 full-time faculty members, 7 research scientists, 15 associate research scientists, 65 graduate students, and 35 undergraduates. Faculty research focuses primarily on the areas of plasma physics and controlled fusion, space-plasma physics, quantum electronics, solid-state physics, and applied mathematics. The department is a research leader in magnetic-fusion energy and free-electron lasers.

Faculty and students also collaborate in research in firms such as Bell Labs, IBM's T. J. Watson Research Center (Yorktown Heights, NY), and Philips Laboratories (Briarcliff Manor, NY). They have a mentoring program that pairs students for summer internships with departmental alumni working in industry. Faculty also have access to Columbia Innovation Enterprises, a university group set up in 1982 to promote industrial funding for R&D and tech transfer and to protect academic intellectual property rights. The group helped Robert Scarmozzino, an alumnus and senior research scientist in the department until 1997, license software he had created.

The department sees benefits for both sides in maintaining good academia–industry relations. "One reason is financial," says Stormer. "In today's climate, where research dollars are not abundant, collaborations between industry and academia can be a good way to optimize resources. The other reason has to do with students. It's important for students to get a feel for research, and for the real world, before they graduate. Being exposed to industry can help them achieve this."

Industrial leadership

Many alumni of Columbia's applied physics and applied mathematics program have gone on to rewarding careers in industry, with several of them pursuing an entrepreneurial track.

Dick Post, who received his Ph.D. in 1973 in plasma physics, is now chief executive officer of Applied Science and Technology, Inc. (ASTeX), a semiconductor-equipment company in Woburn, Massachusetts. Post attributes his education in applied physics at Columbia University with helping to prepare him to prosper in this field. "I was able to use my specific knowledge of plasma physics to get into this industry, and then use the breadth of my education to expand my understanding of semiconductor processing," he says.

The ASTeX chief executive officer believes that business training is just as important to success in industry as technical knowledge. "To make it as a business executive, one needs a broad knowledge of the financial, marketing, manufacturing, and sales aspects of business," he says. "Technical people coming into industry often have no idea of how to relate what they have to offer to the needs of the business." Post advises scientists and engineers in industry who want to go into management to get an MBA—or at least to take a semester of business fundamentals—"so that they can be effective leaders from the very start of their careers." Although Post himself has a Ph.D., he regards the degree as unnecessary for most technical jobs in industry. "The main advantage of having a doctoral degree is the additional depth of knowledge and rigor it gives one," he says.

To bring about closer relations between industry and academia, Post suggests that academics learn more about the culture of business and its ways of operating. Cultural differences between industry and academia often cause academics to erroneously view scientists in industry as "second class." He also encourages interested undergraduate students to do industrial internships to give them an early taste of what the business environment is like.

Alan Todd received his Ph.D. in plasma physics in 1974. After five years at the Princeton Plasma Physics Laboratory, he joined the R&D department of Grumman Corp. (later Northrop Grumman). Todd remained there until last fall, when he and several others formed Advanced Energy Systems, Inc. (Bethpage, NY). Todd, a member of the start-up's board of directors, also serves as its treasurer and as vice president for accelerators and special projects. These multiple roles make him an active participant in both the business side and the advanced-research world.

A good physics education, Todd says—whether at the Ph.D. or bachelor's level, whether in applied or basic physics—"will always prepare the individual for problem solving in general, and to see the forest for the trees. These are traits that can find wide application in industry."

Todd, an active member of the American Physical Society's Forum on Industrial and Applied Physics (see "Voting Goes Virtual," p. 32), also argues that universities and companies can gain much from good industry–academia relations. "Industry generally appreciates the value, in terms of its bottom line, of working with academia and actively seeks out collaborations," he says. "With greatly reduced R&D budgets, companies are eager to find novel ways to leverage academic research in their products and services. Academia has also changed toward a much more favorable view of industry collaboration. Its concerns usually center on the conflict between the academic freedom to publish and the industrial need for a marketing edge through the creation of proprietary data and trade secrets."

Multifaceted and active like the city that surrounds it, Columbia University's applied physics and applied mathematics department has placed its own distinctive stamp on its research and teaching program. Expect its growing ties with industry to stimulate new directions for the future.

B I O G R A P H Y

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