Physics by Any Other Name . . .

The scientists at NIST's Physics Laboratory perform, in the words of its director, Katharine Gebbie, "directed" research. As has generally been the case at NIST, one finds within the Physics Laboratory both pure and applied physics to support industry on timescales from the immediate to the long range. The lab's new mission statement, developed by Gebbie and her division leaders, lays out the goal explicitly: "to support US industry by providing measurement services and research for electronic, optical and radiation technology."

Gebbie and her colleagues have thus chosen to concentrate on assisting three types of technologies. But the research areas are still wide among the lab's eight divisions, each of which has its own specific mission. The divisions are further divided into research groups. From an afternoon spent touring several NIST labs in Gaithersburg, Maryland—where snatches of overheard conversations gave the distinct impression of enthusiastic scientists at work—here are a few brief examples:

Within the electron and optical physics division, the electron physics group studies exchange coupling in magnetic films. They have found that when a nonmagnetic material is placed between two magnetic materials in a sandwich of order 10^{-9} meters thick, the magnetic coupling between the material reverses direction whenever the spacer thickness changes by only a single layer of atoms. This work supports technological applications involving recording heads and sensors. The group also studies very small magnetic structures using scanning electron microscopy with polarization analysis. This work, of fundamental scientific interest, has practical applications in magnetic storage. The group is also studying laser focusing of neutral atoms for possible nanostructure fabrication. Here the laser electromagnetic fields act for atoms as lenses and mirrors do for photons.

William Phillips of the atomic physics division, who in 1990, with Claude N. Cohen-Tannoudji, explained what were then new mechanisms for laser cooling to readers of PHYSICS TODAY (October 1990, page 33), has carried that work further, cooling atoms below 1 microkelvin. How does this research fit with NIST's mission? With an accuracy of one part in 10^{14}, NIST-7 is now the world's most accurate atomic clock, but application of laser cooling to clock making will substantially improve this accuracy, perhaps by as much as a factor of 100. Further research, such as that on laser-cooled trapped ions at NIST's Boulder, Colorado, laboratories, may lead to clocks with accuracies of a part in 10^{18}.

Through the radiation interactions and dosimetry group of the ionizing radiation division, NIST helps provide radiation standards for those directly involved in medical physics, for those in industry who help develop products using radiation, and for all those who work near sources of radioactivity, such as nuclear submarines and food irradiation facilities; NBS started this work in 1927. NIST works with government regulators, such as the Nuclear Regulatory Commission and the Food and Drug Administration, as well as those who produce radioactive sources, such as radiopharmaceutical companies. Scientists in this group do physics inside an energy range of 20 keV to 30 MeV.

The neutron interactions and dosimetry group has established a neutron interferometry station at the Cold Neutron Research Facility. (See PHYSICS TODAY, September 1991, page 17.) Taking advantage of the quantum mechanical "wave-like" characteristics of neutrons, the apparatus allows the study of phenomena using matter–wave interferometry. In neutron interferometry a neutron beam is spatially split and recombined using perfect crystals of silicon as optical elements. The group claimed to have the best such setup in the world and expects further improvements in the future. According to Gebbie, this program is motivated by a desire to carry out worthwhile fundamental physics while developing new measurement techniques. Ultimately, neutron interferometry may provide a new tool for materials science.

The desire to develop tools for materials research has also motivated a program for the polarization of neutrons using nuclear-spin-polarized ^{3}He spin filters. Recently groups outside NIST have made significant progress in ^{3}He polarization, motivated by target development for medium- and high-energy electron scattering experiments. NIST is engaged in extending this technology for neutron polarization for tests of fundamental symmetries as well as for its applications in polarized neutron scattering.

Agency with a mission

How does NIST differ from a typical university physics laboratory? Gebbie pointed out that NIST is a mission-oriented agency and all its research is directed toward fulfilling that mission. Phillips told PHYSICS TODAY that one of the advantages he sees in doing physics at NIST—a place he called "extremely stimulating and exciting"—is the opportunity to work in a strong research group with a team of focused senior colleagues and young National Research Council postdoctoral fellows. In Phillips's picture of NIST, top-notch senior scientists bring great experience and an institutional memory, and the postdocs bring new ideas and "new energy."

While overall funding for NIST has grown greatly and may be expected to continue to grow during the Clinton Administration, the Physics Laboratory enjoys more modest increases. Gebbie says she has had the freedom to make decisions about redirecting Physics Laboratory programs, a process that began in the Bush Administration when she reprogrammed a project to build a free electron laser and greatly reduced efforts in astrophysics. She explains, "NIST cannot do everything. We have to make decisions about those programs where we can have the greatest impact on our mission."

Gebbie thinks that one of the great strengths of NIST physics is to instill confidence: "I feel very strongly—and I think I am supported by NIST's upper management—that the quality of our services really depends on the strength, breadth and excellence of our scientific research. Our contributions are credible only to the extent that they're based on the best scientific judgment available."

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she analyzed microelectronics research and development at the request of the House science, research and technology subcommittee. In 1986 she moved to the Defense Department's Advanced Research Projects Agency as a program manager in the electronic sciences division. She helped create ARPA's microelectronics technology office and served for two years as its director, managing a $300 million budget, before coming to NIST at the end of May 1993.

Illustrating why many are saying that the best vehicle for technology transfer is the moving van, Prabhakar brought the corporate culture of ARPA to NIST. She speaks the business language heard often these days in Washington. "Ultimately, our customer is the taxpayer," she says. NIST must "maximize the value we deliver," help change the "behavior" of companies, but let them "drive the agenda" of the ATP, which she describes as a "partnership" between NIST and the company it's working with.

Prabhakar says the ATP is "designed to do a job that lies between research and product development." In