astronomy," says Weiler, "and clearly identifies areas for NASA's and NSF's attention. Personally, I do not support yet another advisory group." Smith believes that such a committee will face a daunting challenge in matching the different agencies' priorities and cultures in a "scientifically productive" manner. In any case, the community must find a way to get past its differences and unite on the national level, says Giacconi. "We must develop a United States of Astronomy."

**PAUL GUINNESSY**

# NSF Centers Stimulate Research at Physics Frontiers

Cosmology, gravitational wave physics, ultrafast physics, and particle physics are the topics that triumphed in NSF's first annual competition to form Physics Frontier Centers. Four inaugural centers will get up to $3 million a year each for five years, with home institutions chipping in at least 15% more. The money will be for research, conferences, visitors, postdoc and graduate student salaries, equipment, and outreach activities.

The new centers are intended to support physics on a scale bigger and costlier than an individual or small group can typically undertake, but smaller than in major collaborations. Unlike many of the private and public research centers that have cropped up in recent years, these step back from the trend to require interdisciplinarity and ties with industry or government, and physicists are free to dream up center organization for themselves. "These centers are targeted to get at physics frontiers," says Jack Lightbody, executive officer of NSF's physics division. "They are not designed to fill some scientific or political niche. They will have some outreach and educational activities. But the principal objective is cutting-edge science where there is potential for breakthroughs."

## First frontiers

Like all the new centers, the Center for Cosmological Physics at the University of Chicago builds on existing research strengths. "The frontier that we're proposing to explore is, to my mind, the ultimate frontier because it delves into the laws of physics governing the entire universe," says director Bruce Winstein, a recent convert to cosmology from particle physics. The center's founding members meld particle physics and astrophysics, theory and experiment. Initial activities include spearheading a study of galaxy clustering to probe dark energy—which appears to be responsible for accelerating the universe's expansion; participating in Auger and Veritas, detectors of high-energy particles from space, with the goal of homing in on dark matter; building an instrument to measure polarization of the cosmic background microwave radiation; and setting up a data analysis hub for the Sloan Digital Sky Survey. NSF awarded this center $3 million a year.

A host of gravitational wave detectors is on the verge of collecting data—LIGO in the US, VIRGO and GEO in Europe, and TAMA in Japan are ground-based projects set to start next year, and an international space-based project, LISA, is slated for launch later this decade. The mission of the Center for Gravitational Wave Physics "is to help crystallize and develop the emerging field of gravitational wave phenomenology," says Sam Finn, director of the Pennsylvania State University-based center. "The science sits at the interface of the astrophysics and gravitational wave communities. Relativity theory has been developed in the absence of experiment. There is no experimental culture. That is a bridge that needs to be built," Finn says. The center has founding members at nine institutions, and will get $1 million a year from NSF. Its three main thrusts are astrophysical interpretation of observations, testing general relativity, and contributing to the design of source-specific gravitational wave detectors.

At the Center for the Study of Frontiers in Optical Coherent and Ultrafast Science (FOCUS), research will span a huge energy range, from creating relativistic plasmas with high-energy laser pulses, down to manipulating quantum states in optical lattices or Bose–Einstein condensates, says Philip Bucksbaum, director of the center, which is a partnership of scientists at the University of Michigan and the University of Texas, Austin. "Controlling decoherence is the recurring theme," says Bucksbaum. FOCUS won $3 million a year from NSF. Its biggest single undertaking will be to take Michigan's existing terawatt laser and, for about $2 million, power it up to petawatt capability.

Rounding out the first batch of NSF Physics Frontier Centers is the Center for the Origin and Structure of Matter, led by Hampton University in Hampton, Virginia. COSM physicists are involved in strangeness physics at Jefferson Lab, including leading PRIMEX, an experiment that will look at decay of $\pi^0$ mesons to explore quantum chromodynamics at low energies. And for the Large Hadron Collider at CERN, outside Geneva, they are building part of the ATLAS detector, which will hunt for, among other things, charged Higgs bosons. On top of the physics, COSM aims to create a network among particle and nuclear physicists at historically black colleges and universities. Three are on board so far—Hampton, Norfolk State University, and North Carolina A&T State University, says COSM director Keith Baker. "I have been doing physics for more than a decade," Baker says. "This is what I've been building toward." COSM's $1 million a year has been approved by NSF's physics division, but must still wind its way through the foundation's bureaucratic maze.

**TONI FEDER**

CHUCK LONG/HAMPTON UNIVERSITY

**MICROCOSM**: Hampton University student Don Arnold's research on a gas-handling system for CERN's ATLAS detector now falls under the umbrella of the Center for the Origin and Structure of Matter (COSM), one of NSF's four initial Physics Frontier Centers.

# Secondary, Undergraduate Physics in Crisis in UK

The refrain is familiar, but the volume is up: UK secondary schools desperately need physics teachers, and university physics departments should broaden their reach in under-

SCI-FUN, UNIVERSITY OF EDINBURGH

**SCIENCE ROAD SHOW:** The University of Edinburgh takes science demonstrations to schools around Scotland, aiming both to capture kids' imaginations and to give university students a taste of teaching. Here, flame height corresponds to pressure in a standing sound wave.

graduate education. So says the Institute of Physics (IOP) in a report released last month on undergraduate physics in the UK, *Physics—Building a Flourishing Future.*

The facts are grim: Many UK physics schoolteachers are not trained in physics; undergraduate students lack the math skills they need for physics; and more than 10 university physics departments have folded in the past decade.

All that despite job options for physics graduates in, for example, financial analysis, engineering, environmental science, energy technology, and intellectual property law. Employers told the IOP that they seek physics graduates for their problem-solving skills and their "ability to argue on [their] feet," but that they'd like to see better communicating skills and teamwork.

Because of its findings, the IOP will look into developing teaching materials to help university physics departments catch students up in math, and it's calling for departments to partner with schools to sow seeds of scientific curiosity in the young. Such activities go on already, of course, but the idea is to increase their impact. Says Derek Raine, an astrophysicist at the University of Leicester, "They're the sort of things that happen once everyone sees everyone else is doing it. They're given status by IOP promoting them."

The report also says the government should recognize market forces and pay physics teachers more. The government knows there is a crisis in secondary schools—some have even taken to recruiting teachers from abroad. "They're hearing this for the *n*th time," says IOP President Peter Williams. "We hope to get their attention that, in physics, it's particularly acute."

The IOP vows to push for recognition of the MPhys—a combined bachelor's/master's degree that takes just four years to complete—within the emerging Bologna framework of mutually compatible higher-education systems in Europe (see PHYSICS TODAY, May 2001, page 21).

The number of physics majors has remained flat over the past 15 years, while total university enrollment has skyrocketed. Physics should cast a wider net by offering new interdisciplinary degrees that cross with chemistry, computer sciences, and other fields, the report says. Such degrees could feed the job pipeline, help stop more departments from closing, and attract students who like physics but are weak in math. "Within the context that up to half the population goes into higher education, we should look at physics as part of the general culture, not just as training for professional physicists," says Raine. "We should also question why the gender balance and ethnic mix of physics students is unrepresentative."

By and large, physicists who have read the report say it holds no real surprises. They applaud the idea of creating new degrees, though they wonder where the additional cash and staff to do that will come from. And they are skeptical that the government will cough up enough funding to improve conditions for teachers so that the profession can compete with the more lucrative careers available to physicists. The IOP report calls for a study leading to specific recommendations by next year as to what sorts of new degrees to launch, who should pay for them, and where they should be offered. And, says Williams, the IOP will evaluate the costs involved in rejuvenating the teaching pool. "We can't keep hemorrhaging as far as our secondary schools are concerned. Something must be done."

**TONI FEDER**

## Science Teacher Initiative Launched

In an effort to create more and better-prepared K–12 science teachers from the ranks of college physics and physical science students, a partnership of physics organizations, backed by federal grants totaling more than $6 million, has established the Physics Teacher Education Coalition, or PhysTEC.

"We want to create a new generation of elementary and secondary science teachers," said Fred Stein, one of PhysTEC's principal investigators and the director of education and outreach for the American Physical Society. "We need teachers who know physics and who love it."

The program, developed by APS, the American Institute of Physics (AIP), and the American Association of Physics Teachers (AAPT), received a five-year, $5.76 million grant from NSF in August, and a $498 000 grant in September from the US Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE). Most of the funding will be awarded to six colleges and universities that have agreed to improve their science preparation of future teachers.

The schools are Ball State University in Indiana, Oregon State University, the University of Arizona, Western Michigan University, Xavier University of Louisiana, and the University of Arkansas. One of the goals of PhysTEC, Stein said, is to encourage collaboration between the faculty in the physics and education departments to produce a coherent program.

PhysTEC began as an idea that grew out of a meeting in early 1999 of APS, AIP, and AAPT staff members concerned about education, Stein said. "Their governing boards passed a joint statement urging the physics community to take a more active role in improving the pre-service education of physics and other science teachers." The statement reflected the recommendations in several studies, including recent reports by the National Research Council and the National Commission on Mathematics and Science Teaching for the 21st Century, for programs to better prepare future science teachers.

After the physics organizations issued their joint statement, APS Executive Officer Judy Franz thought, "you can put that on your Web site and just forget about it, or you can do something." She knew a program to improve science teacher