in skeletal muscle, on the time scale of a billionth of a second (nanosecond) using synchrotron radiation from the ESRF.[9]

A truly brilliant star has been born in the Midwest sky which, together with the ones already existing in the world and the ones currently under construction, will illuminate our path towards a better understanding of the details and subtleties within the atomic landscapes, islands, continents, and universes that surround us.

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PHYSICS EDUCATION

Recent Developments in Physics Education Research

Physics education research (PER) focuses on improving instruction by studying how students learn the complex concepts of physics. Although this type of work has been going on for decades, it is only within the past few years that the field has seen substantial growth. An expanding international body of scholars has been striving to establish PER as a recognized subfield of physics. This has been promoted by disseminating findings from many studies which highlight the ineffectiveness of traditional instruction. Upon discovering substantial weaknesses in understanding among even their best students, faculty are usually eager for a scientific approach to addressing the problem. This has led to widespread adoption of newer, student-centered pedagogies which are based on the findings of rigorous studies. The strong interaction between PER, curriculum development, and teacher education is a hallmark of the field.

There continues to be a deepening examination of student understanding of many topical areas in physics, including mechanics, optics, electricity, thermodynamics, and even relativity and quantum mechanics.[1–3] Teachers at the high school and college levels are probing their students' knowledge through the use of research-based testing instruments like the Force Concept Inventory, the Mechanics Baseline Test, and the Test of Understanding Graphs in Kinematics. Newer projects are developing similar instruments[4] for other topics. Explorations of knowledge structure,[5] student attitudes,[6] and the viability of specific instructional approaches are also underway.[7–9] Most indicate that computers do not make a sizable impact on learning unless they are embedded within a carefully structured curriculum that emphasizes student activity and involvement with the material. In fact, PER studies[10–12] generally indicate that the most successful instructional techniques appear to be those that account for preexisting ideas brought into the classroom and that place students in situations where they must reexamine their own understanding in light of hands-on activities that challenge their intuition.

Several new research-based textbooks[12,13] and instructional software packages have been published recently. National meetings of the American Association of Physics Teachers have also seen rapid growth in the number of talks, tutorials, and workshops dealing with the findings and classroom applications of PER. Teacher education is expanding at all levels, by virtue of several important efforts for elementary teachers and dozens of projects involving college faculty. One of the most exciting approaches has been the effort to find cost-effective ways of applying the many pedagogical techniques, whose worth has been demonstrated in small classrooms, to large enrollment sections.

The Raleigh Conference on Issues in Physics Education Research, held in October of 1994, was an important milestone for PER. At the meeting, plans were formulated to discuss the establishment of a journal devoted to PER, to develop an electronic network of PER resources, to promote the creation and strengthening of PER groups in physics departments, and to write a position paper on the relationship of PER to other subfields of physics. Since then, good progress has been made on all these fronts. Finding ways to improve the learning of physics through scientifically rigorous investigations is proving to be a fruitful and exciting endeavor.

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NSF Reviews Undergraduate Science Education

On July 11–13, 1996, the National Science Foundation and the National Research Council (NRC) sponsored a conference entitled "Shaping the Future: Strategies for Revitalizing Undergraduate Education" in Washington, DC. The conference was guided by two recently released reports. "From Analysis to Action: Undergraduate Education in Science, Mathematics, Engineering, and Technology" summarized the conclusions of a national convocation organized by NRC and NSF. The April 1995 convocation began the "Year of Dialog," which ran in parallel with a year-long, nation-wide review of the status of undergraduate education in science, mathematics, engineering, and technology (SME&T), sponsored by NSF.

The review considered all aspects of undergraduate SME&T education including the needs of SME&T majors, nonscience majors, and preservice teachers. Institutions ranging from two-year colleges to research-intensive universities participated, with additional input solicited from government and industry. The resulting report, "Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology," produced by the Advisory committee to the NSF Directorate for Education and Human Resources, was the first comprehensive review of undergraduate science education in nearly ten years.

Both reports came to similar conclusions, with the primary imperative being that *"all stu-*