

I exchanged private e-mails with Helen Quinn shortly after our writings appeared in the same issue of PHYSICS TODAY. She wrote that her "impression is that the idea of a law became archaic right about the time it was realized that Newton's laws were not absolutely true in all circumstances. But we never gave up using the term for ideas that had already been blessed with that language usage." She asked, as does William Hooper, who would decide, and whether some international body of physicists should be empowered to promote theories to laws, just as the International Astronomical Union declared that Pluto is not a planet. I agree with that proposal, but I'll caution that Pluto is still a planet to me.

Hence, I make my own prejudice clear as to theories versus laws. Unlike Gregory Mead, Joseph Ribaudo, or Lewis Wedgewood, I find the idea of a law much more compelling than a theory. In my own corner of physics—elementary-particle or high-energy physics—we have, for example, string theory and supersymmetry theory. Although both propose solutions to perceived problems with the standard model of high-energy physics, neither has made a prediction that has yet been verified by experiment. (My theoretical colleagues will disagree, and they will happily point out that in supersymmetric theories, in which every quark, lepton, and gauge boson we currently know acquires a new partner, about half of the supersymmetric particles have already been discovered. Some may argue that the observation of "dark matter" is actually the detection of supersymmetric particles, but to me the connection has not yet been made.) Furthermore, in casual conversation, private thinking, or everyday life, one frequently hears—or asks—the question, "Does it violate the laws of physics?" I've never heard "Does it violate the theories of physics?" I vote for the laws of special relativity, and in deference to history and the input from readers of my letter, let a duly organized body of physicists assign attribution, lest others do it for us.

Richard W. Kadel
(rwkadel@lbl.gov)

Lawrence Berkeley National Laboratory
Berkeley, California

Language of science II: Degrees of knowing

Helen Quinn (PHYSICS TODAY, January 2007, page 8) makes a very good point

that the general public often misunderstands the meaning of "belief" and "theory" as used by scientists. The problem originates, I believe, in the way science is taught in the schools. As Thomas Kuhn noted long ago in *The Structure of Scientific Revolutions* (University of Chicago Press, 1962), science is taught like religion: You'd better believe it or you will get a bad grade. Fundamentalists opposed to evolution have a stronger threat: You'd better not believe it or you will go to Hell.

Today, as a result of the No Child Left Behind Act, US public schools place increased emphasis on testing. Unfortunately this motivates teaching to the test, with little emphasis on the scientific method.

The most important thing to be taught is how scientists have come to believe the present theories, usually after a long struggle, as a result of many experiments and observations. Even for a limited part of physics, it is hard for a student to recapitulate in a semester what may have taken scientists many years to discover. There is always an attempt to cover too much material, as evidenced by the weight of the latest university physics textbooks, which only the stronger students can lift. There is no simple solution, but it is important to identify the problem.

Lincoln Wolfenstein

(lincolnw@andrew.cmu.edu)
Carnegie Mellon University
Pittsburgh, Pennsylvania

Thank you, Helen Quinn! Many physicists need your reminder to watch some of the words we use in our discussions. As teachers, we must be especially careful; and when we talk with nonscientists, it may well be necessary to explicate exactly what we mean by certain words. The majority of the population is not even aware of the incorrect meanings so many people attach to so many significant words.

The recently renewed debate on biological evolution provides a wealth of glaring examples. People often misuse words in important discourse. As a hopefully extreme example, I recall the claim: "I know that God exists, but science is only a bunch of theories." At the same time, people enjoy the use of the most sophisticated gadgets that recent science and technology has made available.

I suggest that the understanding and distinction of the correct meaning of words such as knowledge, belief, hypothesis, and scientific theory must be an essential part of education. It should be taught in all high schools—if not in

PPMS IS A TRADE NAME OF QUANTUM DESIGN INC.

PPMS™ SPM

LOW TEMPERATURE SCANNING PROBE MICROSCOPE

MULTIMODE OPERATION:
MFM-AFM STM-SHPM

**WORLD'S SMALLEST
HALL PROBE: 50nm**

**MFM IMAGE OF HDD:
@300 K**

**VORTICES IN BSCCO
IMAGE COURTESY OF
PROF S. J. BENDING**

**EXPERIMENTAL B(H)
HYSTERESIS LOOPS
MEASURED ABOVE THE
INDICATED POSITIONS
ON THE Fe DISK
IMAGE COURTESY OF
PROF S. J. BENDING**

- **Scanning Hall Probe Microscopy**
 - 50 nm spatial resolution
 - Real time scanning!
 - Unprecedented sensitivity:
 - Up to 6 nT/Hz^{1/2} @ 4K
- **Multi-Mode Operation:**
 - Fibre interferometer for ultimate resolution
 - MFM, AFM, STM, EFM ...
 - Quartz or Akiyama sensor options
- **mK - 300 K Temperature Range for non-PPMS Systems**

**QUANTITATIVE & NON-INVASIVE
MAGNETIC MEASUREMENTS AT
NANOMETER SCALE**

NanoMagnetics Instruments Ltd.

www.nanomagnetism-inst.com
info@nanomagnetism-inst.com