Querying the constancy of Planck's constant

Since its introduction in 1900 by German physicist Max Planck, Planck's constant has played a central role in modern physics and the theory of quantum mechanics. This number appears in a host of fundamental equations, including those defining the smallest amount, or quantum, of energy that a physical system — whether an atom or a baseball — can gain or lose.

By delving deeply into the physics used in making extremely precise measurements of fundamental physical constants, researchers have now obtained the first experimental evidence that Planck's constant remains the same in different physical systems. Scientists had long assumed that only one way existed to quantize physical parameters, but they lacked experimental evidence to support that belief.

"We are trying to establish [whether] it makes sense from an experimental point of view to talk about more than one Planck's constant," says Ephraim Fischbach of Purdue University in West Lafayette, Ind. "This is the first time anybody has shown how you can even address the question, startling as it may be to many people."

Checking for the existence of different Planck constants provides a novel test of the consistency of quantum mechanics itself. It also furnishes a precise measure of energy and momentum conservation at the quantum level.

"Nobody has any doubt that there's only one constant and that all these conservation laws work," Fischbach says. "On the other hand, these are physical principles, and we want to test them."

Fischbach, Geoffrey L. Greene of the National Institute of Standards and Technology in Gaithersburg, Md., and Richard J. Hughes of the Los Alamos (N.M.) National Laboratory report their pioneering effort in the Jan. 21 PHYSICAL REVIEW LETTERS.

To probe Planck's constant, the researchers took a close look at the measurements that went into establishing the numerical value of the fine-structure constant, which measures the strength of the interaction between a charged particle and the electromagnetic field. "I knew there were many different methods, coming from very different realms of physics, by which the fine-structure constant could be determined," Greene says.

In some cases, the researchers could associate the Planck's constant involved in the expression for the fine-structure constant with quantization applied to a specific particle — the electron, photon or neutron. If they found any differences between these particular measurements of the fine-structure constant, they could attribute them to differences in the value of the Planck constants for various particles.

A comparison of the data for three carefully selected determinations of the fine-structure constant revealed that the Planck constants for the electron, neutron and photon are the same to within a few parts in 10 million.

"Now, when I get up in front of a quantum mechanics class and say we believe there is a Planck's constant and that all particles are described by the same Planck's constant, I can point to this result," Fischbach says. "The ingredients for this calculation are some of the most precise numbers in all of physics. Knowing what we know, it would be hard to imagine testing this in any more precise way."

Fischbach, Greene and Hughes now seek to determine what other information they can glean from high-precision measurements of physical quantities. "There are a variety of experiments that are used to determine the fundamental constants," says Hughes. "What a lot of people don't realize is that there is an enormous amount of physics buried in them."

"The hard work has already been done by the experimentalists, who often devoted many years to one measurement," Greene says. "There's a very fruitful collection of experimental data that we can examine to see what we're actually learning about nature." *— I. Peterson*

Probe turns up flaws in Alzheimer's study

When a 1986 research report described dramatic improvements in Alzheimer's patients on an experimental drug, some scientific reviewers hailed the work as a "triumph." The drug may yet fulfill that promise, but the report has since drawn a barrage of criticism from researchers troubled by its missing details. The Food and Drug Administration has now published the findings of a probe that reveals serious flaws in the 1986 study.

William K. Summers, a psychiatrist affiliated with the University of California, Los Angeles, led the team reporting the encouraging findings in the Nov. 13, 1986 NEW ENGLAND JOURNAL OF MEDICINE (NEJM). The study focused on tetrahydroaminoacridine (THA), a compound that inhibits a crucial brain enzyme required to break down the neurotransmitter acetylcholine (SN: 11/15/86, p.308). Most researchers who study Alzheimer's disease believe a lack of acetylcholine may cause memory loss, confusion and impaired thinking in Alzheimer's patients. Indeed, the 1986 report concluded that THA improved memory and cognitive abilities in all 12 men and women with Alzheimer's disease who had taken the drug for about a year.

The report initially met with positive reviews. By the spring of 1987, however, some scientists had criticized the researchers' methodology and others questioned Summers' involvement in Solo Research, Inc., a for-profit company set up shortly after the report's publication for the purpose of selling the experimental drug to Alzheimer's patients. These concerns triggered the FDA probe, designed to determine whether the researchers' laboratory records matched their published account of the study.

The results of that inquiry, published in the Jan. 31 NEJM, reveal "numerous differences" between the journal article and the laboratory records. For example, the researchers stated in their paper that they assigned volunteers to THA or placebo groups in a random and double-blind manner — a standard experimental method that helps eliminate bias by keeping volunteers and researchers unaware of which participants receive treatment or placebo. FDA investigators, however, say they found no documentation of randomly assigned treatment or consistent blinding procedures.

"A substantial proportion of the evidence presented was not collected under blinded conditions, as implied or claimed, but was assembled after the fact from a mixture of sources," states the FDA report. "Not surprisingly, the inspection dramatically altered the agency's view of the importance of Dr. Summers' report. At best, we consider the evidence to be the equivalent of uncontrolled, anecdotal clinical information."

In a response published in the same issue of the NEJM, Summers and his colleagues deny these allegations, calling the FDA report "a personal attack on our group." In a telephone interview, Summers told SCIENCE NEWS that FDA inspectors dismissed handwritten notes that document the team's random assignment of subjects and blinding procedures.

FDA calls the results of its investigation "disturbing," noting that the flawed drug study spurred a flurry of requests for THA, an unproven drug later shown to cause liver damage when given at high doses. Indeed, soon after the 1986 study came out, phone lines at the Chicago-based Alzheimer's Association were jammed by calls from people frantic to get THA, says Creighton H. Phelps, the association's vice president for medical and scientific affairs.

Controversy notwithstanding, THA's benefits may ultimately prove real. A spokesman for THA manufacturer Warner-Lambert Co. hints that a well-designed, double-blind trial of THA has yielded "encouraging" results, which the company may release as early as March. *— K.A. Fackelmann*