

1972 to accept a half-time teaching position. He became a full-time professor in 1985. Over the years, the laboratories with which he was associated produced an astonishing variety of experiments that included electron resonance studies of gas-phase atoms, paramagnetic resonance spectroscopy of disordered materials, Mössbauer spectroscopy of solids, atomic beam studies of gas kinetics, and laser magnetic resonance studies of simple atoms that extended into the far infrared. Simultaneously, Virgilio and his students and collaborators were actively engaged in the related theory, particularly in the use of self-consistent field theory to calculate atomic magnetic moments and in the use of analytic and Monte Carlo modeling to analyze spin resonance spectra of disordered materials. Many researchers worldwide sought his expertise.

Considering his level of engagement in advanced research, Virgilio was remarkably active in teaching at all levels; he held his last class just a few weeks before his death. His four one-semester introductory courses for physics majors at UNAM were notable for their use of experiments that related specifically to the needs and resources of Mexico. Many of his former students are now in academic and research positions throughout Mexico. Moreover, he was also the leading author of numerous textbooks written for Mexican students in the secondary schools and in the early years of college. In those books, he stressed the importance of observation, using, for example, many experiments of his own design that could be conducted using local resources. He also made important contributions to the public understanding of science through his popular articles and his book *To Catch a Photon* (Fondo de Cultura Económica, 1992).

In 1991, the Sociedad Mexicana de Física awarded him the Academic Medal for his contributions to the development of physics in Mexico.

A warm and humane man who cultivated the friendship of his colleagues, Virgilio fought to establish an attitude of tolerance everywhere in Mexico, especially in his beloved UNAM. He will be missed by all who knew him.

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LETTERS

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in 1982, experiments were reported² in which pulses passed through an absorbing medium with little distortion and with a group velocity that “exceeds 3×10^{10} cm/s, equals $\pm\infty$, or becomes negative.” During the 1990s, Raymond Chiao, Paul Kwiat, and Aephraim Steinberg studied faster-than- c effects in the tunneling of single-photon wavepackets.³ Their experiments answered longstanding, subtle questions about how long it takes for a particle to tunnel across a barrier.

The experiments by L. J. Wang and colleagues,⁴ which attracted much of the recent publicity, demonstrate that the peak of the exit pulse can emerge from an amplifying medium before the original peak enters it, and this can occur with essentially no amplification, absorption, or pulse distortion.

Rolf Landauer, Thierry Martin, and others discussed related phenomena in the early 1990s for particular types of wavepackets, and Gerhard Diener⁵ in 1996 presented an especially clear analysis and proof that causality is preserved. While the possibility of reconstructing the complete pulse from an infinitesimally small tail might be regarded as an old story, it is certainly worthy of further study, especially in connection with quantum noise. I suspect that many physicists would agree with Landauer’s comments⁶ that “the easy explanation [that the whole transmitted wave comes from the front end of the much larger incident wave] is unsatisfying,” and that “our understanding of this is not what it deserves to be.”

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Origin of 21-Micron Emission Feature Is a Mystery

The proposed identification of the mysterious emission feature at 21 microns with titanium carbide nanoclusters (PHYSICS TODAY, June 2000, page 21) is certainly a major news item in astrochemistry. However, no mention was made of the feature’s initial discovery or of the 10 years of intensive research into this problem by astronomers and laboratory spectroscopists. Since 1989, when the 21-micron emission feature was discovered in four proto-planetary nebulae observed with the Infrared Astronomical Satellite,¹ many carriers, including large polycyclic aromatic hydrocarbon clusters, hydrogenated amorphous carbon grains, hydrogenated fullerenes, and nanodiamonds, have been proposed. These earlier suggestions were based in part on the great abundance of carbon observed in all of the nebulae that exhibited this emission feature.

The recent precise measurements of the feature’s central wavelength (20.1 microns) and line profile based on observations by the Infrared Space Observatory² preceded the laboratory identification and made a definite identification possible.

Contrary to the impression given by the article that there are only two such objects, we have found 12 objects showing this emission feature, all belonging to a new class of celestial objects called proto-planetary nebulae. Why the 21-micron emission feature would be limited to such a short phase (a few thousand years) of stellar evolution is not understood.

Although the laboratory spectroscopy of titanium carbide clusters is a significant piece of work, it may not represent the final solution to the 21-micron feature mystery. A recent study has suggested that the feature can originate from out-of-plane bending modes of carbon rings with one carbon atom replaced by oxygen.³ Since the stretching and bending modes of aromatic hydrocarbons are commonly observed in proto-planetary nebulae, this suggestion is not unreasonable. Whatever the carrier of the 21-micron feature turns out to be, large-scale molecular synthesis leading to the formation of large organic molecules certainly can take place efficiently even in the low-density circumstel-

lar environment. This may have implications for the question of the origin of life.

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Does Religion Prize Mislead Scientists?

The Templeton Prize for Progress in Religion (see, for example, *PHYSICS TODAY*, May 2000, page 53) may have an undesirable consequence for science. The prize (with exceptions) goes to those who try to create commonality between religion and science, but it may also lead some scientists to compromise their integrity.

When scientists who never wrote a word about religion are suddenly writing books about “god particles” and the like, it indicates to me that the authors consider integrity to be a convenience, truth to be malleable, and both to be subservient to money. Why, then, should anyone trust their research?

The subjects of rigorous intellectual pursuit can be divided into three major categories: science, philosophy, and religion. Religion is based on belief in certain tenets: a god or gods with certain attributes, a priest or seer who can dictate the will of the deity, and perhaps a book of divine laws. Such beliefs do not preclude the use of logic by believers, and a rational investigation of the observable universe can be made based on these beliefs, as can attempts to address philosophical questions. However, if a conflict arises between religious beliefs and the rational implications of those beliefs, or between belief and observation, it is logic or observation that must be perceived as wrong. As an example, given what we know of human physiology, we understand that there is no virgin birth in humans because conception requires

the joining of sperm and egg. Yet Christians believe in virgin birth and therefore, to the believer such an occurrence must be possible, scientific considerations notwithstanding. Questioning the belief is not permitted. In brief, a defining principle of religion is that its fundamental tenets are accepted by its followers to be true beyond question.

In philosophy, axioms and rules of logic are fundamental. These may vary depending on the specific topic being addressed and may be investigated using yet other rules and axioms. The subject of an investigation may be religion and the observable universe, but if a conflict occurs then all elements—the beliefs, the rules of logic, and the axioms—may be questioned, because only the use of a logical system is fundamental to philosophy.

Science is based on observation. And a logical structure is created to describe and unite observations. A defining principle of science is that any conflict between observation and logic or between observation and religious belief, is resolved in favor of repeated observations.

I do not mean to propose that we have evolved religion, science, and philosophy in quarantine from each other or from other intellectual activity—art, for example. Yet it appears that science cannot and does not address religious questions at all. The truth of religious belief, by definition lacking any fundamental connection with observation, cannot be meaningfully evaluated by scientific methods. Nor can the truth or reality of scientific principles be meaningfully evaluated by applying the tenets of a religion, based as the latter is on belief.

Within each category, questions may arise that cannot be adequately answered by referral to the category’s basic tenets. An individual may perhaps resolve such questions to his own satisfaction by taking refuge in other tenets. However, if a scientist chooses to accept as a matter of faith that Planck’s constant is a fundamental quantity, this does not make science a religion, nor imply that religion and science share some fundamental commonality. A religious believer may similarly accept observations as true, but this does not make his religion a science.

Particularly in the context of ongoing attempts by American religious conservatives to infuse public

education with their religion, it seems to me that the Templeton Prize is little more than an incentive for them to continue such an effort. It also is a bribe—one that has successfully lured more than one well-known scientist into becoming a spokesman for the right-wing religious cause.

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Szilard Endorsed Nuclear Medicine by Example

The excellent review of radionuclide therapy by Bert M. Coursey and Ravinder Nath (*PHYSICS TODAY*, April 2000, page 25) reminded me of a story I heard while conferring with the late Jonas Salk on his controversial idea of using an HIV vaccine to treat AIDS.

Leo Szilard, who is best known for obtaining an early patent on the fission bomb (as a method of “producing new elements”), was diagnosed with bladder cancer. Standard treatment consisted of surgery to debulk the tumor along with the in situ use of bacillus Calmette–Guerin (BCG), a tuberculosis vaccine, to stimulate the immune system. Apparently, Szilard declined this treatment and instead accepted radiation therapy. The way I heard it, Szilard consulted with Salk, celebrated for developing the first polio vaccine, and Szilard subsequently had a radioactive sliver implanted in his bladder. The procedure apparently helped cure his cancer.

I have no way of knowing how much of this story is accurate. But it would be interesting if the inventor of the atomic bomb had made a personal choice that served to encourage the medical use of radioactive isotopes. More recently, the term “nuclear magnetic resonance” had to be changed to “magnetic resonance imaging” because the public tends to think of anything “nuclear” as inherently dangerous. At least Szilard would have had a better perspective on what is and isn’t dangerous.

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