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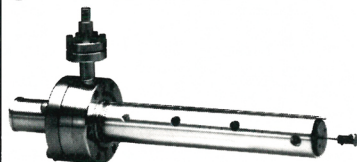
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more useful, than any other belief system. In a society increasingly dependent on science and with science being increasingly dependent on society, it is important that science be seen as concerned with the reality experienced by everyone, not of the reality of its own creation.

ALFRED A. BROOKS

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Lorenzo de la Torre's letter contains a mixture of cogent observations and misleading conclusions. For example, although it is true that many observational facts are theory laden (as many commentators on science put it), this does not necessarily imply that the facts are therefore context dependent. Leaving aside the metaphysical notion of the existence of particles, what gives them the needed stability for us to have confidence in them is their coherence with the interpretation of many other observations. This is the relevant context. In some areas, this context is relatively limited and the theory-laden facts may temporarily be subject to some doubt; in others, the context is so large that lack of confidence would be quixotic. Neutrinos surely are by now in the second category.

To conclude from the fact that the top quark is a mathematical necessity in the Standard Model that "mathematics is essential for the very existence of many elementary particles" is to put the cart before the horse. The theory predicts or implies their existence; that does not mean that after being found, they would not exist without the theory.

De la Torre thinks that "we find that reality is mathematical in nature" because "mathematics plays an inherent role in this process of construction of physical reality." I don't know what "reality is mathematical in nature" means, but the fundamental reason why we use mathematics in physics is that, as I have elaborated elsewhere,¹ it is the most powerful and most economical instrument of logical thought, and we need it as a tool for understanding reality.

Reference

1. R. G. Newton, *The Truth of Science: Physical Theories and Reality*, Harvard U. P., Cambridge, Mass. (1997).

ROGER G. NEWTON

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Indiana University

Bloomington, Indiana

DE LA TORRE REPLIES: One can say that physical reality exists objectively whether or not one is aware of

it, and that physical objects such as neutrinos exist completely independent of the contexts in which they have been predicted and confirmed. Let us call that level of reality "World One."

One can also say that sensory impressions, concepts, connections among concepts, experimental arrangements and rules for data analysis are kinds of knowledge and that they form a large structure that may be called "World Two." Accordingly, World Two would be a representation of World One (and, for some people, perhaps even a faithful mapping of World One). There is nothing wrong with World One, except that we know little—or probably nothing—about it because it is not directly accessible to us. The following question is crucial: Do words such as "objectivity," "reality" and "truth" refer to World One or to World Two? Centuries of discussion show that this question has not been resolved.

Physics does not provide a clear picture of what an electron is, but does provide a good description of its behavior under different circumstances. In this case, we see physics dealing mainly with the interactions among things. Here, the big question is not the reality of things, but the reality of processes. And it is here, in the conception, observation and analysis of processes, that our creativity plays a role. I do not claim that processes are entirely a construction of the human mind; but I can see elements of artificiality in the physical process that took place in the Reines-Cowan experiment of 1956, and in the conclusion drawn from it: the discovery of the neutrino.

LORENZO DE LA TORRE

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University of Antioquia

Medellín, Colombia

Physicist Honored for Acting Bravely—and without Uncertainty

Silvan Schweber's review of Abraham Pais's autobiography in your October 1997 issue (page 99) tells of Hans Kramers writing to Werner Heisenberg for help in saving Pais, who had been arrested by the SS. Heisenberg replied that he "could do nothing."

Although we must come to terms with individuals whose work we admire but whose personal life is not above reproach, our disillusion is redressed by knowing of individuals who may not (yet) be Nobelists but who have behaved admirably. Like

Pais's friend Tineke Buchter, physicist Imre Farkass was hiding Jews at the same time that Heisenberg could do nothing.

Farkass, who recently retired from Bell Laboratories, is—with Buchter—among the Gentiles honored at Yad Vashem, the Holocaust memorial in Jerusalem.

He did something.

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Centenarian Regretted Lack of Better Plan for Working after 65

Your obituary on Friedrich Hund, "the oldest survivor of the original quantum physicists" (October 1997, page 126), calls to mind a remark attributed to him by Werner Lauterborn at the University of Göttingen—a remark that should serve as a guideline and directive for all of my current age (late seventies). On the occasion of his 100th birthday, Hund said, "If I would have known that I would become this old, I would have made greater plans for work after 65."

From his obituary, I would infer that this is one more example of Hund's modesty regarding his accomplishments.

ROBERT T. BEYER
Brown University
Providence, Rhode Island

Recalling Verse, Reader Vexed; Query Terse: What Comes Next?

Close to three decades ago, I remember, some US publication or other carried a lovely and clever poem that began:

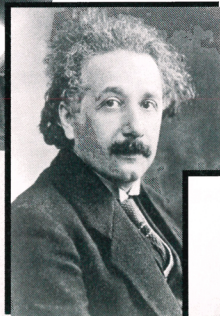
"Twas quantized and the
Feynman graphs
Diverged for large momentum
squared.
When summed o'er all electron
paths
The answers were completely
weird.

Do any of your readers know how the poem continues, who wrote it, and where and when it was published? I'd give a Jabberwock to know.

MICHAEL MCNEIL
(mbm@nrc.gov)
Montgomery Village, Maryland ■



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