

Readers Elaborate on Fashion and Truth, Fact and Theory

Congratulations and thanks to Michael Riordan for his Opinion piece “Science Fashions and Scientific Fact” (PHYSICS TODAY, August 2003, page 50). He has identified a dangerous tendency of some physicists to divorce the truth of an idea or theory from its experimental verification. And he has, I hope, done so early enough that this tendency can be nipped in the bud. However, the confusion leading to the state of affairs that he identified is deeply rooted and part of a broader issue. It has been displayed more than once in the pages of PHYSICS TODAY (see June 2002, page 48, and September 2002, page 10), where we have read, for example, that science need not concern itself with truth but only with theories that are of interest to scientists.

If we could understand that science involves the establishment of facts, then assertions about its lack of relation to truth would be seen immediately as entirely vacuous. I urge that we dismiss the idea that scientific fact is somehow different from other kinds of fact. That the Ptolemaic Earth-centric system is false and the Aristarchean heliocentric system is basically true is a fact, as much scientific as ordinary. That microbes and not “vapors” cause disease is a fact. That Earth is billions and not thousands of years old is a fact. And there is no essential distinction between fact and truth.

Famous scientists may have contributed inadvertently to the confusion. For example, Arthur Eddington wrote:

We cannot pretend to offer proofs. *Proof* is an idol before whom the pure mathematician tortures himself. In physics we are generally content to sacrifice before the

lesser shrine of *Plausibility*.¹ (italics in the original)

Albert Einstein had this comment:

The sense-experiences are the given subject matter [of science]. But the theory that shall interpret them is man-made. It is the result of an extremely laborious process of adaptation: hypothetical, *never* completely final, *always* subject to question and doubt.² (italics added)

If we follow Eddington or Einstein, it would seem that scientific fact is somehow inferior to ordinary fact, since ordinary, everyday fact is not normally in doubt.

The solution to the confusion lies in establishing a clear distinction between scientific theory and fact. The scientists quoted describe a necessary attitude of skepticism toward theories and provide a stern warning against *believing* our theories. But the aim of every scientific theory should be, and normally is, to rise to the status of fact, or, in other words, to have its truth proven beyond doubt—a process that may take decades or millennia. Riordan offers an example of the process with his brief review of subatomic particle theory. The same point can be made with innumerable other examples from all branches of science. Riordan also cautions that some theories may be inherently incapable of ever becoming facts; such theories should be thought of as providing merely a convenient description rather than an explanation.

As long as a theory remains a theory, Einstein’s “never” and “always” are to be heeded. But when the theory becomes a fact, doubting it is no longer productive; our skepticism will then be a sign of ignorance. Physicists must not blur the distinction between theory and fact. “Scientific fact” should henceforth indicate simply a fact uncovered by science, not essentially different from other facts.

References

1. A. Eddington, *The Nature of the Physical World*, Cambridge U. Press (1928, 1948), chap. 15.

2. A. Einstein, *Out of My Later Years*, Carol Publishing Group, New York (1995), chap. 14; reprinted from *Science* **91**, 487 (1940).

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Michael Riordan makes a good point: If a theory does not eventually lead to testable consequences, theorists are doing metaphysics, not physics. Max Planck used different phrasing to express the same idea: “Experiments,” he said, “are the only means of knowledge at our disposal. The rest is poetry, imagination.”¹

Riordan also suggests that all we are doing is reading the Book of Nature. That image is very powerful, but it cannot be literally correct. If it were, that book would already have been written, a finished work in minute detail. But the book is not finished: Scientists can demonstrate experimentally that we are also inside the book, “through our choices,” as Niels Bohr liked to say.² Consequently, we need to move on the razor’s edge by leaving the relativist and postmodernist positions on the one side, and the easy but unreal image of the finished book on the other side, but equidistant.

Including ourselves in the picture creates a serious problem—that is, how to determine the essence of scientific truth, as Riordan says, and how to explain that physics is, nevertheless, objective. Objectivity and truth can be reached in a participatory universe,³ through different experiments converging in the same result. Let’s look at an example.

The Planck constant h can be experimentally determined by many different procedures that are, in principle, independent of each other. Nevertheless, the experiments all converge in the same value of h (allowing for experimental errors). The probability of this convergence happening by chance tends to zero as the number of experimental procedures increases. This is even more dramatic, given that h is related to some other quantities—for example, the electron charge and mass and the velocity of light. These quantities are also built up by independent

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