letters

Language of science I: Theories and laws

In his letter, "Why No Einstein's Laws?" (PHYSICS TODAY, January 2007, page 12), Richard Kadel suggests defining three laws based on Einstein's theory of special relativity. However, Albert Einstein is not the only author of the theory of special relativity. The early publications on special and general relativity were collected and published with comments by Arnold Sommerfeld in *Des Relativitatsprinzip* (4th ed., Teubner, 1922), which was later translated and published in English. The book started with two papers by Hendrik Lorentz dated 1895 and 1904, in which he established the so-called Lorentz transformations that are actually the basic formulas of special relativity. The book also includes two papers by Einstein published in 1905 and a 1908 paper by Hermann Minkowski.

Minkowski died soon after his paper was published. Einstein gave many public lectures on special relativity, and public opinion now erroneously assigns authorship of the theory only to him. However, both Lorentz and Einstein were nominated for the Nobel Prize for special relativity, and Lorentz was number one in that nomination. (The nomination was not supported by the Nobel Committee, probably because of the insufficient experimental confirmation of the theory at that time.) Therefore, it is fair to call it the Lorentz–Einstein theory of special relativity. Einstein was the founder of general relativity.

The first of Kadel's proposed Einstein's laws states that the laws of physics are identical in all nonaccelerating (inertial) frames. However, in his publications Einstein referred to that as the principle of relativity of classical mechanics; some textbooks call it Galileo's principle.

Sommerfeld made a comment directly related to the second proposed law, that the vacuum speed of light, c, is the same for all inertial frames. He wrote, "The principle of the constancy of the velocity of light is of course contained in Maxwell's equations."

I can agree that Kadel's third law, that the total energy E of a body of mass m and momentum p is given by $E = \sqrt{m^2c^4 + p^2c^2}$, may be defined as Einstein's law.

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It was interesting to see in the January 2007 issue of PHYSICS TODAY two pieces that touched on the same question from two different viewpoints. That question is whether an explanation is "just a theory" or an established fact.

Helen Quinn's Reference Frame article, "Belief and Knowledge—A Plea About Language" (page 8), dealt quite generally with the interesting ways in which words are used. Scientists may use them one way while nonscientists interpret them differently. Richard Kadel's letter, just a few pages later (page 12), lamented the fact that relativity is referred to as Einstein's theory when, he argues, it really should be called Einstein's laws of relativity.

President Ronald Reagan's famous comment about evolution being "only" a theory comes to mind. We in the sciences need to have a way of determining when an idea—whether we call it a hypothesis, a theory, or a guess—has been established and accepted well enough that it deserves to be called a law.

Quinn's article correctly emphasizes that some of the words we use have rather flexible meaning even among scientists. She notes, however, that scientists are usually aware of the degree to which any particular idea is supported by evidence, accepted by qualified colleagues, and considered well established by the scientific community, regardless of whether the idea is referred to as a theory, law, hypothesis, model, or other name. At the same time, Quinn says that nonscientists do not always understand the extent to which any given idea is established and accepted. They usually rely on the often mistaken belief that certain terms have rigid meanings; specifically, they believe that a law is a firmly established principle and a theory is little more than a guess. That brings us to Kadel's letter.

Kadel accepts the fact that, whether we scientists like it or not, the general public thinks that anything called a law is a solid description of the truth and that a theory is yet to be proven. Therefore, he argues, relativity should no longer be called a theory, but instead should be a set of laws. I wholeheartedly agree. Yet I have to raise the question: Who decides?

I propose that a recognized body of physicists, such as the International Union of Pure and Applied Physics, the American Physical Society, or the American Institute of Physics, should do this for ideas related to physics. The determining group should then use the new term in its own activities and publications and strongly encourage all its members to adopt the term.

Following Kadel's suggestion, I think the designated group should start by declaring that "Einstein's theory of relativity" should henceforth be called "Einstein's laws of relativity" and should promote the idea to the public. The change (and the discussions leading up to it) could be likened to the recent decision by the International Astronomical Union to state that Pluto is not a planet.

The designated organization should then cooperate with other groups that make such declarations by agreeing to support their declarations. Thus, I would hope an appropriate biology or geology organization would declare that the theory of evolution has now been sufficiently well established that it will henceforth be called "the laws of evolution" and that the physics community would support biologists or geologists in promoting this change in nomenclature.

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