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# On the status of physics

Physics is in essence an experimental science. It is the experiment that relates the thought process to nature. *The experiment is the ethos of physics*. The description of the observations, via the wonderful language of mathematics, is the theory. Good theories can be used to provide a cohesive, and accurate, description of experimental results and they can predict new experimental results.

Even astronomy, and cosmology, can be considered as depending on experimental physics. Crucial to these two sciences are the large telescopes and digital solid state detectors both tools developed in the realm of experimental physics. And what's more, these tools are used to observe the greatest experiment of them all: the one unfolding in the cosmos.

After Newtonian mechanics, Maxwell equations, and Einstein's general relativity, the greatest triumph of physics has been quantum mechanics. In fact, without Maxwell equations and quantum mechanics present day technology including lasers, computers, and the internet, could not have been possible. All the physics mentioned here was developed via a vigorous interaction between the human thought process and the experiment.

As I write today quantum mechanics, introduced in the mid 1920s, remains as the most successful theory of physics. The revolution initiated by quantum mechanics yielded technological breakthroughs in the form of the transistor (1954), the maser (1953), and its visible version, the laser in 1960. Remarkably, the quantum physics of Dirac, Heisenberg, and Schrödinger produced tangible practical devices within 30 years. Quantum mechanics plus electromagnetism provide the bases of the wonderful technologies we enjoy today.

Dirac said that in his time it was easy for "second grade physicists to do first grade physics" and today "is very difficult for first grade physicists to do second grade physics" (Dirac, 1975). I agree. No physics development, since the quantum revolution, rivals the brilliance or importance of quantum mechanics.

Despite a strong current of disapproval, which peaked in the 1980s, related to issues of interpretation no one has been able to successfully contradict quantum mechanics. Post quantum mechanics, the most important piece of physics is the Standard Model although it suffers from various limitations, *ad hoc* constants, and shortcomings recognized and accepted even by some of its creators (Ward, 2004). In this context, the rise of additional post-quantum theories, such as string theory, as branches of physics, represent an interesting development. Freedom of expression is central to physics. However, given the absence of experimental data to support a new theory it should be more appropriate to consider such theory as a part of mathematics rather than physics. In other words, until experimental evidence surfaces in support of unique

predictions of a new theory that theory should remain in the mathematical realm. This is not a new, or solitary, notion as it has been advanced previously by others.

Physics to me is a very personal affair. Physics is like the ideal lover who is always there, always willing to give, always beautiful. Thus, I remain ambivalent about "big science." This approach means layers of administrators, very large budgets, and large numbers of participants. Not my cup of tea. Nevertheless, I observe the activities around large particle physics efforts with keen interest since these might help elucidate some important features of the Standard Model and the Higgs boson. At this stage it might be necessary to reiterate that all this physics has its genesis in quantum mechanics.

On the less expensive side of physics there is *light* and the significant advances in the application of lasers. This includes the present revolution in quantum optics based on the Pryce-Ward probability amplitude for quantum entanglement. This relates to quantum communications, quantum cryptography, quantum teleportation, and quantum computing. A great revolution, indeed.

One final observation: mankind only has a limited vision of the universe conveyed to us by our marvelous and yet limited senses. As such, in my opinion, a final theory is a misguided quest. In this regard, as technology advances, and our measurements improve, and our understanding of the cosmos is enhanced, theoretical understanding will always improve. Personally, I find the concept of a "final theory," or a "theory of everything," rather limiting. The fun of discovery will most likely last as long as the human race continues.

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