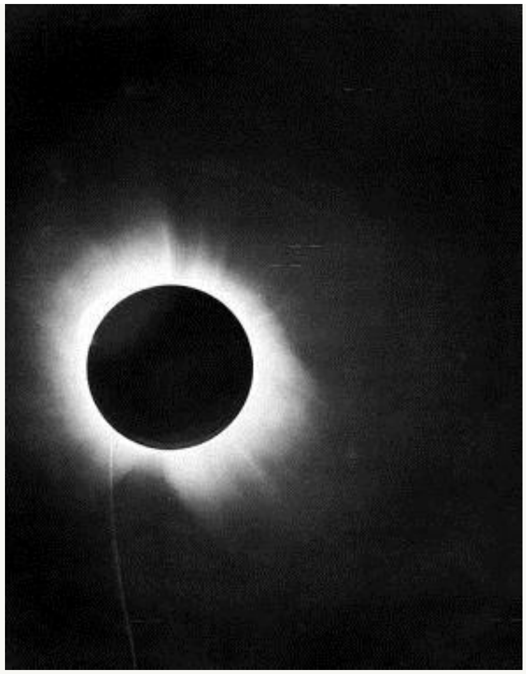
SCIENCE DOESN'T SHOOT FROM THE HIP

The young Max Planck, when completing his high school degree, asked a professor of physics at the University of Munich, Philipp von Jolly, whether he should study physics. He got the famous answer that this wouldn't make much sense, because physics is an almost fully mature science with not much to discover. (If you happen to speak German, it is worth reading the original text, reprinted in this biography of Max Planck.)

Of course, luckily Planck ignored this advice and went on to make some of the most profound discoveries in modern physics. And well, if you think we are in a similarly dull situation in physics at present, the past few weeks would have certainly disproved this, because a couple of intriguing, unpublished (in the academic sense) research findings have appeared widely in the news: neutrinos that continue to appear to be faster than the speed of light, a completely new view on wavefunctions in quantum mechanics, and it seems also that there isn't much hiding space left for the Higgs boson, if it exists.



Arthur Eddington's 1919 photograph of the sun during a total eclipse. The position of the stars appearing behind the sun verified Einstein's theory of relativity. Photo via Wikimedia.

Those discoveries all come with the promise of significant changes to our understanding of physics, and we've seen some exposure in the news (and the occasional hype, too). This is perhaps not surprising. The neutrino experiment questions the theory of relativity. The absence of the Higgs boson on the other hand would open the question again about the different masses of particles. And the new view of wavefunctions seems to add further to the arguments whether the wavefunctions in quantum mechanics are purely an expression of probability to find an object in a certain physical state, or are a representation of actual reality. The paper now rules out the possibility that wavefunctions are probabilistic states, but still having an underlying reality. Instead, there are two interpretations left.

One can either fall back to the argument that there is no underlying reality in quantum mechanics and wavefunctions simply are nothing but probabilistic. Or, the second option is that wavefunctions are an expression of actual reality, abandoning the probabilistic interpretation. Not surprisingly, for this reason the paper got lots of headlines. Most people my colleagues at Nature spoke to were quite enthusiastic, whereas Scott Aaronson didn’t seem to see that much of a surprise. Matt Leifer has an informative, quite detailed description of the paper on his blog.

With respect to the second option of wavefunctions being expressions of a real physical state, what still puzzles me is the interpretation of effects such as wave function collapse, where a measurement of one particle can influence the wavefunction of another particle far away (experimentally, this has been done for hundreds of kilometers). How this instantaneous change could be understood if a wavefunction is a real object is something that doesn’t seem to have an easy answer. But if I understand Matt Leifer correctly, the theoretical framework related to such collapse processes, Bell’s theorem, may have to be revisited. So, plenty of questions that still need to be explored…

In any case, what this discussion shows is that we should not get ahead of ourselves with dramatic conclusions on this and the other studies in the news. The search for the Higgs boson at the LHC is far from over.

And with respect to the faster-than-light neutrinos, even though the mere notion that Einstein's theory of relativity might be violated will be encouraging even more than the usual crackpot theories, it is very important to stress that these findings need to be verified first. The OPERA team that has done this experiment has now put its own findings on a firmer footing. But clearly there might still be a subtle mistake in there somewhere, and as a next step it will be important to repeat this experiment elsewhere.

To understand how important verification is to physics, it might be worth taking a look at the history of Einstein's theory of relativity. General relativity, with its hugely profound implications, was only accepted broadly by scientists once it was verified experimentally by Arthur Eddington. Experimental verification is a central mechanism in science. And even though this process can be drawn out, it is exciting to watch science happening this way, how physicists wrangle for the truth. In the meantime, we need to be patient with headline-grabbing conclusions. Science doesn't shoot from the hip. Whatever the outcome of the studies mentioned above, it's a win-win situation for science.

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