

Is the Time of Falsifiability Over?

Falsifiability has been an extremely important idea in the hard sciences for many years, but in the past decade this method has been challenged. Falsifiability is simply the idea that a theory can be tested and proved right or wrong. In the past, many famous theories have passed the test of falsifiability (Becker, 2015). An example being Einstein's theory of general relativity, which was proven correct when, during a solar eclipse, light from distant stars was shown to bend around the sun (Coles, 2019). Falsifiability has been a staple in the scientific method for years, however many theorists have questioned its validity in recent years, mainly because of string theory.

String theory originated in the 1960s as a possible way to unify general relativity and quantum mechanics. String theory states that the fundamental particles of our universe like quarks, photons, electrons, etc. are strings of varying length vibrating at a different frequency (Wood & Stein, 2022). At first string theory may seem farfetched but this idea solves many of the issues that physicists had when trying to unify general relativity and quantum mechanics. Before string theory, when physicists tried to unify general relativity and quantum mechanics, infinities would appear in the mathematics, resulting in problems when describing the physical universe. However, when one considers string theory the infinities disappear due to the one-dimensional nature of the strings (Wood & Stein, 2022). The unification of general relativity and quantum mechanics is the reason string theory has become so famous, as this problem stumped physicists for decades. Unfortunately, string theory has its own problems.

The problem many physicists have with string theory is that for the theory to work nine spatial dimensions are required. Six of these dimensions would have to be so small that physicists could never confirm, nor reject, their existence without a great leap in technology

(Wood & Stein, 2022). This has caused some physicists to believe that string theory will never be able to be confirmed or rejected by experimental evidence. Many physicists reject string theory because of this issue, as string theory does not pass the test of falsifiability. However, string theory is the best solution to the unification problem, even though it does not pass the falsifiability test. Due to this, many physicists believe that falsifiability should be abandoned. The idea of discarding falsifiability has split scientists all over the world, some believe that falsifiability is halting breakthroughs in the world of physics, while others believe that such a long-standing idea should not be discarded just because one theory does not pass its test (Becker, 2015).

Sean Carroll, a theoretical physicist at the California Institute of Technology, originally called for the abandonment of falsifiability in 2014. Carroll is a massive advocate for string theory, which he argues is elegant and fits with the data we have. Carroll claims that in the world of modern physics, specifically when theorizing about quantum gravity, experiments used to confirm these ideas are likely to require massive amounts of energy which we cannot obtain. If a theory needs to be able to be proven right or wrong experimentally, then it seems a theory unifying general relativity and quantum mechanics may never be found (Carroll, 2014). Instead of falsifiability, Carroll argues that scientific theories should be definite and empirical. A theory is definite if it explains something about our universe, it is empirical if it fits the data which is known to be true. String theory passes these tests, but some physicists are not ready to adopt the tests which Carroll proposed.

On the opposite side of the argument are physicists who firmly believe that the scientific community should not get rid of the concept of falsifiability. George Ellis and Joe Silk offered a counterargument to Carroll's essay later in 2014. Ellis and Silk argue for falsifiability in two

different ways. The first is claiming that the public may lose faith in the hard sciences if the idea of falsifiability is abandoned. They argue that some of the public already ignores the hard sciences due to the issues of climate change and evolution, and that removing falsifiability would only further exacerbate these feelings of distrust (Ellis & Silk 2014). Ellis and Silk also point out that many theories, which are also elegant, have been disproved through experimentation. They provide the examples of the steady state model for the early universe or the Georgi – Glashow model which attempted to unite the strong force and the electroweak force. They use these examples to show that just because a theory is amazing and eloquent, it is not excused from having to pass tests to prove its viability, as doing so may allow for other misleading theories to become prominent (Ellis & Silk 2014).

Carroll along with both Ellis and Silk make good arguments against and for falsifiability. In general, falsifiability should not be discarded as it is still useful and important in the greater scientific community. Ellis and Silk's argument regarding how abandoning falsifiability could damage the reputation of the scientific community and allow for more phony theories to surge is a serious risk. However, for the specific cases of quantum gravity, falsifiability may not be a realistic benchmark. As Carroll stated in his essay, theories which successfully combine quantum mechanics and general relativity may not be able to be tested with our current technological capabilities. If this statement holds true, an exception to the rule of falsifiability should be made for theories of quantum gravity, as they cannot be tested. This is not to say that string theory should be taken as true, instead, physicists should try to build upon string theory while also attempting to develop new theories of quantum gravity that may solve some of the issues which string theory has encountered.

Ultimately, both sides of this argument have made good points. Falsifiability should not be discarded completely, as doing so may have dire consequences like a further loss of public trust. However, if a feasible theory of quantum gravity is to be accepted by the scientific community an exception may need to be made pertaining to falsifiability.

Bibliography

Becker, K. (2015, February 11). *Does science need falsifiability?* Nova.

<https://www.pbs.org/wgbh/nova/article/falsifiability/>

Carrol, S. (2014). 2014 : WHAT SCIENTIFIC IDEA IS READY FOR RETIREMENT? *Edge*.

<https://www.edge.org/response-detail/25322>

Coles, P. (2019). Einstein, Eddington and the 1919 eclipse. *Nature*, 568(7752), 306–307.

<https://doi.org/10.1038/d41586-019-01172-z>

Ellis, G., & Silk, J. (2014). Scientific method: Defend the integrity of

physics. *Nature*, 516(7531), 321–323. <https://doi.org/10.1038/516321a>

Wood, C., & Stein, V. (2022, January 20). *What is string theory?* Space.Com; Space.

<http://space.com/17594-string-theory.html>