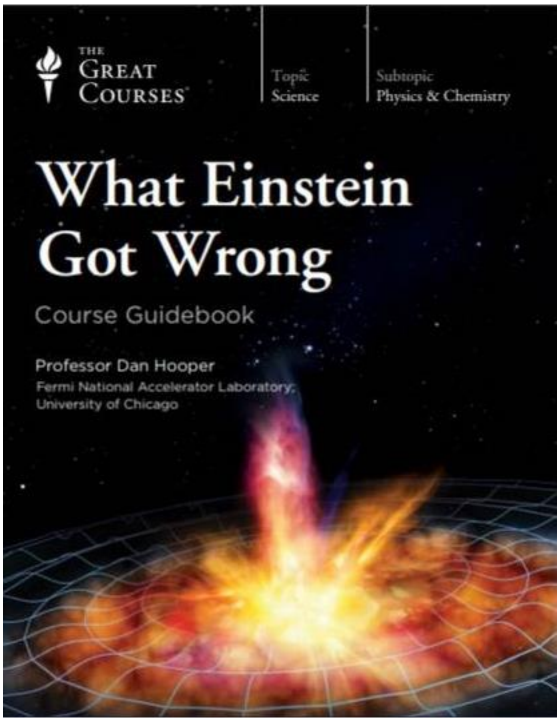

What Einstein Got Wrong

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In 1905 Einstein published 5 papers changing the world of physics forever.

“What Einstein Got Wrong”, by Dan Hooper is one of the many books to explain and illustrate the significance of Einstein among the “giants” of physics. Dan Hooper takes an interesting and different approach – by describing Einstein not only as the genius thinker having lost contact with the ordinary world but despite his achievements was a fallible human being after all.

The book is divided into 12 lectures the first two lectures spelling out Einstein’s astonishing breakthroughs and insights –a personal lesson for me was the explanation of how Einstein came across his declaration of the constant speed of light: challenged by his postulation of light “quanta” (now called photons) moving through a medium (ether) showing wave characteristics, experimental physicists tried to determine the movement of those light quanta through other media but never found any difference. So Einstein postulated a constant for the speed of light and all other depending parameters like space and time had to give – and this was proven by many experiments afterwards.

Following the understandable (as far as possible for an educated engineer) explanation lectures on special and general theories of relativity Dan Hooper moves on to Einstein’s flawed predictions – which of course have been well published, discussed and judged in the past also – however Dan Hooper does it in an amiable and concentrated way which leads the reader to admire Einstein’s achievements even more – demonstrating that with all his genius Einstein was human prone to errors and misleading and of course Einstein’s handling of his blunders obliges the reader to respect also.

In the following lectures the author discusses Einstein’s “blunders” and traces their mysteries, developments and their consequences up to today’s knowledge.

Black Holes (“black holes are prevented by nature”): The Schwarzschild solution, Eddington’s contribution on the inner workings of stars and the Russian physicist’s role of Yakov Zel’dovich, predicting an observable “wobbling” of stars in the vicinity of black holes that finally proved the existence of black holes are described and honored.

Gravitational Waves: This lecture is about a consequence of general relativity that is similar to black holes in that it was a prediction that Einstein rejected - at least for a time. He thought that gravitational waves were just a mathematical artifact that was somehow connected to the approximations he had made in his much-earlier calculations. He now thought that any gravitational waves would instantly collapse. A peer reviewer of the Physical Review journal, the physicist Howard Percy Robertson identified a crucial mistake that Einstein had made in his calculation: Einstein had made a poor choice for the system of coordinates. In a later paper to the Journal of The Franklin Institute Einstein no longer argued that gravitational waves were impossible. As we know now, the first actual gravitational wave was measured on September 14, 2015 by the Laser Interferometer Gravitational-Wave Observatory (LIGO).

Cosmological Constant (“my biggest blunder”) and Cosmology: By about 1917, only a few solutions to the field equations had been identified. The famous Schwarzschild solution was the first exact solution for a special case. To tackle this problem, Einstein put as an input into his field equations a uniform, or homogeneous, distribution of matter, filling all of space, and at the time our universe appeared to be static to astronomers. This helped to strengthen Einstein’s belief that the universe was eternal and unchanging. With this in mind, Einstein set out to find a way to make his theory consistent with a universe that was neither expanding nor contracting. To accomplish this, he added into his field equations an entirely new piece: a new term in the equation that contained what he called the cosmological constant.
After Hubble proved the expansion of the universe, Einstein reluctantly withdrew his cosmological constant. But as turned out later the work of Einstein, Hubble, Slipher and others, over the course of the 20th century, the observations made by cosmologists came to increasingly support what is now called the big bang theory and finally led to the re-introduction of a another cosmological constant into the gravitational field equations called “dark energy” helping to explain the phenomena of an *accelerating* expansion of the universe.

Quantum mechanics (“god does not play dice”)
As mentioned above, Einstein’s fourth paper, published in 1905 offered a radically different view of the nature of light. In doing so, he proposed and offered evidence in support of the idea that light doesn’t only behave like a wave, but that it is also made up of individual pieces, or particles—then called quanta and now called photons. Thus, this paper represented the beginning of what would become known as quantum physics. As time went on, however, Einstein became less and less comfortable with some of the strange implications of the new quantum theory.
Many scientists suddenly became very interested and engaged in this new ideas and in the following years worked out a very new *probabilistic* view explaining those strange phenomena – while Einstein grew very uneasy with this non-deterministic approach and rejected it.
In the late 1920s, a consensus was starting to form around a refined version of Max Born’s interpretation known as the Copenhagen interpretation: according to the Copenhagen view, quantum particles behave like waves. These particle waves are each described by their wave function. The shape of a given particle’s wave function represents the probability that it will be found at different locations or with different velocities. At the 1927 Solvay Conference, it became clear that a consensus view was starting to form around the Copenhagen interpretation of quantum mechanics. Most of those in attendance—including Albert Einstein, Erwin Schrödinger, Max Born, Niels Bohr, Louis de Broglie, and Werner Heisenberg—seem to have accepted the probabilistic nature of their new theory. But Einstein was still far from accepting the new consensus view of quantum mechanics. He felt sure that big pieces of the theory were still missing. He hoped would restore determinism to the subatomic world – but never succeeded.

Quantum Entanglement

As early as the late 1920s, Einstein had started to think about groups of particles with wave functions that depend directly on each other trying to support his deterministic approach. Today, we say that such wave functions are entangled with each other.

Although it would take years before Einstein would fully explore the implications of quantum entanglement, he recognized fairly early on that this was an inevitable consequence of the Copenhagen interpretation.

It wasn't only the role of chance and probability in the Copenhagen view that bothered Einstein; he was also very uncomfortable with the way that a given particle could be in multiple places at once or could be moving with multiple speeds, all simultaneously.

After years of debate and consideration, Einstein ultimately came to take and insist on a philosophical position known as scientific realism.

The heated controversy between the Solvay physicists and Einstein about the strange quantum behavior culminated in the "Einstein, Podolsky, Rosen paper" (EPR-paradox) and the thought experiment of "Schoedinger's cat". Neither group could convince the other – and on a low level the discussion is still going on with new interpretations.

After having presented and explained all the facts and arguments, studies and experimental results the author leaves it to the reader to make up his own mind. It might probably require a future "second Einstein" to finally come up with a undisputed understanding.

As an engineer I tend to lean more to Einstein's scientific realism representing our deterministic view of the world, rather than to embark on the "many-worlds" interpretation of the American physicist Hugh Everett III, introduced in 1957.

It is unbelievable that a single mind has been able to generate so many new ideas that have kept a century alive with a whole new view of our universe and which still lead to new insights. It even turns out that Einstein's blunders, after exhaustive scientific research, still lead to amazing new results.

This collection of lectures not only presents the blunders, but also provides a comprehensive overview of what Einstein got very right about of the foundations of general and special relativity theory and his other trailblazing work, but also describes the latest state of research on the "big questions".

With the understanding this book conveys, one can follow well informed the discussions of the last open cosmic secrets such as dark matter, dark energy, black holes, multiverses, and quantum entanglement, quantum computers and how close we can come to the initial spark (infinitely hot, infinitely dense) of the big bang.

The metaphysical questions - what was before and where we go - remain, however, left to the theologians and philosophers.

Studying those lectures assembled in the book means well spent hours because the author Dan Hooper imparts so much knowledge in a concise and understandable way – without detailing the highly complex mathematical background, and holds you up to the level of today's modern science methods and results.

Therefore the book "What Einstein Got Wrong" is highly recommended because it also raises the admiration and respect for the gigantic brain power of Albert Einstein.

June 2019, Joachim J. Kehr, Editor SpaceOps News for the Journal of Space Operations & Communicator
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