

An Einsteinian Incident

Kennefick D. Einstein Versus the Physical Review. *Physics Today* 2005;58(9):43-48.

Peer review has saved many scientists from the embarrassment of publishing a flawed paper—even Albert Einstein. While living in Germany, Einstein published many of his scientific papers in German physics journals. At the time, German journals were considerably less selective than American journals, which had already begun to use a rigorous peer-review system. Historians who studied the editorial practices at the *Annalen der Physik*, the leading German journal in the early 1900s, found that its rejection rate was very low because the editors were reluctant to reject any paper from an established scientist.

When Einstein relocated to the Institute for Advanced Study in Princeton, New Jersey, in 1933, he began to submit his papers to American journals, expecting the same gentle treatment that he had come to enjoy from German journals. He was shocked and angered, however, when the *Physical Review*, one of the leading American journals in the early 20th century, sent back one of his papers for revision after putting it through peer review. That is believed to be Einstein's first genuine encounter with anonymous peer review. Although Einstein responded angrily to the critical review of his work, in the end, the referee's criticisms proved to be valid.

Einstein's relationship with the *Physical Review* began when the journal published one of his papers while he was visiting the California Institute of Technology in 1931. After moving to Princeton, Einstein had two more papers published in the *Physical Review* with his American assistant, Nathan Rosen: the famous 1935 paper by Einstein, Boris Podolsky, and Rosen on the EPR paradox and the 1936 paper by Einstein and Rosen that introduced the concept of a wormhole. The 1936 paper was the last one Einstein would have published at the *Physical Review*, however, after receiving the negative critique from a referee on his paper on gravitational waves later that year. The full story of Einstein's interaction with

the referee was not known until recently, when Martin Blume, who was the editor-in-chief of the *Physical Review* from 1996 to March 2007, and his colleagues uncovered the journal's logbook records and confirmed the identity of the referee.

Einstein introduced gravitational waves into his theory of general relativity in 1916. At the time, the concept of gravitational radiation was relatively new, and there was no evidence to support it. But the analogy between the electromagnetic field and the gravitational field was so strong that by the 1930s most scientists believed that gravitational waves "must exist in principle". Because electromagnetic waves exist, it seemed logical for gravitational waves to exist.

In 1936, however, Einstein began to have second thoughts about the existence of gravitational waves. In a letter to his friend Max Born, Einstein said, "together with a young collaborator, I arrived at the interesting result that gravitational waves do not exist, though they had been assumed a certainty to the first approximation." Later that year, Einstein submitted his paper titled "Do Gravitational Waves Exist?" to the *Physical Review* with Rosen as coauthor.

Not everyone was easily convinced of Einstein's conclusion that gravitational waves do not exist, however. According to the *Physical Review's* logbook, the journal received Einstein's gravitational-waves paper on 1 June 1936. On 23 July, the journal's editor, John Tate, returned the manuscript to Einstein with a critical review attached and asked for Einstein's reaction to the referee's criticisms. Einstein responded to Tate on 27 July with an angry letter withdrawing his paper from the journal and dismissing the criticisms. On 30 July, Tate wrote back that he "regretted Einstein's decision to withdraw the paper, but stated that he would not set aside the journal's review procedure." After withdrawing his paper from the *Physical Review*, Einstein submitted it to the *Journal of the Franklin Institute* in Philadelphia, where it was accepted for publication in its original form.

In his response to Einstein, Tate was careful not to say that the peer-review process was mandatory for acceptance by the journal. In fact, the *Physical Review's* logbook suggests that Einstein's previous two papers were accepted in their original form without peer review. "But apparently gravitational waves were already such a well-accepted prediction of the theory [of general relativity], despite the absence of experimental support, that [Tate must have felt] such a surprising result warranted some scrutiny." It seems as though Tate did hesitate, however, in his decision to have Einstein's gravitational-waves paper peer reviewed: more than a month passed from the time the journal received the manuscript to the time Tate sent it to the referee.

In summer 1936, Howard Percy Robertson, one of the most distinguished cosmologists of the time, became friends with Einstein's new assistant, Leopold Infeld, who replaced Rosen in 1936, while he was at Princeton. Robertson told Infeld that he did not agree with Einstein's conclusion, and while Robertson was going over Infeld's version of the proof, he and Infeld found an error. Interestingly, Infeld said that when he told Einstein about the error he and Robertson had found, Einstein claimed that he had independently found an error in his own proof the night before but had not yet found the solution.

It turns out that Robertson held the key to solving Einstein's problem. Back when Einstein and Rosen were searching for the solution to gravitational waves, they could not do so without introducing a coordinate singularity—a problem that is "analogous to the problem one encounters when attempting to find the longitude of the North Pole." This problem is what led them to believe that gravitational waves do not exist. Robertson, however, pointed out that the singularity was "merely appar-

ent and not real" and could be dealt with simply by changing the coordinate system. That would remove the difficulty Einstein was having. "The irony, of course, is that Einstein could have found that escape route months earlier, simply by reading the referee's report [returned with his manuscript from the *Physical Review*] that he had dismissed so hastily."

Robertson had always been suspected of being the referee who critiqued Einstein's paper, and that suspicion was confirmed when Blume released the *Physical Review's* logbooks. "Finding that Einstein had completely ignored his written critique, [Robertson] took the opportunity of their collegial closeness at Princeton to correct the great man in a less confrontational fashion."

In early 1937, Einstein and Rosen's article appeared in the *Journal of the Franklin Institute* with "radically altered conclusions". To explain why the paper had to be drastically changed in proofs, Einstein wrote a letter to the journal's editor saying that "'fundamental' changes in the paper were required because the 'consequences' of the equations derived in the paper had previously been incorrectly inferred".

By sending Einstein's gravitational-waves paper to Robertson for peer review instead of just publishing it without question, Tate saved Einstein from making an embarrassing mistake. Thus, "a great scientist can benefit from peer review, even while refusing to have anything to do with it."

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