Ripples in Spacetime

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In February last year, the Polish Academy of Sciences (PAS) organized a press conference in the Staszic Palace in Warsaw to mark the experimental discovery of gravitational waves – a historic achievement that confirmed Einstein's general theory of relativity. Extremely sensitive detectors in three locations across the globe registered a signal sent out by a cosmic collision: a merger of two black holes. Traveling at the speed of light (300,000 km/s), gravitational waves had taken more than a billion years to reach us. The atmosphere of the conference was that of yet another triumph for Einstein. Although near the end of the meeting, Prof. Jerzy Kijowski from the PAS Center for Theoretical Physics did unexpectedly comment that Einstein himself had not believed for a very long time in the existence of gravitational waves, that did not spoil the atmosphere of celebration. In fact, Einstein is known to have written in a letter to Max Born in 1936: "I arrived at the interesting result that gravitational waves do not exist." While delivering a seminar at Princeton, he ended with the statement: "If you ask me whether there are gravitational waves or not, I must answer that I don't know."

The nature of gravitational waves differs from that of electromagnetic waves: the latter represent electric and magnetic fields moving through immovable space, whereas the former are "ripples" in the fabric of space itself. We can imagine them as being like the waves that are created on the surface of water hit by a stone, with the "rippled" water itself being the wave. Einstein's doubts were aroused by the solutions for the equations he himself wrote, because they did not seem to make physical sense. On closer inspection, however, it turned out that Eistein had been wrong. In other words, the equations of his general theory of relativity had more in them than their author expected – in a sense they were "smarter" than the great Albert himself.

This story bears a certain resemblance to another landmark event in the history of physics. In 1928, Paul Dirac published an equation that brought the special theory of relativity and quantum mechanics together. The equation gave two types of energy for electrons: positive and negative. Negative energy did not seem to make sense – it raised many doubts and the most convenient thing to do would be to reject it. Four years later, however, new particles were discovered experimentally. These particles, now referred to as positrons, corresponded to the negative energy in the Dirac solutions. Positrons are now treated as the first known example of antiparticles. Again, one can say that Dirac's equation proved wiser than its author.

Some works are indeed smarter than their own authors, and this holds true not only in physics. Voltaire wrote numerous plays, historical works, novels, philosophical letters, and indecent poems. He also wrote tales, which he did not value much. However, Voltaire's tale of a simpleton named Candide in which the author satirized Leibniz's philosophical optimism about "the best of all possible worlds" is his most famous work, which is read by both children and adults all over the world (alas, not the best of all possible ones). *Candide* turns out to have more to it than Voltaire put into it. Mozart, in turn, composed countless pieces of music, over 20 operas, 23 concertos and 19 piano sonatas, as well as works of sacred music, including his brilliant *Requiem*. What we hear most often, however, is his modest Turkish March. There is more to this march than Mozart expected – it is one of the pieces that are said to be too easy for children and too difficult for pianists. Chopin refused to publish his *Fantaisie-Impromptu in C sharp minor* during his lifetime, feeling it was not good enough. Fortunately, it was published after the composer's death and is now one of his most frequently performed pieces. Apparently, the piece has more to it than Frédéric himself could hear. Time works in mysterious ways.

When leaving the Staszic Palace after the conference in February, we felt uplifted. Some will obviously ask: what is the point of looking for tiny effects of something that happened God knows how far away, of no relevance to our everyday life? An American physicist once told me that the costly manned missions to the Moon made no sense. I disagreed with him back then, and I still think he was wrong. Such achievements are precisely what allows us to rise above everyday life and offer hope that we will not trample Mother Earth to death. The conference was especially enjoyable, as those who analyzed the gravitational signals from the edge of the world included some of our colleagues from the Polish Academy and Polish universities. We can only envy them. ■