Pitt physicist wins 2011 Einstein Prize for lifetime unraveling, reshaping general relativity theory

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This is Ezra T. Newman of the University of Pittsburgh. Credit: University of Pittsburgh

During his 60 years in general relativity, the field of physics established by Albert Einstein, University of Pittsburgh Professor Emeritus of physics and astronomy Ezra T. Newman not only worked alongside some of Einstein's closest colleagues to revitalize the theory of general relativity, but he also helped reshape it by working out one of the most influential reformulations of the revered scientist's original theory, among other lasting solutions and insights to the Einstein equations.

To recognize Newman's lifetime of work at the forefront of general relativity, the American Physical Society has awarded him the 2011 Einstein Prize for his part in devising the renowned Newman-Penrose formalism—an extension of Einstein's theory of general relativity—as well as for composing a variety of solutions to Einstein's equations, particularly the Kerr-Newman black hole. The prize also commends Newman's ongoing work to explain the significance of far-flung light energy.

Newman joins a select roster of physicists who have received the biennial $10,000 prize since its 2003 inception, including noted Einstein collaborators John A. Wheeler of Princeton University, and Syracuse University (SU) physicist Peter Bergmann, Newman's mentor when he pursued his PhD degree at SU, which he earned in 1956.

In 1962, six years after Newman joined Pitt's Department of Physics and Astronomy, he and University of Oxford professor Roger Penrose developed the Newman-Penrose formalism, one of the most-cited sets of equations in relativity. In short, the formalism is an alternative method for describing Einstein's equations that replaces Einstein's own version, Newman explained.

The significance of the Newman-Penrose formalism is that it allows for special conditions to be imposed before one even attempts to solve an equation—conditions for which Einstein's original theory does not allow. Instead of using the four standard space-time coordinates, the Newman-Penrose equations use four different vectors to describe the geometric constructions of the theory that arise from massive objects in motion.

"We knew we had something good," Newman recalled. "We performed the Goldberg-Sachs theorem, which originally required a great deal of effort, at the drop of a hat. We knew it was a powerful technique then. I've used it virtually every day since the original paper, and when I lecture now to a technical audience, I assume that most people are familiar with it."

Three years later, in 1965, Newman inadvertently took part in constructing another important solution, the Kerr-Newman black hole.

As a hotshot young physicist, Newman stated in the Journal of Mathematical Physics that a class of solutions to Einstein's equations did not exist. In all of Newman's mathematics, however, there was one lowly plus-sign that should have been a minus. Roy Kerr, then a professor of physics at the University of Texas at Austin, discovered the error and found that the class of solutions did in fact exist. But it turned out that the now-correct equation easily allowed Newman to solve the Einstein-Maxwell equations for describing rotating, electrically charged black holes and their surrounding region. The Kerr-Newman stands as one of four solutions of Einstein's equations describing black holes.

In his more recent work, Newman investigates null foliation, or the patterns light rays form as they fill space-time. In 1980, Newman first identified a property known as H-space that occurs at the outer reaches of light's range when light rays no longer have physical contact—like the fingertips of a splayed hand. Newman is currently working on possible applications of H-space theory for explaining observable phenomena. [Also known as Heaven theory after a good-natured play on the "H" coined fittingly at a lecture Newman gave in Israel, the work gained notoriety after antipork-spending crusader Sen. William Proxmire (D-Wisconsin) took the name seriously and decried Newman's National Science Foundation grant application for a project to find "Heaven." Newman got the grant anyway.]

Newman's outpouring of research and many collaborations characterize the spirit of the golden age of general relativity that fell approximately between 1955 and 1975, he said.

Contemporary audiences may struggle to imagine a time when Einstein's theories were not highly regarded. Yet, when Newman entered Syracuse in 1951 as a graduate student in Bergmann's lab, general relativity was out of fashion, having been superseded since the mid-1920s by quantum theory. There were rumblings, however, partly attributable to Einstein's dismissal of major quantum principles, that quantum theory had serious shortcomings. Bergmann—who collaborated with Einstein on his unified field theory work—and his group began to revisit general relativity along with research groups at Princeton, in the United Kingdom, and in Eastern Europe.

"When I joined Bergmann's group, general relativity was in the doldrums. No one worked on it and Einstein, though honored as a great thinker, was considered to be passé, a fogey," Newman said.

"But groups in a handful of institutions around the world began accepting Einstein's theory of relativity as relevant to the physics of the day. There was an open exchange of ideas among the different groups that stimulated a rapid revitalization of relativity," Newman continued. "Soon, a deeper understanding of the Einstein equations was developed and predictions of the existence and properties of gravitational waves were made. The theory of relativity became mainstream.

"Those were wonderful years of friendship and collaboration."

Provided by University of Pittsburgh

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