Beyond Einstein

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A ceramic depicting Einstein by Tabitha Pennekamp

"I wish my physics professor had been like that" said one member of the audience after listening to a presentation by Abhay Ashtekar. Few professors of physics have the ability to convey the complexities of cosmology to the public, which is why Ashtekar was chosen to deliver a Science Frontiers lecture at Boca Raton's Florida Atlantic University. Ashtekar, who holds the formidable title of Director of the Institute for Gravitational Physics and Geometry at Pennsylvania State University, took his audience on a journey beyond Einstein.

Appropriately enough, just a few steps away from the lecture venue, sat a ceramic vase depicting the great Einstein himself. The image is based on the famous photo of him with his tongue sticking out like a little kid. It was part of a series of 12 ceramic vases, done by Tabitha Pennekamp as her Master of Fine Arts thesis exhibition at Florida Atlantic University. There is a secret message encoded in the series- each vessel stands for a letter that spells out a phrase.

The exhibit was the perfect complement to Ashtekar's lecture, which showed how physicists over the past century have gradually been piecing together clues from various objects that are leading to an understanding our how our universe began. Ashtekar subtitled his talk "An Ode to the eternal themes of the Beginning and the End." It all began a hundred years ago when Albert Einstein ignored the advice of one of the world's leading physicists.

Asked by Max Planck what he was working on, now that the theory of Special Relativity was behind him, Einstein replied he was working on a new theory of gravity. He felt it was needed because the results derived from Newton's work did not agree with Special Relativity. Planck advised against such an endeavour. "Even if you succeed, no one will believe you," he said to Einstein. "Fortunately for us," said Ashtekar, "Einstein did not take the advice seriously."

The result in 1915 was General Relativity, which "possessed both beauty and a compelling nature."

Using a simile from the theatre, Ashtekar likened objects such as stars and planets as "actors in the eternal drama of the universe. Through General Relativity, space and time join the troupe of actors- they are no longer the stage."

In a concept many people still have trouble comprehending a century later, Einstein realised that "gravity is geometry. The gravitation field is encoded in the very geometry of space-time." Going back to Elizabethan writer Francis Bacon, Ashtekar said Relativity displays Bacon's idea of "strangeness in proportion. If something is very, very strange it is likely wrong, but Relativity is strange in just the right proportion" to make it believable.

The most recent measurements by our most sophisticated space probes have confirmed the reality of Relativity. Suppose you were just given a baby one hour old to examine, posited Ashtekar. From its appearance then, show how

it will appear as a 40-year-old. "That is the power of Einstein's equations" when applied to the universe. We can look back to when the universe was just 380,000 years old, where tiny fluctuations in the matter present then led to the formation of galaxies and planets billions of years later.

Dr. Abhay Ashtekar

"But we have to go beyond Einstein to understand the origin" of these fluctuations. Several decades ago a theory called Inflation was developed, which can take physicists back to a point where all the matter in the universe appears to come together at a single point. But it is at this point that "inflationary physics throws up its hands and comes to a halt." To find out how the universe really began, Ashtekar and others around the globe are working on a new theory called Loop Quantum Gravity.

The most startling thing to emerge from this theory is that there was no Big Bang after all. "Quantum gravity creates a new repulsive force which overwhelms gravity. The Big Bang is replaced by the Big Bounce."

Instead of everything coming together at a singularity where numbers go to infinity and physics breaks down, this theory shows that there is a tiny bottleneck through which everything came from an earlier time. Not a different or parallel universe, but another aspect of our own universe that existed more than 13.7 billion years ago.

While the first paper on quantum gravity was published 25 years ago, it has really just been within the last five years that physicists have made this major breakthrough, and much work remains to be done.

Ashtekar suggested that people interested in the subject can consult non-technical articles and videos at his university website: www.gravity.psu.edu.