The Branes Behind String Theory

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“The thing about our universe,” says David Lyth, a professor at Lancaster University in the United Kingdom, “is that it is not completely uniform. This has been a bit of a puzzle to cosmologists.” He explains that there are several theories out there describing the formation of the universe, the simplest consisting of a uniform gas.

“But,” Lyth explains to *PhysOrg.com*, “that doesn’t really explain how we have a non-uniform universe. So what we require is that this early gas have some parts that are denser than others.”

Lyth collaborated with Antonio Riotto from CERN in Geneva and INFN in Italy to produce a theory about how the end of brane inflation results in curvature perturbation. Their idea is explained in a Letter published on September 18 in *Physical Review Letters*, titled, “Generating the Curvature Perturbation at the End of Inflation in String Theory.”

Lyth and Riotto explain in their Letter that inflation refers to the process by which the universe began expanding. In this model, the primordial gas at the beginning of the universe had denser spots, which explains the non-uniform positioning of the galaxies, planets and other objects. This is known as curvature perturbation. As the density and gravity waves fluctuations are created by quantum fluctuations, the whole experiences superluminal expansion, or “inflation.”

“Our paper describes how perturbation might have originated as a brane and an anti-brane that collided together,” says Lyth. A brane, he explains, is to do with the fact that there are more than three dimensions.

Branes are spatially extended objects appearing in String Theory, where a 1-brane is a string and there are higher-order branes. “Our world is a three-dimensional brane, embedded in a higher dimension,” says Lyth. “There may be other three-dimensional worlds embedded in extra dimensions, and one of these might be anti-matter, an anti-brane.”

According to Lyth and Riotto’s theory, the curvature perturbation that accounts for the denser areas of the primordial gas arose as a result of a brane and an anit-brane colliding. “This would at some stage annihilate. It would be fairly dramatic, and what was left over would become our universe,” explains Lyth.

Lyth admits that his and Riotto’s Letter deals with the simplest realization of the theory. “In the most naïve realization,” he explains, “curvature perturbation should be the same on all the scales, no matter how big or small.” Observation, however, is on the verge of ruling out this realization. “If observation rules us out,” says Lyth, “we’ll come up with a different way of implementing the idea.”

He points out that in the study of the early universe it is difficult to pinpoint one theory; the range of observations is limited compared to the range of theories regarding the formation of our universe. “This reminds us that in science there is a value judgment. If there are enough observations that support a theory, then it becomes accepted. It’s survival of the fittest. A theory can be ruled out by a single observation and it has to survive several. But that’s how science is working.”

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