New String-Theory Notion Redefines the Big Bang

March 31 2006

String theory — the concept that all particles can be represented as strings or string-loops of incredibly minute length, oscillating at various frequencies — was initially developed to help explain why quarks, the tiny fundamental particles that make up protons and neutrons, are always confined within larger composite particles. However, string theory has evolved to allow scientists to deal with some wider issues. For example, they can use string theory to devise explanations for some grand problems in cosmology, such as the state of the universe — its shape, size, etc. — just after the Big Bang, when quarks roamed freely.

Along these lines, a group of theoretical physicists has recently published an interesting string-theory scenario that describes a new way to approach the development of the Big Bang. They propose that the universe began as a type of theoretical space-filling object called a "brane."

This work was published in the January 27, 2006, online edition of *Physical Review Letters*.

"Perhaps the most ambitious problem in cosmology is the question of the initial conditions of the universe — what it looked like before expanding into the stars and planets we see today," said a physicist involved in the study, Robert Leigh of the University of Illinois, to *PhysOrg.com*. "We propose that the universe, before expansion, was an unstable brane that decayed into innumerable string-loops to form the universe as we now know it."

The conventional model for the expansion of the universe assumes that the universe once existed as a very small, point-like volume called a "singularity." Then the Big Bang occurred, and the universe rapidly expanded. An extension of this, and one main competitor of the brane model, is the Big Crunch/Big Bang theory, which assumes that the universe was once vast, then "crunched" down to a singularity before expanding. The Big Bang/Big Crunch model implies that time existed before the Big Bang.

The problem with the Big Crunch/Big Bang model is that the mathematical laws of classical general relativity do not work at a singularity. And if scientists cannot mathematically understand the singularity, they cannot, in theory, fully understand the geometry of spacetime, either before the Big Crunch or after the Big Bang.

"Our brane model allows us to mathematically address what might have happened at the Big Bang, and also gives a novel interpretation of time in string theory," said Leigh.

He and his group propose that time began when, via a Big Bang-like event, the brane decayed into closed strings (loops) that propagated off to create the ordinary matter that makes up the universe. This scenario, while avoiding the mathematical problems of a singularity, also helps explain some other issues. For example, to us, the universe looks the same in every direction. Within this brane model, the homogeneity of the universe could be explained as the result of an early universe with homogenous initial conditions, such as a brane that evenly filled space. Leigh and his colleagues may further explore this in additional studies.

Citation: "Brane Decay and an Initial Spacelike Singularity," *Phys. Rev. Lett.* 96, 031301 (2006)