

String theory and the origin of the universe—new idea, old problem

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Perhaps the most serious problem with the big bang theory is the *singularity problem*, which involves the original cause of the universe and the origin of matter and energy. Big bang theorists can attempt to describe the early universe, but so far they have not explained why there is a universe to describe. However, there have been numerous attempts at such an explanation, and recently Paul J. Steinhardt has suggested yet another idea, this one based on string theory. String theory is a new physical theory that seeks to solve the conflict between general relativity and quantum mechanics, thus providing a unified, overall description of physics as it is now known. But despite the advanced physics involved, Steinhardt's model does not overcome, or even address, the old problems that have plagued all previous naturalistic origins theories.

An introduction to string theory

Quantum mechanics and general relativity are both tremendously successful scientific theories. Quantum mechanics describes the bizarre workings of matter and energy on the smallest imaginable scales; general relativity describes the force of gravity, and becomes useful when gravitational fields are so extreme that they begin to depart from Isaac Newton's much simpler description. The problem is that these two theories seem to be mutually exclusive. Both appear to be accurate descriptions of the world, but they cannot both be true. General relativity assumes that space-time is a smooth continuum which is curved by gravity. Quantum mechanics, by contrast, involves random, violent distortions of space-time in what

has been called 'quantum foam' at the smallest scales. This is usually not a serious drawback, since strong gravitational fields, the domain of general relativity, usually occur on large scales, where the quantum effects are not noticed. But in some cases, such as the singularity inside a black hole, there are strong gravitational fields (requiring general relativity) coupled with very small scales (requiring quantum mechanics). If one simply joins the equations of general relativity to those of quantum mechanics, they give totally nonsensical answers to calculations, such as infinity.¹

String theory is the most successful, and the most popular, attempt to unify these apparently conflicting theories in a coherent description of reality. A critical part of this new theory is the idea that elementary particles such as the electron are not points, as is generally believed, but oscillating loops of 'string'. This apparently unrelated suggestion actually has profound implications for the conflict between general relativity and quantum mechanics.

When you want to probe something at very small scales (and assuming for the moment that you cannot see it directly), you can shoot very small projectiles at it and see how they are deflected, thereby reconstructing its image. Large projectiles will reveal only the largest-scale structure of the object in question, giving only a crude picture. Very small projectiles, however, can be deflected by the smallest irregularities in the target, revealing the finer details. In common experience we do this with photons, particles of light, without even thinking about it. The pattern of light and shadow, revealing an object's shape, is a result of the way light is deflected by the surface.

It takes small objects to probe small scales, and no object can be used to probe a scale smaller than its own size. Therefore, if all elementary particles are actually loops of string, then no scale smaller than these strings can possibly be probed. The problem of the ultra-small quantum foam that

gives relativists a headache arises on precisely that scale. String theory therefore eliminates the problem and allows a unified description of nature.²

String theory involves a number of very strange ideas. For example, the universe consists of nine or ten spatial dimensions, along with the one dimension of time.³ Furthermore, all forces arise from the same underlying force (just as electricity, magnetism and the weak force are already known to be interrelated). The properties of elementary particles are believed to arise from the patterns of vibrations in strings. String theory has not yet been completely developed or understood at the mathematical level, but so far it seems to have great potential.

Despite its apparent theoretical promise, string theory does have the problem that there is not yet any experimental evidence for or against it. That will have to wait until either the theorists or the experimenters (or both) develop their techniques and ideas further. In the meantime, however, string theory seems to be the most promising solution, even if speculative.

String theory and the origin of the universe

As might be expected of such a new physical theory, string theory has important implications in the field of cosmology, and it has been applied to the singularity problem.

Paul J. Steinhardt and Neil G. Turok have claimed that string theory allows for the possibility of an eternal universe.⁴ In their model, called the ekpyrotic model, our universe is only one of two. These two universes, or 'branes', lie side-by-side in a higher dimension (an analogy would be two flat sheets lying parallel in the third dimension) and are attracted by a 'new kind of force arising from quantum interactions' between the two branes. This attraction causes the branes to collide, with the energy of the collision producing a big bang. The branes then separate, space expands in each brane,

stars and galaxies form, life evolves and asks where it came from, etc. Eventually, this attractive force pulls the two branes back together in another big bang, and so it goes, in an eternal cycle with no beginning, no end, and no need for a cause or a creator.⁴

Unfortunately, despite all the advanced (if unproven) physics involved in this theory, these two scientists have made a very elementary mistake that could have been perceived long ago. The ekpyrotic model, like any other theory that claims the universe is infinitely old, ignores the simple fact that the Second Law of Thermodynamics disallows any such possibility. According to the Second Law, any isolated system must tend toward randomization and disorder or, more precisely, it must increase in entropy. Obviously, nothing that is wearing out can last forever, so this well-demonstrated law of physics requires that the universe cannot be infinitely old. This argument has been made many times before, and big bang theorists will sometimes admit to it when it is convenient. But when an otherwise apparently promising origins theory contradicts the Second Law, that law is ignored, as in this case. (Sometimes it is claimed that this argument is not correct, since the Second Law applies only to isolated systems, whereas in the ekpyrotic model, the universe we live in is interacting with another, and thus is not isolated.⁵ However, the two universes can still be counted *together* as an isolated system. This *overall system* must still increase in entropy.⁶)

Conclusion

Naturalistic theories of the origin of the universe generally fall into two categories: those that claim the universe appeared from nothing with no cause, thus denying causality and the conservation laws; and those that claim the universe is infinitely old, thus denying the Second Law of Thermodynamics. The recent idea based on string theory makes no more progress than the previous

attempts, indicating that there is something fundamentally wrong with the naturalistic assumptions behind such ideas.⁷ If we simply take the laws of physics at face value, however, it becomes obvious that the universe must have had a beginning, and that it must have been caused by some outside agent. Thus there is no scientifically valid way to avoid the conclusion that ‘In the beginning God created the heavens and the earth.’

References

1. Greene, B., *The Elegant Universe: Superstrings, Hidden Dimensions and the Quest for the Ultimate Theory*, Vintage Books, New York, pp. 127–129, 1999.
2. Greene, ref. 1, pp. 152–157.
3. Greene, ref. 1, pp. 201–204.
4. Naeye, R., Delving into extra dimensions, *Sky & Telescope* **105**(6):43–44, 2003.
5. This was the response Sky & Telescope Senior Editor Alan M. MacRobert gave to my letter-to-the-editor concerning this problem. I wrote back, clarifying, as below, that I was referring to the overall system of both ‘universes’, an overall system that is still bound by the Second Law. There was no response to this second letter.
6. One might suggest that the Second Law does not necessarily apply to the universe (consisting of two branes) as a whole. But the general methodology of scientists is to assume that known physics is correct until a problem is found with it (whether theoretical or observational), not to assume it is false until proven correct. The known laws of physics are ‘assumed innocent until proven guilty’—so to speak. All of astronomy would be impossible if this approach were not taken. Astronomers base their conclusions about distant objects on the assumption (not always provable) that the known laws of physics apply in those distant parts of the universe. The Second Law applies in all known cases, and there is no reason from theory or observation to suppose it does not apply to the universe as a whole.
7. It is also interesting that a cosmology based on unproven physics is taken so seriously. Cosmology is a very speculative enterprise even when it is based on solid, tried-and-true physics, but the ekpyrotic model is a speculative theory based on untested physics. Imagine what the response from evolutionists would be if a creationist used this approach!