String theory researchers simulate big-bang on supercomputer

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(PhysOrg.com) -- A trio of Japanese physicists have applied a reformulation of string theory, called IIB, whereby matrices are used to describe the properties of the physical universe, on a supercomputer, to effectively show that the universe spontaneously ballooned in three directions, leaving the other six dimensions tightly wrapped, as string theory has predicted all along. Their work, as described in a paper pre-published on the *arXiv* server and soon to appear in *Physical Review Letters*, in effect, describes the birth of the universe.

String theory, as most are aware, is the combining of quantum mechanics with the theory of general relativity, which is supposed to be the “theory of everything”; one single theory that can sum up and describe everything that takes place in the universe. A pretty tall order to be sure, but one that thus far has proven to be useful in describing such disparate phenomena as electromagnetism, gravity and the working’s of black holes. The problem with string theory thus far though has been that because of its very nature, it’s been very difficult to prove its real, i.e. that there are actually nine dimensions, with time as a tenth, and that rather than an infinite number of particle points forming the basis of everything, it’s all instead made of an infinite number of lines that oscillate, called strings. Complicating matters is the fact that we can only see three of those dimensions, because, theoretically, the other six are scrunched down into tiny structures called Calabi-Yau manifolds.

To get around these problems, the researchers turned to the IIB matrix model, which is where string theory is represented using an infinitely large matrix; though in this case, it was scaled down to just 32x32 for practical purposes. The team modeled such a matrix on a supercomputer then replicated it to create hundreds of thousands of matrices each simulating the very first moments of the universe. They then ran the simulation for two months averaging the results as they went. The simulation allowed the team to in essence watch as the universe reached the expansion point during the big bang. But more importantly, they were able to see all nine dimensions appear, as if on cue, in three directions, with six of them remaining wrapped tightly, just as string theory has suggested happened during the birth of the universe.

The team next plans to see if they can model how quantum space-time evolves into the one we now perceive around us, by building bigger models using larger matrices.

More information: Expanding (3+1)-dimensional universe from a Lorentzian matrix model for superstring theory in (9+1)-dimensions, arXiv:1108.1540v2 [hep-th] arxiv.org/abs/1108.1540

Abstract
We reconsider the matrix model formulation of type IIB superstring theory in (9+1)-dimensional space-time. Unlike the previous proposal in which the Wick rotation was used to make the model well-defined, we regularize the Lorentzian model by introducing infrared cutoffs in both the spatial and temporal directions. Monte Carlo studies reveal that the two cutoffs can be removed in the large-N limit and that the theory thus obtained has no parameters other than one scale parameter. Moreover, we find that three out of nine spatial directions start to expand at some "critical time", after which the space has SO(3) symmetry instead of SO(9).

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