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Here comes hypertime - Want to sidestep your future or rearrange your past? An extra time dimension could be all you need, says Gabrielle Walker, and it might even be the key to the theory of everything

01 November 1997 by Gabrielle Walker
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SPACE, it seems, is fair game. For years, physicists discontented with the paltry three dimensions of space that our senses offer us have been merrily adding extra ones to their equations. First there were four, then there were nine. The best bet today appears to be ten dimensions of space, with seven of them curled up so tightly that we can't see them.

Time, on the other hand, has been largely left alone by the theorists. One time dimension is all you need, they say. Add any more and all hell will break loose. But in the past couple of years all that has changed. One daring physicistCumrun Vafa from Harvardhas discovered that an extra time dimension could solve more problems than it creates.

But problems there certainly are. Where is this extra time? Is it just a mathematical convenience or is it really out there? What will it do to our notions of past and future, cause and effect? "We find ourselves floundering around when there's more than one time," says theorist Michael Duff of Texas A&M University. "It becomes very confusing."

The whole idea that extra dimensions can be useful stems from attempts to unify the different forces of nature. Back in 1920, mathematicians found that moving up to five dimensions, instead of the four dimensions of space-time, helped them to reconcile electromagnetism with gravity. It was like climbing a hill to look down on a two-dimensional battlefield. Suddenly, they could see how all the parts of the battle plan fitted together.

In recent years, more dimensions have entered the fray. In 1984 came the superstring revolutionthe idea that the Universe is made up of one-dimensional strings vibrating in a background of nine dimensions of space and one of time. Then in 1995, Edward Witten of the Institute for Advanced Study at Princeton, New Jersey, and Paul Townsend of the University of Cambridge added a further space dimension to create M-theory. At a stroke, this last addition seemed to unify the embarrassing plethora of string theories that physicists had dreamt up ("Into the eleventh dimension", New Scientist, 18 January, p 32).

Yet despite its great promise, M-theory has not ironed out all the differences between the various string theories, which is where Vafa and his "F-theory" comes in, upping the ante to 12 dimensions. The remaining problems began to fall away with an extra dimension, and theorists eagerly welcomed Vafa's equations. But the new dimension was one of time, and the philosophical implications are rather more troubling.

"Most theorists would shun the idea of more than one time," says Duff, who has himself dabbled with the idea of a 12th time-like dimension. "It brings all sorts of headaches that we would rather do without." It's easy to see why. If time is one-dimensional, like a straight line, every point on the line is either before or after every other point. Future and past are well defined. Every set of events has a unique sequence. But add another dimension and the line becomes a plane. How do you define future and past now? How do you link eventsthe whole game of physicswhen the idea of effect following cause has evaporated?

According to Duff that's not the end of it. Time dimensions differ fundamentally from space dimensions in one important respect: when you insert time into your equations it tends to come in with a negative rather than a positive sign. If you start to mess around with extra time dimensions, all sorts of nasties start to emergeobjects that travel faster than light, photons with negative energy, events where the probabilities of all possible outcomes don't add up to one.

Primitive tools

Admittedly, says Duff, the tools we use to understand the world may be at fault. Perhaps the existing approaches are too primitive to describe multiple times. But since these are the only tools around, the best approach seems to be to treat Vafa's extra time dimension as a convenient device rather than a real physical entity. Exploit the benefits it offers and finesse your way around the disadvantages.

Indeed, Vafa's new time has some suspicious characteristics that could justify this approach. For instance, while the 11 dimensions of M-theory obey Einstein's relativity principle, which says that the laws of physics should look the same to all observers, Vafa's 12 dimensions do not. This is one more reason for physicists to discount the new dimension's physical reality. "It's by no means on the same footing as ordinary time," says Frank Wilczek of the Institute for Advanced Study. Duff agrees. Though it looks like time in some limited ways, he says, "it's not a real, honest-to-goodness extra time dimension."

Vafa admits that his extra dimension has many of the hallmarks of an abstract mathematical device rather than a real physical entity. But this may not be the case for much longer. "At this point, it's making the formalism look nicer," he says. "Whenever that happens in the history of physics, there's usually something behind it." Take quarks. A few decades ago, quarks were a mathematical constructiona way of thinking about the make-up of particles such as protons. According to the equations, quarks could never exist as single individuals. They seemed to be theoretical conveniences. Now, says Vafa, most physicists agree that quarks do exist in the physical world. The same happy fate could await his mysterious extra time dimension.

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From issue 2106 of New Scientist magazine, page 40.

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