ONLINE FEATURES
Cities Guide Go
Country Briefings Go
Audio interviews Go
Classifieds Go

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Full contents
Enlarge current cover
Past editions

GLOBAL AGENDA
POLITICS THIS WEEK
BUSINESS THIS WEEK
OPINION
Leaders
Letters
WORLD
United States
The Americas
Asia
Middle East & Africa
Europe
Britain
Country Briefings
Cities Guide
SURVEYS
BUSINESS
Management Reading
Business Education
Executive Dialogue
FINANCE & ECONOMICS
Economics Focus
Economics A-Z
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Technology Quarterly
PEOPLE
Obituary
BOOKS & ARTS
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Style Guide
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Weekly Indicators
Currencies
Big Mac Index
DIVERSIONS
RESEARCH TOOLS
CLASSIFIEDS

Printable page
E-mail this

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A braney theory

Oct 6th 2005

From *The Economist* print edition

An explanation for the anthropic principle comes a little closer

DID God have a choice? Or, to put the matter less theologically, does the universe have to be the way that it is? The answer to this question, posed by Einstein among others, remains elusive. But it is important, not least because a universe with laws only slightly different from those actually observed would be one in which life—and therefore human life—could never have come into existence.

That observation, known as the anthropic principle, disturbs many physicists because they cannot see any fundamental reason why things could not be different. In particular, they cannot see why space has to have three dimensions. But a paper due to be published this month in *Physical Review Letters* by Andreas Karch of the University of Washington and Lisa Randall of Harvard University suggests that the laws of physics may, indeed, be biased towards three-dimensions. Curiously, though, they have a similar bias towards seven-dimensions.

The idea that there may be more dimensions than the familiar ones of length, breadth and height (and also, to be strictly accurate, the fourth dimension of time) is a consequence of attempts to solve an old problem in physics. Ever since Einstein developed his theories of space, time and gravity, physicists have sought a "theory of everything" that would unite those theories with quantum mechanics—the part of physics that describes electromagnetism and the forces that hold atomic nuclei together. Such a theory would, it is hoped, describe how the universe developed from the Big Bang. It would explain why there appears to be more matter than anti-matter. It would even indicate the nature of the dark energy and dark matter that lurk at the edge of perception.

To date, the best candidates for a theory of everything are various versions of a branch of mathematics called string theory. Unfortunately for common sense, these theories require the universe to have ten or even 11 dimensions rather than the familiar three of space and one of time. To get round this anomaly, some physicists propose that the familiar dimensions are "unfurled", while the other six or seven are rolled up so tightly that they cannot be seen, even with the most powerful instruments available. For an everyday analogy, think of a thread of cotton. This appears one-dimensional for most purposes. Only under a magnifying glass are the other two dimensions perceptible.

A second interpretation of multidimensionality, however, is that the extra dimensions are not always rolled up, but that even when they are not humans cannot readily observe them because they are not free to move in them. In this version, the space inhabited by humans is a three-dimensional "surface" embedded in a higher dimensional landscape. The particles of which people are composed, and the non-gravitational forces acting on them, are strictly confined to this surface—called a brane (short for membrane)—and, as such, have no direct knowledge of the higher dimensional space around them. Only gravity is free to pervade all parts of the universe, which is one of the reasons why it obeys a different set of rules from the other forces.

It is this second interpretation that is invoked by Dr Karch and Dr Randall. They assume that, initially, the universe was filled with equal numbers of branes and anti-branes (the antimatter equivalent of a brane). These branes and anti-branes could take any number of up to ten different dimensions. Dr Karch and Dr Randall then demonstrated, mathematically, that a universe filled with equal numbers of branes and anti-branes will naturally come to be dominated by 3-branes and

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Dr Karch and Dr Randall will publish their research in *Physical Review Letters*. A philosopher at Oxford University posts an overview of the anthropic principle. America's Public Broadcasting Service has video presentations on string theory and the theory of everything.

7-branes because these are the least likely to run into their anti-brane counterparts and thus be annihilated.

This result is interesting for two reasons. It is the first piece of work to show that branes alone can explain the existence of hidden dimensions. They do not have to be rolled up to be inaccessible. It is also the first to suggest an underlying preference in the laws of physics for certain sorts of universe, and thus perhaps provide a solution to the anthropic principle. Yet it is not a total solution. Other realities, whether three- or seven-dimensional, could be hidden elsewhere in the landscape. And life in seven-dimensional space would look very different from life on Earth—if, indeed, it existed at all. That is because the force of gravity would diminish far more quickly with distance than it does in this world. As a result, seven-dimensional space could not have planets in stable orbits around stars. Like dark matter and dark energy, therefore, the anthropic principle is still grinning from the sidelines, taunting physicists to explain it.