FOR AND AGAINST

Should we take the cyclic universe theory seriously?

Yes

Professor Martin Bojowald
Pennsylvania State University, USA

"The problem with the standard Big Bang scenario is that it seems to predict a 'beginning' some time in the finite past. That's an incorrect interpretation of Einstein's theory, which actually just breaks down at the Big Bang in a so-called singularity, and doesn't tell us anything about what happened. What we really need is a theory which is free of this singularity, and the most straightforward alternative is a cyclic universe, which simply reverses the direction at the Big Bang – so a universe that was shrinking in size bounces and begins expanding.

"There are quantum gravity effects which can bring about this turnaround and also get rid of the singularity problem. But they're a double-edged sword, because we also end up with counterintuitive quantum effects, such as a loss of certainty about what happened before the Big Bang. Understanding the universe before the Big Bang involves daringly long extrapolations. And while theory may tell us that there was a universe before the Big Bang, the most important questions concerning its behaviour remain to be addressed."

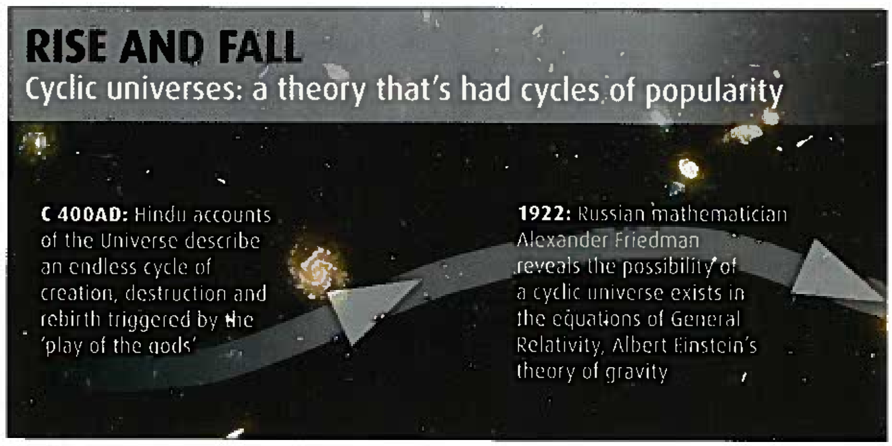
No

Professor Andreas Albrecht
University of California, USA

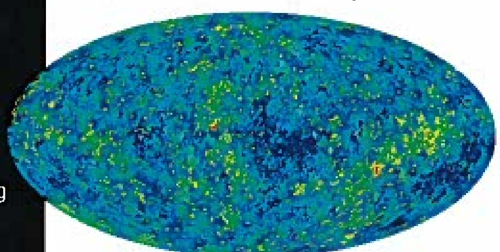
"The principal problem with both the cyclic universe and models based on Loop Quantum Gravity (LQG) is the lack of knowledge about the fundamental equations we should be using to understand what happened before the Big Bang. Not many people are convinced that LQG offers a compelling theoretical framework for addressing these questions.

"Nor am I enthusiastic about Steinhardt and Turok's original ekpyrotic concept, because it does not allow different possible starting conditions for the colliding branes to produce a universe like the one we actually observe. They have tried to remedy this in their cyclic model, but they still put essential parts of their explanation into the era before the Big Bang – and no-one knows how to reliably calculate what happens when the universe passes through that event.

"But trying things like this is how we learn, and the hope of new theoretical insights and good observational tests certainly keeps me excited about this field."



The 'microwave sky' that Planck will study, seen from the WMAP probe



➡ LQG can give reliable answers, and believes that the previous universe could have been quite unlike ours.

For now, theorists are focusing on building confidence in LQG by showing that – like GR itself – it can produce a universe resembling our own. And they've been encouraged by the discovery that the theory is compatible with what most cosmologists believe is one of the most crucial features of our own Universe: cosmic inflation.

Inflation is widely held to be the driving force of the Big Bang. A sub-atomic force field with powerful anti-gravitational effects, it is thought to have led to the expansion of the early Universe after the giant explosion. Its existence explains many phenomena we can see in today's Universe.

Cosmologists are deeply suspicious of theories that don't include inflation – hence the delight of Singh and his colleagues that LQG does. And that could also prove to be a decisive advantage over the ekpyrotic concept of Steinhardt and Turok, as their theory doesn't. Instead of inflation, their theory envisages a relatively leisurely expansion following the collision between the two branes. The end result is a universe that looks almost identical to that predicted by inflation – almost, but not quite.

Planck talk

It's those differences that are about to become the focus of intense study, as the Planck mission begins looking for telltale signs of inflation in the radiation left over from the Big Bang (see 'Testing the theories', p58). Known as the cosmic microwave background (CMB), the radiation is the fading heat of that primordial explosion, stretched by billions of years of cosmic expansion into microwaves.

Inflation leaves evidence in the form of a pattern of hot and cold spots in the CMB we can observe today. The trouble is that the inflation process makes that pattern very similar to what we'd expect from the ekpyrotic universe – and the difference between the two is so subtle that it will be hard to get a definitive answer to the question of which theory is right.

That said, Planck should be able to get impressive evidence tending to support one over the other. While Planck's instruments are capable of analysing the hot and cold spots, they can do much more besides. The radiation they detect also carries the scars of the upheaval in the very fabric of space-time triggered by the Big Bang. Known as gravitational waves, they remain intact over billions of

NASA/WMAP, NASA/HUBBLE SPACE TELESCOPE, FLORIS LEEUWENBERG/THE COVER STORY