Two ways to investigate the truth about cyclic universes

PLANCK

Due for launch onboard an Ariane 5 rocket in October, the European Space Agency's Planck satellite is designed to observe the background heat left over from the Big Bang in unprecedented detail. Some theories of cyclic universes predict the appearance of patterns in this background heat caused by so-called quantum gravity effects triggered at and before the Big Bang. Hints of these effects have already been seen with ground-based observatories, but Planck is needed to confirm them.

The radiation released in the Big Bang is 'stretched' by billions of years of cosmic expansion until it turns into microwaves

Parked at a gravitationally stable point 1.6 million kilometres from the Earth, Planck will study these microwaves, which are predicted to interact with gravitational waves – ripples in the fabric of space-time – causing them to vibrate in certain directions, an effect called polarisation

Analysis of the polarisation signal gathered over the duration of Planck's 21-month mission will allow theorists to check competing theories of what happened at and before the Big Bang

BIG BANG OBSERVER

Predicted by Einstein's theory of gravity but never directly observed, gravitational waves are undulations in the fabric of space and time with characteristics capable of giving insights into events at and before the Big Bang. Ground-based gravitational wave detectors have already been built, but theory suggests that the waves created by the Big Bang will only be detectable using vast space-based observatories such as the Big Bang Observer (BBO) which NASA hopes to build some time in the "coming decades".

The BBO will consist of three sets of three satellites arranged in equilateral triangles. The sides will stretch 50,000km long, each set forming a triangle in solar orbit

Gravitational waves generated by cosmic events pass through the Solar System, altering space-time – and thus altering the distance between the satellites

The laser beams passing between the sets of satellites detect gravitational waves through the effects of interference, which shifts the light waves relative to one another

Data collected during the mission is analysed to see which explanation of the Big Bang gives the best fit

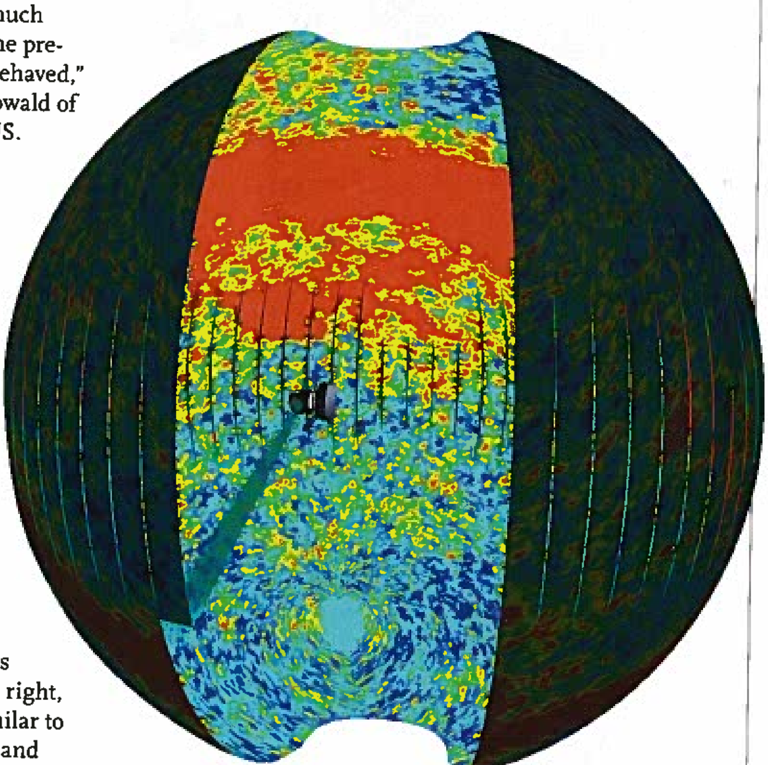
known as Loop Quantum Gravity (LQG). Developed over the last 20 years, LQG is more mathematically rigorous than M-theory, but it produces a broadly similar view of the Big Bang. Calculations by Singh and his collaborators have revealed that LQG also produces a universe that goes through a singularity-free 'Big Bounce'. So it seems that the idea of a cyclic universe is not just some bizarre quirk of M-theory.

But the greater power of LQG allows it to do more, opening up the possibility to glimpse what happened before the Big Bounce. Not surprisingly, the results so far remain very controversial.

Initially, theorists hoped they could probe conditions in the previous universe with some confidence, but subatomic or 'quantum' effects are notoriously difficult to pin down, and would have been important when the Big Bang took place – making predictions of exactly what happened around this time almost impossible. "Violent quantum effects near the Big Bang are important, and it's much more difficult to decide how the pre-Big Bang universe may have behaved," says LQG theorist Martin Bojowald of Penn State University in the US.

In the last few months, new calculations by Singh and colleagues have given theorists renewed hope, by showing that these quantum effects would only be important if our Universe – and the one before it – were incredibly small. And clearly our Universe is not small. "This is easy to understand from common lab physics," says Singh. "Though quantum effects are present, their relevance is insignificant."

So what was the previous universe like? If the calculations by Singh and his colleagues are right, then it may have been quite similar to our own, with galaxies, planets and perhaps even life. But Bojowald is far from convinced that the theory of ➡



The 'microwave sky' has been mapped by NASA's WMAP probe