Do we finally have proof of the multiverse?

The theory that our universe is constantly splitting into parallel worlds goes back to ancient Greece. But now there's actual evidence

By Steven POOLE

BEFORE THE BIG BANG
by Laura Mersini-Houghton

240pp, Bodley Head, £16.99 (0844 8711514), RRP £20, ebook £9.99

★★★★★

Is the universe all there is? The Greek philosopher Democritus considered this question and concluded that, no, there had to be a multitude of universes zooming around in infinite space and sometimes crashing into one another. The Stoics, meanwhile, were troubled by the riddle of what came before the universe, and so decided it must undergo an eternal cycle of death and rebirth. A couple of millennia later, both are still live theories in modern cosmology, the discipline named after the "kosmos" (universe) of the ancients. Not everyone believes in multiple universes, aka the multiverse, but among those who do, there is a veritable zoo of attractive models.

If you have long suspected that our particular universe, far from being exquisitely hospitable to life, is in fact "barely habitable", then this book has the right theory for you. It is the brainchild of cosmologist Laura Mersini-Houghton, who has written a fascinating and unusual hybrid of pop science and memoir to describe her intellectual journey. Growing up as she did in communist Albania, there were many things you couldn't say or do. But no one could stop you looking at the stars, and Mersini-Houghton went on to study physics at the university of Tirana before going to America and ending up discussing multiverse theories with such luminaries as Roger Penrose and Stephen Hawking.

It's an unlikely trajectory, though not as unlikely as the existence of our universe itself, or so it was long thought. People were troubled by the apparent "fine-tuning" of the cosmos: the fact that the laws of nature and distribution of matter we observe seem to be just right to enable the eventual evolution of life; if they were only slightly different, the whole universe would just be a miasma of chaotic rubbish.

▲ How long is a piece of string theory? Benedict Cumberbatch, star of *Doctor Strange in the Multiverse of Madness*

verses could actually be better tuned for life than ours, which is, after all, quite hostile in many ways (and thus "barely habitable"). And most radically, these alternative universes are not merely mathematical hypotheses: they really exist. Lots of them.

In the theory she proposes, called the "quantum landscape multiverse", each cosmos begins as a quantum wave-packet bubbling away in a primordial "disordered landscape" described by string theory, before undergoing a Big Bang and inflation to blossom into a whole universe of its own, along with many, many others. (Some unlucky wave-packets, unfortunately, fail the "quantum selection" process and never get the chance at metamorphosis. They are called,

This kind of conclusion, though, has been resisted in some quarters because it seems rather profligate. Positing millions of universes in order to explain one is not very economical metaphysics. But the mathematics can seem to oblige physicists to accept it, as many (but not all) now accept the "many-worlds interpretation of quantum mechanics", according to which the universe is constantly splitting into many different branches, or "parallel worlds" as the idea leaked into mainstream science-fiction culture. As Mersini-Houghton describes this, it means that: "Every time you tweeted something that you wished you hadn't, there was an identical copy of you in a parallel universe that decided not to." Theoretical physics can sometimes be of psychic comfort.

The author's explanation of such exotic ideas is vivid and good-humoured, and much enlivened by tableaux from her education in Albania. (I was especially fond of her favourite maths teacher at university, Professor Bardulla: "He wore an old suit covered in cigarette burns, and he was almost always drunk, even during lectures." Academia isn't what it used to be.) The other advantage of her narrative approach is that it brings a pleasurable rhythm of bafflement, detective work and discovery to the story, most intriguingly when she describes how her theory is supported by evidence.

Wait, evidence? But the whole point of multiple universes is that

before breaking the umbilical cord with its Big Bang. And that break might have left "scars" on the universe we can still see.

So, she (with co-authors Richard Holman and Tomo Takahashi) predicted, in the 2006 paper "Cosmological Avatars of the Landscape", that we should see a massive hole in the cosmic microwave background that permeates the universe. And indeed, such a hole was later observed. You might not have anticipated that you would cheer upon hearing about the discovery of a "giant void", but such are the unexpected pleasures of this book.

So, have we finally proved Democritus and friends right? Well, other theories of the multiverse, as Mersini-Houghton points out, are available. Alternative explanations