'Crazy' ideas taken seriously

Written by Wendy White
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What came before the Big Bang? Sir Roger Penrose has some opinions on the subject, and discussed them at his recent UWA lecture.

The common answer to this question 'What came before the Big Bang?' is that the question itself is nonsense - there was no time, so asking about 'before' makes no sense.

This is the response that renowned mathematical physicist Sir Roger Penrose himself would have given to this question a couple of years ago - but not any more.

You may remember reading about the groundbreaking research on the expansion of the universe which has concluded that not only is the universe expanding, it is accelerating - not slowing down, as was previously thought.

Which means the "big crunch" theory - that the universe would eventually shrink and collapse - was out the window.

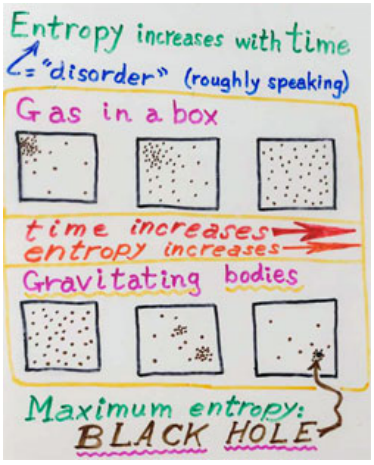
These conclusions started Sir Roger on a series of thoughts that have lead to his new "crazy ideas" as he describes them - but as he points out, "the fact that [these ideas are] crazy doesn't mean you can't take them seriously!"

Roger Penrose used this image by M.C. Escher to talk about negative curvature of space. To our eyes, portions of this devil/angel image near the origin (centre) have little distortion and regions near the map border are greatly distorted. However, it is possible to move the focus of the hyperbolic map to change the regions which are in focus.

It starts very simply, with entropy.

Most people will be familiar with the concept - that over time, things become more and more random, and less organised. A block of ice melting in a glass is a classic example of entropy.

Entropy is central to the second law of thermodynamics and the combined law of thermodynamics, which deal with physical processes.



One of the visuals Roger Penrose used during his lecture.

Another way to think about entropy is that it is a measure of the decay of a system - differences in temperature, pressure, density, and chemical potential will slowly become smoothed out over time, like a gas in a container which slowly spreads out until it is evenly distributed.

Our universe is subject to the laws of entropy, so as time increases, so does its entropy.

Wind the tape recording of our universe back, then, and visit the moment of its creation - the Big Bang. This logically must have been the time of minimum entropy, when everything was so compressed and ordered that entropy must have been near-zero.

Our universe does not spread out entirely evenly like gas in a container does, however.

Clumps of matter are drawn to each other, and forming larger clumps - the biggest of these becoming super massive black holes.

The black holes won't be there forever. According to Stephen Hawking (who has worked with Roger Penrose previously on several ideas about space and time) the temperature of a black hole is not quite zero. What this means as the universe expands, becoming colder and colder and distributing energy more evenly, the black hole will begin to lose heat to surrounding space.

This will lead to the black hole becoming smaller (and therefore, hotter, increasing the rate of its energy/matter loss) until eventually it disappears, with a 'pop!'

"I say 'pop' rather than 'bang' because on the cosmological scale...okay, it wouldn't be a nice thing to go off in this room, but from the cosmological point of view it's nothing," said Penrose.

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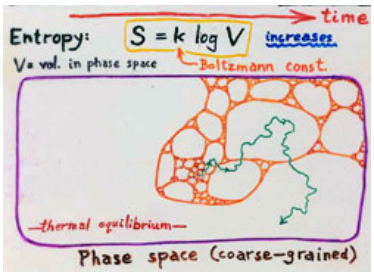
Which he found rather disappointing, as it means that over time the universe will become more and more uniform, which is to say, more and more boring!

Sure, the black holes are interesting, and will take their time getting to the 'pop' stage - about 10^{66} years - but then there will be nothing much to watch, as the universe slowly becomes more and more homogeneous.

Not that we'd be around to watch this, mind you - only a bunch of photons, which "aren't easily bored."

"A photon goes zipping along here, and the first tick of the clock it doesn't even hit at all... photons don't experience the passage of time. So as far as a photon is concerned, infinity is not big deal; zip, there you are."

From thinking further about the eventual 'boring' state of the universe however, Penrose began to form his crazy idea.



'My picture isn't very accurate here, it being two-dimensional...' Penrose's sketch of a journey through coarse-grained phase space - a space in which all possible states of a system (such as the universe) are represented, with each possible state of the system corresponding to one unique point in the diagram.

His idea is this: our universe is just one of several phases, which he refers to as 'eons'. As our universe becomes more boring, more uniform, it spreads over a larger and larger area. Eventually, all matter is merely radiation, and time no longer exists (as the universe is experienced only by things like photons). At this point, the universe 'forgets' to be large, and becomes very very small once more.

This is the end of our universe, our eon, and the beginning of another, as everything is brought into the same state as it was for our own Big Bang.

If Penrose's model of the formation of eons is true, it will mean some interesting things for the contentious "information paradox" issue. The information paradox is the concept that any information that enters a black hole is lost forever. This information loss supports Sir Roger's ideas, as it would balance the overall entropy equations describing the universe.

A **light cone** is the pattern describing the temporal passage of a flash of light. The horizontal axis is space, and the vertical is time.

The bottom cone where the photon could be in the past, and the top cone is where it could be in the future. The point where they meet is the current observed 'location' of the photon.

The way light cones behave in general and special relativity were one of the concepts mentioned during the lecture.

Is it possible to look for information in the universe which may support Penrose's ideas? Yes - studying the cosmic microwave background for variations which come about from remaining black holes in the previous eon affecting the uniform state of the current eon's Big Bang.

The black holes are like raindrops making ripples in the water, leaving faint fingerprints of the previous eon on our own - assuming the eon is governed by similar laws of physics, which Penrose hopes to be true, although he allows that this may not be the case.

In many ways, it is quite a positive outlook - yes, the universe is expanding, accelerating - becoming less exciting and eventually (a long, long way in the future) being so far spread out that there are no galaxies, no stars, nothing other than a few remaining 'raindrops' or black holes.

That this may not be the end - that another Big Bang may result, creating a whole new universe to start over again - is actually quite heartening!

Roger Penrose's lecture "What Happened Before the Big Bang?" was an informative and engaging event. If you would like to learn more, the University of Cambridge has scans of older versions of Penrose's visual aids from a 2005 lecture, and if you click on the thumbnails for each scan, not only will you see the full-sized notes but will be provided with an mp3 recording of the segment of the lecture that accompanied these notes.

Sir Roger Penrose, knighted in 1994 for his services to science, is well known for his discovery of Penrose tiling and has contributed greatly to the theory of General Relativity and our understanding of black holes. During his lifetime has been awarded no less than fourteen honorary degrees, and he has an Erdős number of three.

He has also written several books, the latest being *The Road to Reality: A Complete Guide to the Laws of the Universe*, the purpose of which is to provide a comprehensive guide to the laws of physics and hopefully inspire younger people to become interested in the disciplines of science and mathematics. It is full of mathematical equations for you to try at home, but Roger gives you permission to skip a of few of them if you must.

Western Australia's own Gravity Discovery Centre is one of the observatories Penrose has used in his research to further investigate his ideas on the formation of our universe, and he shall certainly be visiting to use the Square Kilometre Array if WA successfully wins the bid to build this fantastic space science research facility.

Sir Roger turned 76 on the day of this lecture and had the dubious privilege of having a 40-hour long birthday due to spending parts of it in Britain, Australia and New Zealand. It was a pleasure to have him visit and we hope to see him again soon (hopefully the hearty rendition of "Happy Birthday" the audience sang at the lecture's conclusion hasn't put him off!)

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