

# The Shape of the Universe in Brief

Contrary to what you might think, this topic is as much about philosophy as it is science. That it is deeply linked to such ideas as quantum mechanics and relativity does not diminish the key observation that needs to be made: that we are discussing the nature of **Reality** here. Something that has engaged philosophers and scientists for as long as there has been thought itself. All of our belief systems, considerations of identity, societal rules and obligations, sense of morality, etc. all rely on a consistent sense of reality which is the foundation of all other superstructural institutions. What we are as human beings is **MADE** by our sense of what is 'real', and where the divisions between the real and unreal lie.

To ask about the Universe is akin to goldfish asking about the goldfish bowl. *Does the bowl have boundaries? If not, could it possibly be infinite? How did 'the Bowl' come into being? How come I, the Fish that I am, end up being in this Bowl and not some other? What am I supposed to do about being a bowl-ridden fish? Was the Bowl created? If not, then how is it here at all?* Now substitute 'person' for 'fish' and 'Universe' for 'Bowl' and you may get the idea of how important such thought explorations are.

To make matters more interesting, human beings live in two 'Worlds': **The Phenomenal World**, and **The Existential World**. The Phenomenal World is that of our **day-to-day experiences**. How our World looks to us, feels to us, and how we relate to its obvious nature as presented to us by our senses. Yes, the Phenomenal World is 'flat'! Why? Because that's how it presents itself to us everyday. I walk across a flat surface. You say it is curved? But only at certain global scales. Day to day I live with it being flat. The Phenomenal World has a habit of overriding the Existential World, which is the uncertain and scarily counter-intuitive **world of logic**. I say logic and not maths or science, because the latter both rely on logic for their validity. The Universe has to be consistently logical (even if it sometimes seems nonsensical) for us to know anything at all. And logic needs to pervade the Universe. There cannot be logical anomalies, otherwise any Laws of Nature we could understand would be particular only to this region of space and not everywhere. Whatever 'everywhere' might mean.

So what is The Universe? The fishbowl analogy falls when we ask this question. The Universe is reality itself. Its 'laws' give us a lever to understand reality. It has been discovered, for instance, that every object in the Universe is flying away from each other. This means that the Universe is expanding. Two consequences come from this simple discovery: (1) that the Universe must have been smaller in the distant past, and (2) that it will continue to expand until... well, no one really knows. Also, this expansion is accelerating over time. It is **spacetime** itself that is expanding. Think of space and time as one thing. Think of them as essentially the same. You can't have space without time (and vice versa) Then think of spacetime as the dough of a Universe-cake spotted with raisins (stars, galaxies, worlds...): it is the **dough** that is expanding, as the cake cooks, leading to the space between each raisin growing.

If the Universe was smaller in the past, then how much smaller? Calculations give a start point for the Universe at about 14 billion years ago, That's fourteen with nine zeroes after it. At that point, the Universe was very, very hot, and very, very dense. Some cosmologists speculate that it was a '**singularity**', that is to say, a point of infinite energy and mass.

If this is true, then logically the rules of quantum mechanics were in effect all those millennia ago. Quantum mechanics deals with the behaviour of extremely small objects, like singularities. It is a very precise and proven field of science, showing that at a fundamental level small objects behave totally differently from the way our Phenomenal World experiences would suggest. They can pop in and out of existence randomly. They can jump from one place to another without seemingly moving. They can be particles and waves at the same time. And we are all made from these objects.

Hence it is possible that the Universe just popped into existence unbidden. Much though this may offend both religious and common-sense belief, it is the logical conclusion drawn from following a chain of reasoning, based on currently available sound evidence. But what of the future?

How the Universe evolves will depend on one thing: how much **mass** is contained within it. Mass is simply a measurement of substance. Don't confuse it with weight, even though they use the same units. Mass is constant, but weight varies upon where you happen to be (for example a woman **weighing** 72 kilos of earth would be only 14.4 kilos on the moon, but her mass always stays the same at 72 kilos). Einstein also discovered that mass 'bends' spacetime (in his General Theory of Relativity). So, the curvature of space will tend towards a sphere depending on how much mass there is within it. If it was a sphere, then there is a likelihood that it would remain as it is for all eternity. But how much mass is there in the Universe? **Not enough** to cause any curvature that is measurable. The Universe is, hence, essentially 'flat'. This means that the expansion that I mentioned earlier will never be constrained. There will never be any contraction back towards a singularity again. The Universe will go on expanding... **forever**.

It will go dark. Stars and planets, which seem so permanent to us in our Phenomenal World, have a limited life span. One day they will all end. And as the last stars die, as the planets crumble to dust, and when the Black Holes evaporate (as Stephen Hawking has shown they will), then in the very far distant future all there will be is blackness in all directions. Nothing to see. No orientation. Total emptiness.

If humanity survives that long, then it is certain that our Phenomenal World will be totally alien. It seems to me then that we, for the sake of our future generations, should get used to the Existential World's logic of the Universe. Its queerness and contradictions. Its uncertainties and mysteries. Because it is through this very understanding that our futures lie.

**Original text written by Bea Groves. March 2024**