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Looking back in time and space



“Space is big. You just won’t believe how vastly, hugely, mind-bogglingly big it is,” wrote Douglas Adams in *The Hitchhiker’s Guide to the Galaxy*.

“I mean, you may think it’s a long way down the road to the chemist’s, but that’s just peanuts to space.” But not only is space mind-bogglingly big, its mind-boggling bigness has an extraordinary consequence: most of the Universe we see in our telescopes is not really there.

It is all down to light, the means by which news of distant celestial objects reaches us on Earth. Although the speed of light is huge by terrestrial standards – about 300,000 km per second – it is not infinitely fast. And so vast are the expanses of space it must span to reach us from distant stars and galaxies that light appears to crawl across them at the pace of a cosmic snail.

The farther across the Universe we see, the farther back in time we probe. We see the Moon as it was 1.25 seconds ago, the Sun as it was 8.5 minutes ago and the nearest star system, Alpha Centauri, as it was 4.25 years ago. It is literally impossible to know what the universe looks like at this moment in time. In fact, the concept of “now” is entirely meaningless in our cosmos.

We can be reasonably certain that the Moon, the Sun and the nearest star system are still there – and probably the nearest galaxy, Andromeda, which we see as it was 2.5 million years ago when our hominin ancestors were still scabbling a living in the horn of Africa. But this may not be true of galaxies we see as they were many billions of years ago. They may have long ago died, their stars may have winked out, their hearts may have been cannibalised by other galaxies.

Take, for example, “quasars”, which derive their phenomenal light output from matter heated to incandescence as it swirls down onto a central “supermassive” black hole. Quasars long ago exhausted their food supply of gas and ripped-apart stars. So no quasars exist in today’s Universe. When they pop up in the field of view of our telescopes, they are like persistent after-images of super-bright fireworks that long ago faded and died.

The snail-like progress of light across our enormous Universe essentially transforms telescopes into time

machines. And here, what nature takes away with one hand it gives back generously with the other. For although we cannot know what the Universe is like now, by looking further and further out into space we can see what the Universe was like at successively earlier epochs.

To get some idea of what astronomers experience when they look through their telescopes, imagine that light is slowed to a speed of 100 metres per century and so brings news of terrestrial events rather than cosmic events at a snail’s pace.

Say you live in central London. You look out of your window and 100 metres away you see horse-drawn carts clogging the streets. The Great Fire of London is turning the sky ruby red 350 metres away. Two kilometres away, the first Roman ships are docking on the marshy banks of the River Thames.

Historians and archaeologists would kill to have the ability to see back through time in this manner. But this is exactly what it is like for astronomers. Their telescopic time machines permit them to see the entire evolution of the Universe laid out before them, all the way from the Big Bang to the present day. And this ability is the reason we are the first generation in history to realise that our Universe originated in a blisteringly hot fireball that popped into existence 13.8 billion years ago – and the Milky Way in which we live is but one of two trillion galaxies that congealed out of the cooling debris of that fireball.

There is a further twist. Not only is much of the Universe that we see in our telescopes no longer there but, when it was there, it was not the way it appears to us. This is because the light of distant galaxies, on its long journey across space to the Earth, passes by more nearby galaxies. And the gravity of those foreground galaxies bends and distorts the light of the more distant galaxies.

This phenomenon, predicted by Einstein and known as “gravitational lensing”, was observed for the first time a century ago during a total eclipse of the Sun on 29 May 1919. It means that much of what we see through our telescopes is distorted, like looking through the frosted glass of a bathroom window. So not only do we live in a ghost Universe – but even the ghosts we observe are not what they seem. ●