Thoughts on Generosity

We shouldn’t be here. We shouldn’t exist. We’re a cosmic fluke, a galactic accident. A mistake, even. We humans are ridiculously fragile. Heat us up or cool us down by just a fraction, and we expire. Change the composition of the air we breathe by just a few per cent, and we perish. Withhold any number of complex molecules or key trace elements from our diet, and we sicken and die. So why are we here? How is it possible that life on Earth has not only survived for billions of years, but has even flourished and expanded with the passage of time?

At first glance the universe seems a harsh place. Much of it is an empty, inhospitable vacuum at a frigid temperature of -270 C. Occasionally, a cosmic traveller might encounter the welcoming beacon of a star. But stars are not steady sources of warmth or gently twinkling points of light, they are gargantuan, boiling balls of gas at temperatures of thousands of degrees, which emit endless torrents of harmful radiation. Often, when these stars reach the end of their lives, they detonate in catastrophic supernova explosions, laying waste to vast expanses around them. Others collapse into black holes, and spend the rest of eternity sucking in anything that strays too close.

But look a little closer and you will discover a universe that is remarkable in its generosity. A surprisingly nurturing, solicitous universe that has seemingly bent over backwards over the eons in order to create at least one tiny corner of the cosmos in which life, then intelligence, then sentience, could all emerge.

There is overwhelming evidence that space and time both came into abrupt existence 13.75 billion years ago, in the sudden moment of cosmic creation we call the Big Bang. Within twenty minutes of the Big Bang, as the cosmos rapidly expanded and cooled, the basic atomic proportions of the universe took shape: 75 per cent of the matter that was forged in the intense furnaces of the early universe was hydrogen, and 25 per cent was helium. Apart from some traces of lithium, that was pretty much it. But while clouds of hydrogen and helium might not be able to shed tears or sing opera, they have mass, and therefore exert gravity. With the passage of time, these primordial clouds slowly collapsed under gravity’s gentle influence. After hundreds of millions of years, the dense, hot cores of these clouds ignited: the universe began to fill with light as the first stars turned on.

The heat and light of a star come from nuclear fusion, the same terrible, furious, atomic reaction that powers a hydrogen bomb. In those very first stars, hydrogen was fused to form helium, and helium was fused to form carbon. These first stars lived brief, intense lives, quickly consuming their fuel and then catastrophically exploding, scattering their own ashes back into space. When the next generation of stars came to life, fusion could run its course again, this time turning carbon into additional elements: oxygen, neon, sodium and magnesium. After they had exploded, a third generation of stars used the recycled star-stuff as their own fuel, forging silicon, sulphur and phosphorus. With each successive round of star birth, the chemists’ treasured periodic table gradually came into being.

Fast-forward nine billion years or so, and clouds of gas throughout the universe had become rich with almost every element known. At some point, like trillions of times before, a cloud of gas collapsed under gravity, began shining, and became a yellow star like any other. But this time not all of the gas cloud collapsed. A tiny, insignificant fragment remained, which eventually coalesced into clumps of varying sizes, and began to orbit around the central fiery globe. The largest clumps became the mighty gas giants of our solar system: Jupiter, Saturn, Uranus and Neptune. Four smaller masses became the rocky inner planets: Mercury, Venus, Mars, and our home, the planet Earth.

Does The Cosmos Care?

By Bryan Gaensler
At this point there was nothing on Earth even remotely resembling life. But thanks to the stellar furnaces that had worked unceasingly for billions of years, our planet was replete with oxygen, carbon, nitrogen, and all the other materials needed for living creatures to someday emerge. The Big Bang, then gravity, then starlight, was all it took to furnish the panoply of elements needed to make a human being — indeed, we are stardust. Every atom of every person who has ever lived was there right from the moment our planet formed, ready and waiting to be assembled in just the right way. There’s the oxygen and carbon that make up more than 80 per cent of our bodies. There’s the nitrogen and phosphorus threaded throughout our DNA. And there’s the calcium in our bones, the iron in our blood, and even the zinc in our eyeballs. From the perspective of biology, all this is a given. But from the perspective of cosmology, the palette of chemical elements that comprises a human being is the fingerprint of the glittering night sky.

However, providing the raw ingredients was not enough. Liquid water is absolutely essential — no life form on Earth can survive without it. For a planet to host water it must be exquisitely positioned — only between a tiny sliver of temperatures does the water on Earth remain liquid. Without it, there would be no us. For a planet to host life it must be exquisitely positioned — only between a tiny sliver of temperatures does the water on Earth remain liquid. Without it, there would be no us. For a planet to host life, the sun must be at the right distance from the planet so that water is liquid. This is a given. But from the perspective of cosmology, the palette of chemical elements that comprises a human being is the fingerprint of the glittering night sky.

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Why are we here? Are we alone? Today, this quandary, once the realm of philosophers, is the subject of worldwide astronomical research, advancing at a breakneck pace. In less than a decade we may well know whether we’re the cosmos’ first and only living progeny, or if there are others.

Since the 1990s, we have known what we had long suspected: our solar system is not unique. There are other worlds — more than 700 at last count — with water, lakes and rivers. What we take for granted, whenever we fill a bathtub or sit in the sun, is something universally special. This is the universe where it’s safe to walk unexposed. Our planet’s magnetic field continually deflect or absorb these cosmic nasties, making our planet one of the few places in the universe where it’s safe to walk unexposed.

It’s hard to know why the universe has gone to all this trouble to form us out of stardust, to put the universe where it’s safe to walk unexposed. The Big Bang, then gravity, then starlight, was all it took to furnish the panoply of elements needed to make a human being — indeed, we are stardust. Every atom of every person who has ever lived was there right from the moment our planet formed, ready and waiting to be assembled in just the right way.

A star explodes as a supernova at lower left, temporarily outshining its entire galaxy. The violent death of a star hurls newly forged elements into the reaches of interstellar space, ensuring that the next generation of stars and planets forms from a rich cocktail of atoms and molecules. Wonder at the patience of a cosmos that waited billions of years to form our sun, then carefully moulded the planets of the solar system, then let the Earth gradually evolve and age to produce the right cocktail of water, oxygen and sunlight. And be thrilled that through this stargazing we’ve been able to reveal the vast number of steps in a grand story, a story that has led to the arrival of us curious, wondrous, creative creatures who have never ceased exploring the world around them.