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opening extract from

A Really Short History Of Nearly Everything

written by

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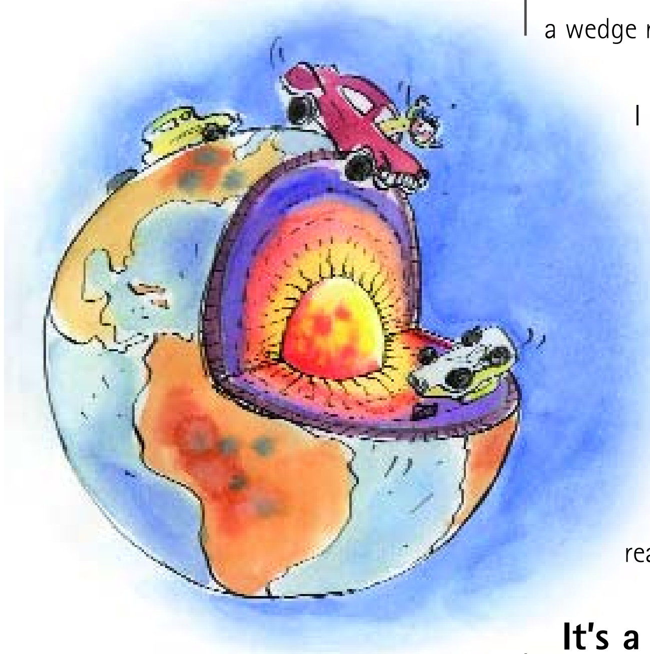
please print off and read at your leisure.

How do they know that?

Me at elementary school, USA.

This is a book about how IT happened – in particular, how we went from there being nothing at all to there being something. And then, how a little of that something turned into us, and also some of what happened in between – and since.

My own starting point, for what it's worth, was a science book that I had when I was in fourth or fifth grade at American elementary school. It was a standard issue 1950s schoolbook – battered, unloved, heavy – but near the front it had an illustration that just captivated me: a cutaway diagram showing the Earth's interior as it would look if you cut into the planet with a large knife and carefully withdrew a wedge representing about a quarter of its bulk.



I clearly remember being transfixed. I suspect my interest was based on the horrifying image in my mind of streams of unsuspecting motorists plunging over the edge of a sudden 4,000-mile-high cliff into the centre of the planet. But gradually, I did turn in a more student-like manner to the scientific meaning behind the drawing and the realization that the Earth consisted of separate layers, ending in the centre with a glowing sphere of iron and nickel, which was as hot as the surface of the Sun, according to the caption. And I remember thinking with real wonder: **How do they know that?**

It's a miracle!

I didn't doubt the correctness of the information for an instant – I still tend to trust what scientists say in the same way I trust surgeons and plumbers. But I couldn't for the life of me conceive how any human mind could work out what spaces thousands of miles below us, which no eye had ever seen and no X-ray could penetrate, could look like and be made of. **To me that was just a miracle.**

I grew up convinced that science was extremely dull – but suspecting that it needn't be.

How and why?

Excited, I took the book home that night and opened it before dinner – an action that I expect prompted my mother to feel my forehead and ask if I was all right – and, starting with the first page, I began to read. **And here's the thing. It wasn't exciting at all.**

Above all, it didn't answer any of the questions that the illustrations stirred up, such as:

- How did we end up with a sun in the middle of our planet and how do they know how hot it is?
- And if it is burning away down there, why isn't the ground under our feet hot to touch?
- And why isn't the rest of the interior melting – or is it?
- And when the core at last burns itself out, will some of the Earth slump into the void, leaving a giant sinkhole on the surface?

Who's got the answers?

The author was strangely silent on such details. It was as if he wanted to keep the good stuff secret by making all of it totally unfathomable. Then, much later – about ten years ago – I was on a long flight across the Pacific, staring idly out of the window, when it occurred to me that I didn't know the first thing about the only planet I was ever going to live on.

I also didn't know...

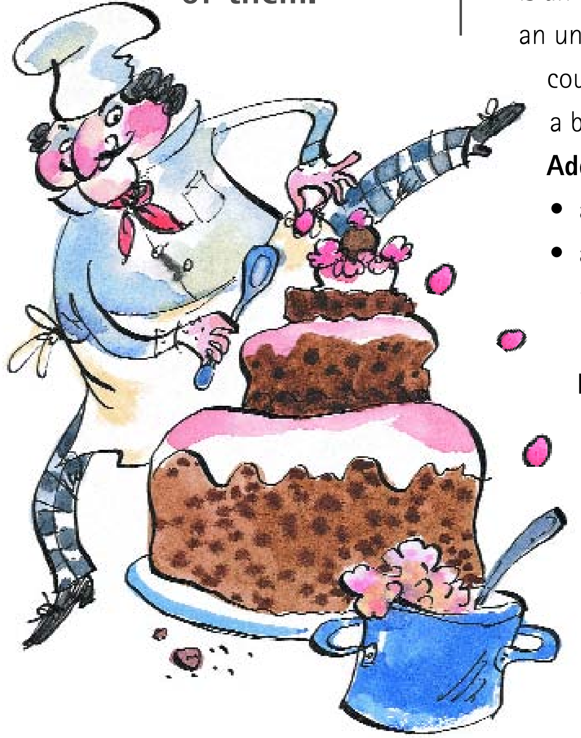
- **what a proton was, or a protein;**
- **how to tell a quark from a quasar;**
- **how geologists could look at a layer of rock in a canyon and tell you how old it was;**
- **how much the Earth weighs or how old its rocks are, or what really exists in the centre;**
- **how and when the universe started and what it was like when it did;**
- **what goes on inside an atom;**
- **why scientists still can't predict an earthquake or even the weather.**

I am very pleased to tell you that until the late 1970s, scientists didn't know the answers to these questions either. They just didn't let on that they didn't.

Cooking up a universe

So where did we come from and how did we get started? Well, when things really got going, it was all down to atoms – those minuscule particles of matter that make up everything there is. But for a very long time, there were no atoms and no universe for them to float about in. There was nothing – nothing at all anywhere – except for something unimaginably small, which scientists call a singularity. **As it happened, this was enough!**

Protons form a tiny part of the centre of an atom. They are so small that a little dib of ink like the dot on this 'i' can hold about 2,000,000,000,000, 000,000,000,000, 000,000,000,000 of them.



Recipe for cooking up a universe:

You will need:

- one proton – shrunk down to a billionth of its size;
- every last particle of matter (that's dust, gas and any other particles of material you can find) between here and the edge of creation;
- a space – much, much smaller than the extremely small proton!

Take one proton . . .

No matter how hard you try you will never be able to grasp just how tiny a proton is. It's just way too small. A proton is an infinitesimal part of an atom, which is itself, of course, an unimaginably tiny thing. Now imagine, if you can (and of course you can't), shrinking one of those protons down to a billionth of its normal size.

Add . . .

- all the particles of matter you found;
- and squeeze them into a space so infinitesimally tight that it has no dimensions at all.

Excellent! You are ready to start a universe.

Get ready for a really BIG BANG

Naturally, you'll wish to retire to a safe place to observe the spectacle. Unfortunately, there's nowhere to retire to because surrounding your tiny, tiny mixture of ingredients, there's no 'where'. It's natural to want to think of whatever started us as a kind of dot hanging in the dark, limitless space that surrounds it. But right now there is no space and there is no darkness. Our universe will begin from nothing.

We're on our way

In a single blinding pulse, a moment of glory much too swift and dramatic to put in words, your ingredients suddenly take shape.

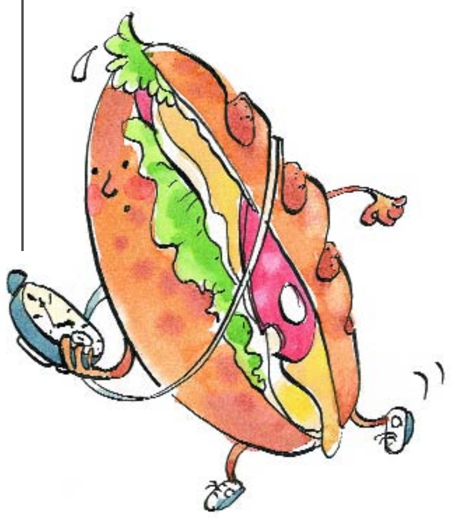
- The first lively second produces gravity and the other forces that govern physics.
- In less than a minute, the universe is a million billion miles across and growing fast.
- There's a lot of heat, 10 billion degrees of it, enough to begin the nuclear reactions that will eventually create the lighter elements – mainly hydrogen and helium.
- And in three minutes, 98 per cent of everything there is, or will ever be in the universe, has been produced.

And so, from nothing, our universe begins

Quite when this moment happened is a matter of some debate. Cosmologists have argued for a long time over whether the moment of creation was ten billion years ago or twice that, or something in between. The consensus seems to be heading for a figure of about 13.7 billion years, but these things are impossibly difficult to measure, as we shall see further on. All that can really be said is that at some unknown point in the very distant past, for reasons equally unknown, there came the moment known to science as 'time equals zero', or **t = 0.**

Before the Big Bang, time didn't exist. However, in a fraction of a split second, t would be something. Let's find out what.

We have a universe. It is a wondrous place and beautiful too. And it was all done in about the time it takes to make a sandwich.



The Big Bang

The Big Bang theory isn't about the bang itself but about what happened after the bang. Not long after, mind you. By doing a lot of maths, scientists believe they can look back to one ten million trillion trillion trillionths of a second after its birth when the universe was still so small that you would have needed a microscope to find it.

Here comes gravity...

At one ten-millionth of a trillionth of a trillionth of a trillionth of a second after the Big Bang, gravity emerges.

Electro-magnetism,

nuclear forces – the stuff of physics – are present in an instant.

Particles of 'stuff'

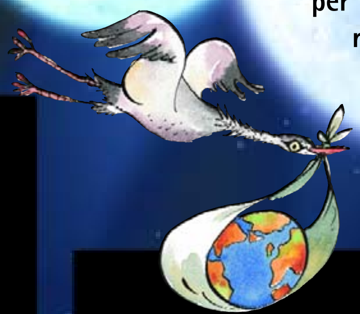
arrive from nothing at all. Suddenly there are swarms of protons, electrons, neutrons and more.

Here's our Sun

A great swirl of gas and dust some 25 billion kilometres across begins to assemble in space. Virtually all of it, 99.9 per cent in fact, goes to make up the Sun.

Here's Earth

Out of the floating material that's left over, two microscopic grains float close enough together to be joined by electrostatic forces. This is the moment our planet is born.



Although everyone calls it the Big Bang, many books tell us not to think of it as a normal kind of explosion. It was, rather, a vast, sudden expansion on a whopping scale.

'Baby' planets

All over the solar system, the same was happening. Colliding dust grains formed larger and larger clumps. Eventually, the clumps grew large enough to be called planetesimals. As these endlessly bumped and collided, they broke or split or joined up again in endless ways. But in every encounter there was a winner, and some of the winners grew big enough to dominate the orbit around which they travelled. It all happened remarkably quickly. To grow from a tiny cluster of grains to a baby planet probably took just a few tens of thousands of years.

Some big numbers!

Most of what we think we know about the early moments of the universe is thanks to an idea called 'inflation theory'. Imagine that a fraction of a moment after the dawn of creation, the universe underwent a sudden dramatic expansion, that it inflated at a huge speed. In just one million million million million millionths of a second – the universe changed from something you could hold in your hand to something at least 10,000,000,000,000,000,000,000,000 times bigger.

So, in a single instant . . .

we had a universe that was vast – at least a hundred billion light years across, but possibly any size up to infinite. It was perfectly laid out, ready for the creation of galaxies, those massive collections of stars, gas, dust and other matter orbiting around a single centre.

Here comes our Moon!

At some point, about 4.4 billion years ago, an object the size of Mars crashed into the Earth. It blew out enough material to form a second, smaller clump. Within a hundred years this had formed into the spherical rock we call our Moon. (Most of the lunar material is thought to have come from the Earth's mantle, not its core, which is why the Moon has so little iron, while Earth has lots.)

Now our atmosphere forms

When the Earth was only about a third of its present size, it was probably already beginning to create an atmosphere, mostly made up of carbon dioxide, nitrogen, methane and sulphur. Amazingly, from this poisonous stew of gases, life was able to form. Carbon dioxide is a powerful greenhouse gas and helped to hold in Earth's warmth. This was a good thing, because the Sun was a lot dimmer and cooler back then. Had we not had the benefit of carbon dioxide, the Earth might well have frozen over permanently and life might never have got started. But somehow it did.

Last, but not least, here comes us!

For the next 500 million years, the young Earth would continue to be pelted relentlessly by comets, meteors and other galactic debris. These brought water to fill the oceans and the components necessary for the formation of life. It was a truly hostile environment and yet somehow, tiny bags of chemicals twitched into life and WE WERE ON OUR WAY.