

DIGITAL ACADEMY

How Many Stars Are There? Gazing up at space on a dark night, it feels like there are too many stars to possibly count. But people have tried.

On a moonless night in the countryside, human eyes can detect light from several thousand of the very brightest stars. With the help of binoculars, we can see light from much further and fainter stars – up to 200,000 of them.

And with a small telescope, we can see millions!

So how many stars are there altogether? This is impossible to answer. Even with the most powerful telescopes, only part of the universe is visible from Earth. We can't count stars that we can't see. But we can estimate – or make a best guess – using the evidence we do have. The highest estimate suggests the universe contains around a trillion, trillion (1,0000,000,000,000,000,000) stars. This number is amazing, but it's probably wrong! Estimating is difficult, because stars aren't spread evenly through space, but clumped together in big groups called galaxies. Our galaxy, the Milky Way, is thought to contain a least 100 billion stars, but we can't even be sure of this. Learnings more about the Milky Way should help us to make better estimates about the entire universe, but we'll never know for sure how many stars there are.

The universe is unimaginably vast, and is constantly changing as old stars die, and new stars flicker into life. Look up at the stars this evening. How many can you count?

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How Big is the Universe?

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Earth might look pretty big from where you're standing, but our planet is but a speck of dust in a universe so enormous that just thinking about it is guaranteed to boggle your brain! We can measure the distance to nearby cosmic objects, such as the Moon or Mars, by sending out a beam of radio waves, and timing how long it takes the beam to bounce off these space rocks and back to Earth. We know how fast radio waves travel through space, so we can work out the distance they have travelled in that time. Measuring the distance to distant stars and galaxies is harder, because most of them are further away than radio waves can travel in a human lifetime. But if we look closely enough, there are clues hidden in the light that has travelled to Earth from those distant objects. For example, the closer a star is to us, the brighter it appears. By studying the light from stars, we've worked out our galaxy – the Milky Way – is about 120,000 light years across. A light year is the distance that light can travel in one year and it's a HUGE distance, because light moves VERY quickly.

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It works out at 1140 quadrillion km from one side of the Milky Way to the other! In a family car going at top speed on a motorway, this journey would take a trillion years.

You should definitely stop for a loo break before you leave the Milky Way, because the next nearest large galaxy, Andromeda, is around 2.5 million light years away – that's another 21 trillion years in a car! But even this is close compared to the very furthest galaxies that telescopes can see – thought to be a whopping 46.5 billion light years from Earth. If we can see 46.5 billion light years in every direction, this tells us the universe must be at least 93 billion light years across.

It doesn't stop there, but the problem is, we can't see any further than this. The light from stars and galaxies more than 46.5 billion light years away simply hasn't had time to reach us yet!

Some space scientists have estimated that the entire universe is up to 250 times bigger than the part we can see! We'll never be able to measure the whole universe, but there is one thing we do know for sure: the parts we can see are more than big enough to keep even the most intrepid explorer busy.

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Are Aliens Real?

It's impossible to answer yes, because no one has even seen an alien.

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But it's impossible to answer no, because we haven't yet looked on (or under) every rock in the universe.

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Nearby planets and moons may look lifeless in photographs, but so do many deserts and mountains on Earth – until you flip over the right rocks! Future probes and rovers sent to explore our solar system will be able to flip over more and more rocks, and may discover aliens living closer than we thought ... Here's what we do know: our Sun is not the only star that is orbited by planets. In fact, scientists estimate there's an average one such planet – or exoplanet – orbiting EVERY star in the universe! Space is so unimaginably vast, it's very likely that in galaxies far, far away, all sorts of aliens are happily going about their lives. So where should we look first?







All living things on Earth have lots in common – for example, they all need water to survive. Alien life may not follow the same rules as Earth life, but for now, the things we know about life on Earth are the best clues we have to follow when alien hunting.

Earth is known as a 'Goldilocks' planet, because it's just the right distance from a star (the Sun). it's not too hot, and too cold, but just right – not only for making porridge, but for liquid water and for living things.

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So far, astronomers have spotted dozens of these Goldilocks planets in our Milky Way neighbourhood.

These would be great places to start looking for aliens.

Unfortunately, the nearest exoplanet is 4.2 light years away. Even the world's fastest spacecraft would take 6,500 years to make the trip!

One day we might invent telescopes powerful enough to get a closer look. In the meantime, we can look for aliens closer to home, in our own solar system. Or ... we can wait for aliens to come and look for us!



How Many Atoms Are There in My Body?



Atoms are the building blocks of everything in the universe, including our bodies. They are so small, that if you magnified an atom to the size of an apple, and magnified the apple by the same amount, you'd end up with an apple the size of Earth!



It's impossible to count the atoms in a human one by one, but we can make a sensible guess. We can weigh an atom and work out how many atoms add up to the weight of a human.



This isn't as simple as it sounds, because there are more than 90 different types of atoms (known as elements) and each one has a different weight. So, first, we need to know which atoms humans are made of.



It turns out that a human body is mostly made of hydrogen, oxygen and carbon atoms.

> 65% Oxygen

18,5% Carbon

9,5% Hydrogen

3,5% Nitrogen Crunching the numbers tells us that a 10-year-old child weighing 45 kg (7 stone) is made of about ... (drumroll) ...

4,500,000,000,000,000,000,000,000

(4,5 octillion) atoms!



These atoms aren't just piled up in a human-shaped heap. They are organised into millions of different molecules, which do all the different jobs in your body. Every time you pull out an eyelash, chew off a fingernail or pick your nose, you lose trillions of atoms.





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But don't worry – every drink, breath and meal, tops you up with trillions more!

What Are Atoms Made From?



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For 2000 years, atoms were thought to be the smallest building blocks of everything. The word atom even means 'impossible to cut up'.





But around a hundred years ago, scientists realised that atoms could be split into even smaller particles, which were named protons, neurons and electrons.



Inside each atom, these particles are arranged a bit like a teeny tiny solar system. At its centre is a clump of heavy protons and neutrons – particles so small you could line up a trillion of each on the full stop at the end of this sentence.



This clump is known as the 'nucleus' of the atom. It's orbited by a cloud of even smaller electrons. Finding out that atoms were made from these three types of particles has helped scientists to explain some of the stranger things about the universe, such as electricity (which is just electrons on the move).

To learn more about atoms, scientists built machines called particle accelerators that can smash particles into each other at enormous speeds.

They discovered that it is possible to break protons and neutrons up into even tinier particles known as quarks. Like electrons, quarks are so tiny they almost seem to have no size at all. We still have lots to learn about quarks and electrons, but at the moment they seem to be the smallest particles of all – and the building blocks of all the atoms in the universe.



Do Animals Have Imaginations?

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Imagination is the way we build different worlds inside our heads. We use our imaginations when we read and write stories and paint pictures.

Animals don't do these things (or not that we've noticed)

But we also use our imaginations when we plan a birthday party, invent a toy that doesn't exist, or worry about speaking in front of the class.

The worlds we build inside our heads help us to plan for things that might happen, instead of just reacting to what is happening right now. O

Some animals DO seem to be able to do this, and funnily enough, most of them are birds.



Our first brainy birds are Western scrub jays. They aren't as cute as they look. One of their habits is stealing food that has been collected by other jays! After doing this once, they seem to be able to imagine other jays doing the same to them. If they spot another jay watching them hide food, they will go back and move it later. Just like a person hiding chocolates from the rest of their family, the jays are using old memories to predict something that might happen in the future – then planning ahead! New Caledonian crows are also brilliant at planning ahead! In one experiment, the crows were given a box filled with yummy food, and a selection of tools. The only way to get the food was by using a long, thin, stick, but this was one tool they didn't have. They didn't give up. Half of the crows managed to invent and build the right kind of tool, using the materials they had. They must have been using imagination!

So far, these brainy birds are some of the best evidence we have that animals really do have imaginations. And studying bird behaviour isn't just interesting for animal experts. It may help us to better understand how our own amazing imaginations work.

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