

To my Morecambe school pupils
who continue to inspire me.

— S. C.

To Chestnut, who purred through long nights
working on this book.

— W. T.



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UNIVERSITY OF
CAMBRIDGE



THE SPEED OF LIGHT



written by
**SIMON
CHAPMAN**

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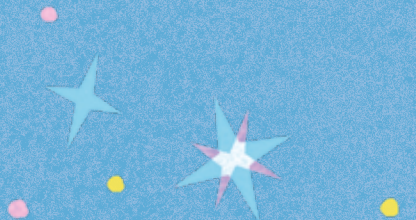
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Introduction

You press the light switch and instantly the room is bright. It is as if the light coming from the bulb took no time at all to get to you. But it did take time. It's just that light travels incredibly fast. What's more, as things travel close to the speed of light, strange things happen. Objects become heavier. Distances get squashed. Time stretches out.

These ideas are incredibly complex and yet, remarkably, they were all thought up by just one scientist over 100 years ago: Albert Einstein. He called these ideas his theory of relativity.

With every advance in technology since, from sending people into space to building huge machines to smash particles together at close to the speed of light, we are finding out that the things Einstein said keep proving to be true.

-SIMON CHAPMAN



Who was Albert Einstein?

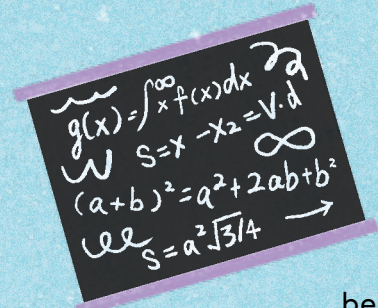
Albert Einstein is probably the most important physicist of the twentieth century. He was the first scientist to come up with an explanation for how stars change the gas they are made of into pure energy, and he developed the quantum physics that led to solar panels which use the power of the Sun.

But his biggest idea was his **theory of relativity**. Einstein's theory contained a lot of incredible ideas about the behaviour of light, **gravity** and space. He said that as objects approach the **speed of light**, distances squash and time itself stretches.

If this sounds strange to you, you are not alone! When Einstein published his mind-bending theories, many other scientists did not believe them. But again and again, they have been proved to be correct.

THE LIFE OF EINSTEIN

1879 Born in Ulm, Germany. Einstein's father runs an electrical company and his mother is a keen musician. As an adult, Einstein loves playing the violin. Einstein does well at school but annoys his teachers by always questioning their ideas.



1896 Fails the exam to attend a research university in Zurich, Switzerland, but is let in anyway because his maths scores are so high.

1902 Works in the patent office in Bern, Switzerland. The office looked at new inventions to check they were original ideas. While working here, Einstein daydreams 'thought experiments' which lead to his theories on space and time.



1915 Einstein's wonder year. He writes up his ideas and becomes famous.



1921 Einstein wins the Nobel Prize for Physics.

1930 Einstein moves to the United States and starts working at Princeton University, New Jersey.



1955 Einstein dies aged 76, and his brain is preserved for science. Surprisingly, it is slightly below average size.

Einstein's theory of relativity involves complicated ideas that are hard to understand all at once. But break it down into smaller parts, and you will soon get a better idea of how Einstein's ideas have shaped how we see the universe.

How fast is light?

To begin to understand the theory of relativity, first, we need to comprehend the speed of light. It's not just fast, it's SO fast that it's hard to even imagine.

Let's compare it to things you might be more familiar with. How far can people, animals and machines move in one second?

NOTHING FASTER THAN LIGHT

Light travels 300,000,000 metres every second through air and space. Nothing in the universe is faster. What's more, light does not get tired and slow down like cheetahs, human sprinters and horses. It does not run out of fuel like cars, planes and rockets. Light travels at this speed forever.

Light years sound like a measurement of time, but they are actually the way we measure distances between **stars**. A light year is equal to the distance light travels in one Earth year, which is about 9.5 trillion kilometres.



X15 rocket plane
2,020 metres



Saturn V rocket
2,760 metres

Light
300,000,000
metres

F-15 Eagle fighter jet
715 metres



Shanghai
maglev train
143 metres



Person walking
1.3 metres



Olympic sprinter
12.4 metres



Horse galloping
14 metres



Cheetah sprinting
29 metres



Formula One racing car
100 metres

Are you sitting still?

Next, we need to try and wrap our heads around the idea of relativity. Einstein tested his ideas through daydreams, which he called thought experiments.

Here's an example you can try ...

THINK LIKE EINSTEIN: The Moving Chair

IS YOUR CHAIR MOVING?

IS YOUR ROOM MOVING?

IS YOUR HOUSE OR SCHOOL MOVING?

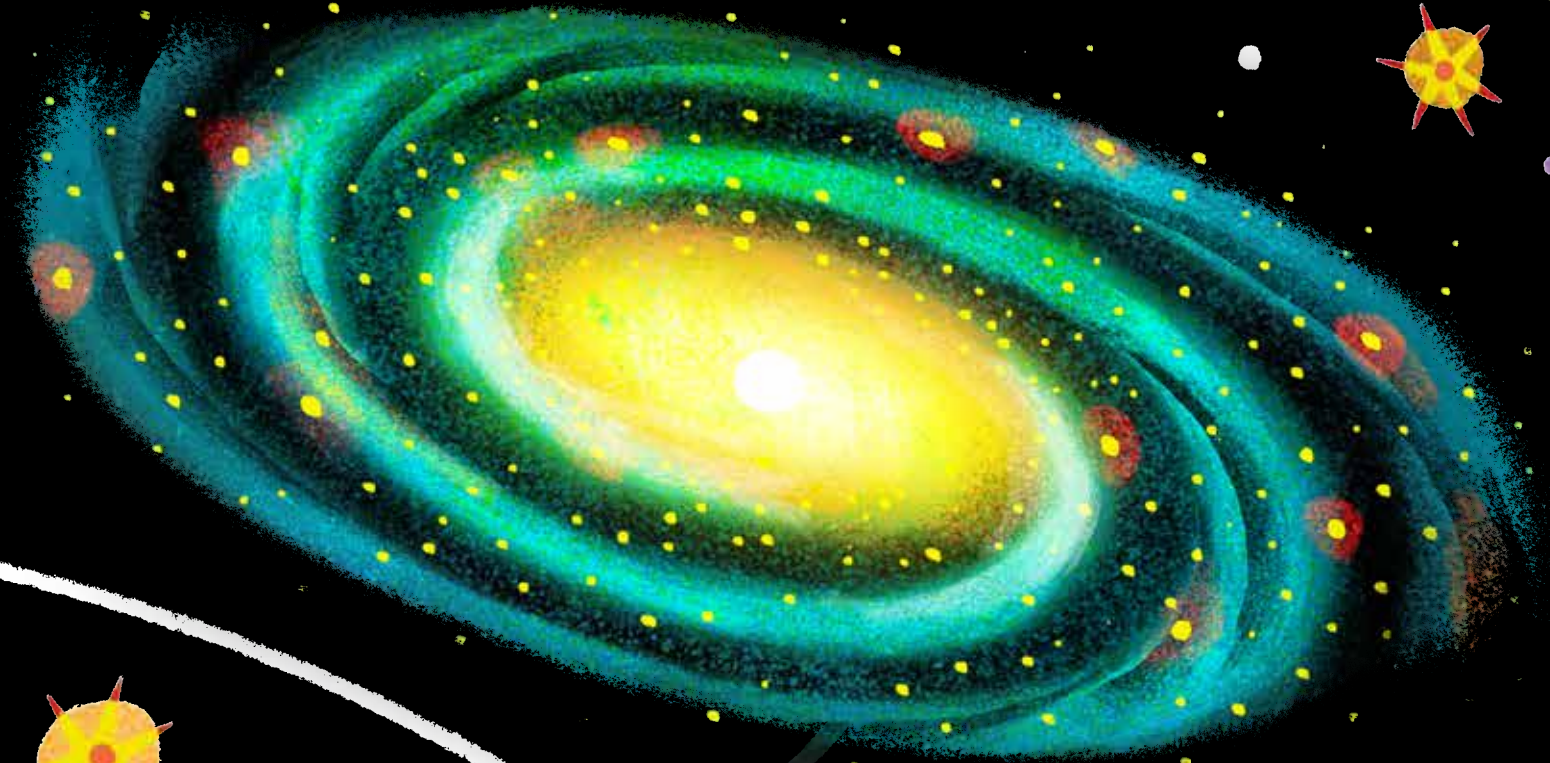


From your point of view, everything stays just where it is. But Earth is turning on its axis (an invisible line that goes through the centre of the planet). It takes one day (24 hours) to spin around once. So, while you appear to be sitting still, you are actually moving at 460 metres per second.

Added to that, the Earth orbits (goes around) the **Sun** every year.

For that matter, the Sun is one of millions of **stars** in our **galaxy**, all moving around the galactic centre.

Our galaxy is moving too. It is one of millions of galaxies that make up the **universe**.



SO, ARE YOU REALLY SITTING STILL? NO!

You are moving incredibly quickly. However, everything else around you is moving at the same speed, which is why you don't feel like you are on a never-ending rollercoaster.

This is **relativity**: how fast something appears to be moving depends on what you are comparing it to.

In other words, you might feel like you are moving slowly or not at all, but to an outside observer (for example, an alien watching Earth from deep space) you are moving extremely fast.