

Penguin



Readers

STEPHEN & LUCY HAWKING UNLOCKING THE UNIVERSE

EVERYTHING
YOU NEED TO
TRAVEL THROUGH
SPACE AND TIME



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CHAPTER ONE

Introducing the Universe

The word “**universe**” comes from an old word that means “everything”. The Universe for us today is everything around us on the Earth and up in **space**. Everything that we can see if we look up at the sky, like the Sun, the Moon, the **stars** and the other **planets** of our **Solar System**, is in the Universe. And everything that we can see with a very **powerful telescope**, like the Milky Way **Galaxy**, is in it, too.

Our Solar System is in the Milky Way Galaxy, but there are other galaxies **further** away that maybe we cannot actually see at all, and these are also part of the Universe.

How we think about the Universe has changed a lot over the years. In the past, people had very different ideas about it. More than 2,000 years ago, the Greek Aristotle believed that the Earth was the centre of the Universe. Not everybody agreed with him, but for more than a thousand years, most people thought that Aristotle’s idea was correct.

Then, in the 16th century, the Polish **astronomer** Copernicus showed that the Earth and other planets **orbited** the Sun. This was a new idea that made the Sun suddenly seem more important than the Earth.

In the 16th century, astronomers thought that our Galaxy, the Milky Way, was just a cloudy line of light in the sky and nothing more. But, when the Italian

astronomer Galileo looked through his own telescope a few years after Copernicus, he saw that in the Milky Way there were millions of stars. Galileo discovered that the Sun had a less important position in the whole Universe, because the Universe was much bigger than people had thought it was before.

By the 18th century, people believed that the Milky Way was a circle of stars that were held together by **gravity**. But most astronomers still thought of the Milky Way as the whole Universe, with nothing outside it.

Then, in 1924, Edwin Hubble, an American astronomer, **measured** the **distance** between our Galaxy and the next big galaxy, called Andromeda. He discovered that Andromeda was too far away to be a part of the Milky Way. So, once more, the Universe had grown!

Hubble also found information about several other galaxies near the Milky Way. He discovered that the Universe is **expanding**, and that the further away from us a galaxy is, the faster it is moving away. So, the speed at which galaxies move away from our Galaxy can tell us how far away from us they are. This is called Hubble's Law. Astronomers have used Hubble's Law to find the distance of a part of the Universe that is tens of billions of **light years** away, where there are hundreds of billions of other galaxies that we have not yet discovered.

But how and when did our Universe begin? Most astronomers agree that it began about 13.8 billion years ago with the Big Bang. At that time, the **matter**, which



The Andromeda Galaxy is the nearest large galaxy to the Milky Way.

things in the Universe are made of, was very hot and pressed together. The moment when this matter started to expand is called the Big Bang. During a very early stage, called “inflation”, the expansion happened so quickly that the Universe became very **smooth** and flat. But it was not totally smooth, so the **temperature** was a little different in different places. This also meant that some parts of the Universe grew more slowly than other parts. When the slower parts stopped expanding, they **collapsed** to **form** galaxies, stars and planets, and because of that we have life on Earth.

Our Solar System was formed when a cloud of **dust** started to collapse. This was maybe **caused** by a supernova – a star that **explodes** and becomes very bright. Then, a ball of this dust turned round and round, until it became a very flat circle. As the circle **attracted** more dust, it got bigger and turned more quickly.

The middle of the circle got hotter and hotter, until it started to burn and became a star. As the star burned, the dust in the circle around it slowly held together to form rocks. These rocks finally became planets, which all orbited the bright star in the middle – our Sun.

These planets formed groups. In the first group, near the Sun where it is hotter, the planets are made of rocks. In the second group, far away from the Sun, are the gas planets, which have gas on the outside and **liquid** inside them. Furthest from the Sun are the ice planets, which have ice and gas.

The planets cleaned their path round the Sun by attracting all the bits of rock that got in their way. Hundreds of millions of years later, the planets had developed **clear** paths, or **orbits**, round the Sun.

CHAPTER TWO

People who helped us to discover the Universe

Galileo Galilei

Galileo Galilei (1564–1642) was born near Pisa in Italy, although his family came from Florence. He was studying to be a doctor before he changed to maths and philosophy – the study of the meaning of life. When he was just eighteen, he watched a light high on the ceiling in Pisa Cathedral. It was moving from side to side, and each time it moved it took the same number of seconds before it changed direction, however far it actually travelled. He used this information to help develop better clocks. There is also a famous story about Galileo and the Tower of Pisa. According to the story, Galileo climbed to the top of the tower and dropped stones from it. He discovered that the speed they fell in a straight line was the same for any size or **weight** of stone.

Galileo developed a new telescope, which marked the true start of **astronomy**. With his telescope, Galileo discovered many things in space.

In 1610, he saw four moons orbiting the planet Jupiter. So, he realized that not everything in the Solar System went around the Earth as people had believed before. This totally changed the idea of the Earth's place in the Solar System and in the Universe itself. Another astronomer,

Simon Marius, who discovered the moons just one day after Galileo, named them Io, Europa, Ganymede and Callisto.

Galileo also discovered that Saturn did not look like other planets, because it had rings around it. He could not see these rings very well because Saturn is even further away from Earth than Jupiter. So, for a while, he thought that the planet had ears and not rings!

In 1989, the Galileo space **probe** was **launched**, which was named after the famous astronomer. In 1995, it finally arrived at Jupiter and spent 8 years studying the planet and its moons. It sent back lots of information about Jupiter's fourth-largest moon, Europa. Galileo was also the first space probe to fly near an **asteroid**, and the first to discover an asteroid with a moon.

Isaac Newton

Sir Isaac Newton (1642–1727) was born in England. His father died when he was a child, so he was looked after by his grandmother. At school, he enjoyed discovering new things. He studied maths and physics, and he also developed a new kind of telescope. There is a famous story about Newton, too. When he saw an apple fall off a tree at home, it helped him to understand the laws of gravity – a **theory** he had developed by the time he was just twenty-three years old.

In 1687, Newton wrote two important ideas: the Laws of Motion, which describe the way that things move; and the Law of Gravitation, which explains how everything in the