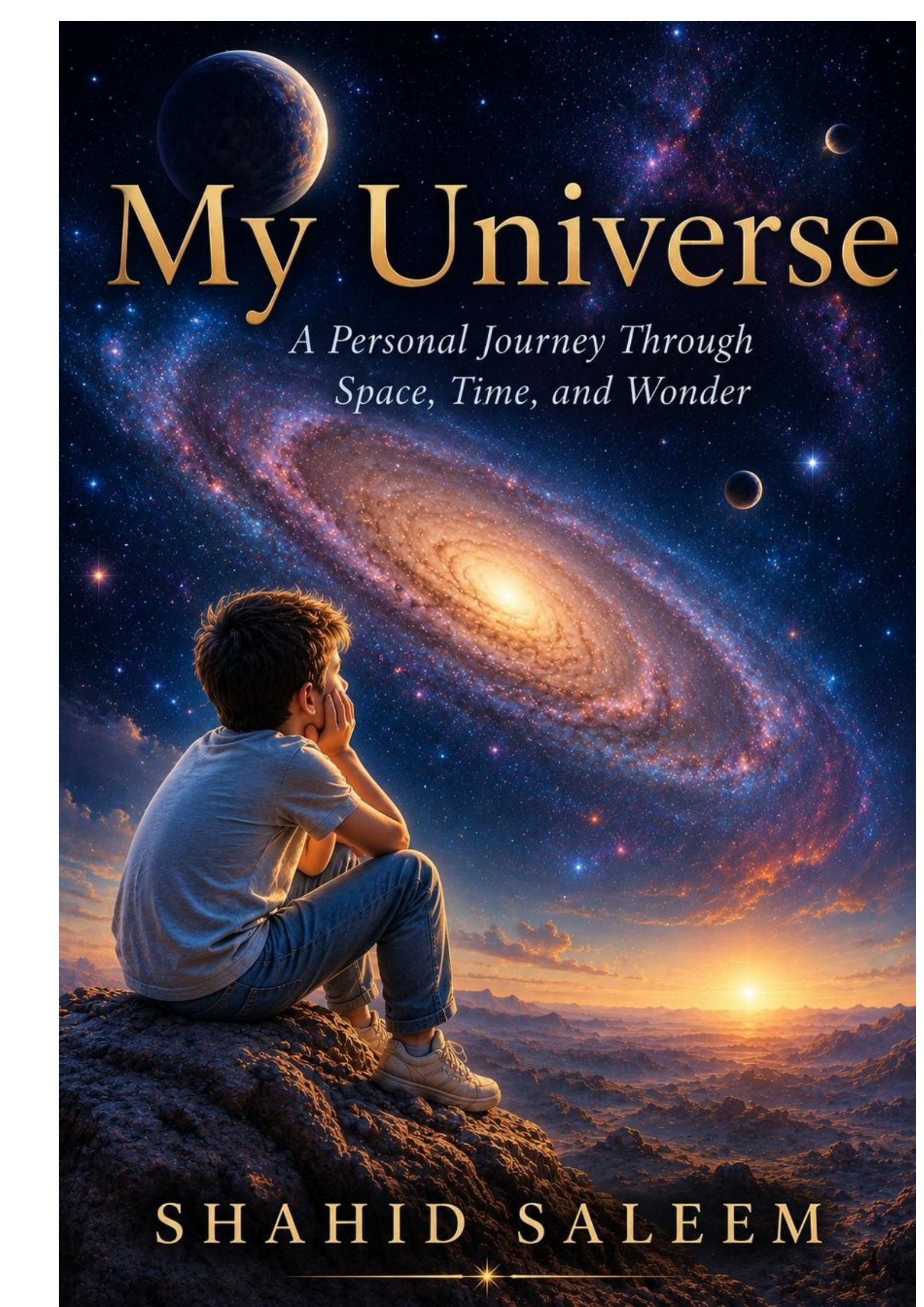




My Universe

*A Personal Journey Through
Space, Time, and Wonder*

SHAHID SALEEM

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1 - Preface

When I look up at the night sky, I often feel as though I'm standing at the edge of infinity — a tiny observer in a vast, unfolding story that began nearly fourteen billion years ago. The stars that twinkle above us are not just distant suns; they are time machines, sending their light across unimaginable distances so that, for a fleeting moment, we may glimpse our cosmic past.

My fascination with the universe began not in an observatory, but in quiet moments of wonder — moments that made me ask: Why? How? What if?

Those simple questions led me on a lifelong journey to understand not just how the universe works, but what our place within it means. Knowing that I do not know has been one of the driving forces in my life. No one taught me that; I discovered it early on. Over time, I realized that sharing this sense of wonder with others brings me as much joy as discovering it myself.

As an amateur astronomer and educator, I have spent countless evenings discussing stars, galaxies, and black holes with students and curious minds. Their questions — sometimes simple, sometimes profound — have shaped the way I think and teach. They remind me that curiosity is not something we outgrow; it is part of what makes us human. I often tell my students:

“If I can understand it, so can you.”

Because the universe does not belong to scientists alone — it belongs to everyone who looks up and wonders.

This book is a collection of lectures, essays, and reflections — the essence of what I have shared in classrooms and under open skies. It is both a personal journey and an invitation: a journey through the grand architecture of the cosmos, and an invitation to feel connected to it. You will not find equations on every page, but you will find stories, explanations, and ideas that aim to make the universe a little more familiar — and perhaps a little more personal.

We are all travelers through space and time, carried effortlessly by the motion of our planet, our galaxy, and the expanding universe itself. Though we may feel still, we are participants in a cosmic dance billions of years in the making. My hope is that these pages help you feel that movement — to see science not as distant theory, but as something alive and meaningful.

The universe is vast, mysterious, and sometimes overwhelming. Yet it is also profoundly intimate. Every atom in our bodies was forged in the heart of a star, and every question we ask about the cosmos is, in some way, a question about ourselves.

So wherever you are reading this — on a quiet evening, beneath a clear sky, or by the soft glow of a lamp — take a moment to look up. The universe is not something “out there.” It is within us, around us, and unfolding through us.

Welcome to *My Universe*.

2 - I Have a Dream ...

Dreams have always been with me — not just the ones that visit at night, but the ones that accompany me through the day like quiet companions. Real dreams, wild dreams, daydreams. Growing up as a boy in Pakistan, I lived in a world full of people — family, neighbors, friends — yet inside my mind I was alone, carrying questions no one seemed ready to hear.

I was not a lonely child. I simply lived in a solitude shaped by curiosity, and that solitude is still my companion.

My mind was full of questions long before I knew which questions were worth asking. I studied in schools, colleges, universities, and many other institutions. Yet I never met a teacher who nurtured wonder. No one ever said, “Tell me what you are thinking.” No one challenged my curiosity, no matter how insignificant my questions may have seemed. The education system taught answers and methods of memorization, but rarely curiosity. That has been a source of frustration for much of my life, and I still carry some of that frustration with me. And because no one could guide me, I became my own teacher.

So I learned about the world by wondering.

I stood under a tree and asked how water reached the very top.

I held small stones and wondered why they carried so many colors.

And for years, I believed tiny people lived inside the radio and played the music for us.

My greatest concern was how they survived the heat inside that tiny box.

To me, everything was a mystery worth exploring.

One day in school, a teacher proudly told us, “The atom is the smallest thing in the universe. It cannot be divided.” I accepted that truth — until years later, when I discovered that long before I was born, Lise Meitner had already shown that atoms could indeed be split. She had escaped Nazi Germany, walked through the snow in Sweden, and helped change physics forever. My teacher had no idea. The world had moved on, but our classroom had not.

Back home, nights were my sanctuary. I slept on the rooftop under the open sky while the rest of the family slept indoors. I waited for nightfall the way others waited for morning. Birds kept me company until the last light faded. When darkness came, the stars took over. In my imagination, the birds became my friends. I talked to them as if they understood, and in a strange way, I think they did. I imagined them whispering about me in languages I didn't know.

And then came the stars — silent, patient, ancient. Two of them were always together, like best friends. They became my secret confidants. I spoke to them freely, from the heart. And somehow, I felt they listened.

I am grateful no one knew about this. They might have tried to fix me, to make me “normal.”

Time passed, but the dreams remained.

With almost no resources, I trained to become a pilot at Tullinge Airfield in Stockholm. The day I lifted off the ground for the first time, I was not just flying an airplane — I was fulfilling a promise I had once made to the birds. For a moment, the wings felt like my own. Later, I earned my night-flying qualification, and the stars once again became my companions — not above me, but around me.

The more I flew, the deeper my curiosity became. I realized that I wasn’t just flying through the air — I was flying through the universe. Because we are made of stardust. Every atom inside us was forged in the heart of a star. We are not outside observers of the universe. We are participants in it.

Even today, whatever I do, I often look up. A part of me is still there — still that boy on the rooftop in Sialkot, speaking to birds and listening to stars.

My dream has changed over the years. It is no longer about achievement or proving anything. My dream now is to awaken dreams in others. I want children, young people, adults — anyone who has ever felt alone with their questions — to know that curiosity is not a flaw.

It is a gift.

I want to share the feeling of flying freely, of exploring places not yet discovered, and of knowing that the universe is not indifferent to those who seek it.

When I was a teenager, I kept a world map on my desk. The whole planet felt like home. Years later, I replaced that desk with a round, 360-degree table. Sitting at its center on a revolving chair, I could imagine the universe unfolding around me — the planets moving, galaxies drifting, and Einstein and Newton explaining gravity like old friends.

I still do that almost every day.

And maybe that’s the secret — to keep turning the chair, to keep turning the mind, to look at the world from a slightly different angle.

To stay curious.

To stay amazed.

I have a dream.

My dream is that no one stops dreaming ... ever.

3 - Standing on the Shoulders of Giants

I have always believed that if I can understand something, then anyone can.

Not because I am exceptionally gifted — but because I am not.

My mission has never been to impress people with complex theories or numbers.

My mission has always been to make the universe accessible — to translate the language of the stars into something every curious mind can understand. I want people not only to learn, but to feel the cosmos — to sense that it belongs to them too.

Richard Feynman once said, “If you want to master something, teach it.”

Those words follow me everywhere. Every time I stand in front of students and try to explain what spacetime is, or how a star is born, I end up learning something new myself. Teaching is not just sharing knowledge — it is rediscovering it through the eyes of others. It humbles me. It excites me. It keeps me curious.

But I did not walk this path alone.

Before me walked giants — educators, dreamers, and explorers who dared to speak about the universe not only with equations, but with emotion and humility.

Carl Sagan taught me that the universe is not a cold laboratory — it is a home.

He spoke of galaxies the way poets speak of love. He made millions of people feel the warmth of belonging to a larger story. Thanks to him, “we are made of star stuff” is not merely a scientific fact — it is a feeling.

Richard Feynman showed me that simplicity is not the absence of depth — it is its essence. He approached physics like jazz: playful, curious, improvisational. He gave us permission to be confused, to laugh, and to wonder.

Neil deGrasse Tyson carried the torch into the modern world, blending science with culture and identity. Brian Cox speaks of the universe with calm precision and quiet awe, as if each sentence were a poem. Brian Greene takes us to the edge of imagination with string theory and the multiverse. Claudia de Rham reminds us that the future of cosmology is still unfolding, shaped by those who dare to ask deeper questions. Jim Al-Khalili weaves science with history and philosophy, reminding us that knowledge is never just data — it is meaning.

And then there were two giants who shaped me in more personal ways.

Einstein — whose mind rearranged the universe.

He showed that imagination can be one of the most powerful scientific tools of all.

Abdus Salam — a man I had the honor of shaking hands with.

He showed me that genius can be born anywhere, even in places where nobody expects it.

I will return to both of them later — they live in a deeper part of my inner cosmos.

These people — without ever knowing me — shaped me.

Through their words, I learned that science is not a closed door.

It is an open window.

Their voices guided me toward my own. And each time I stand before students — whether in a classroom, beneath a night sky beside a telescope, or in a crowded public square — I feel that I am not standing alone.

I am standing on the shoulders of those who came before me.

They lifted me.

Now, I try to lift others.

Because science is not an exclusive club.

It is a shared human story.

And we all deserve a place in it.

4 - How the Universe Works

When we look up at the night sky, we're not just looking at stars. We're looking at movement. We're looking at history. We're looking at the rules that govern everything — including us.

And the first thing worth knowing, the first idea, is this:

Nothing in the Universe is standing still.

We often feel still — sitting on a chair, lying on a sofa, waiting at a red light. But in reality, we are traveling through space at unbelievable speeds. The Earth spins at over 1,600 kilometers per hour at the equator. At the same time, we are orbiting the Sun at 30 kilometers per second. The Sun itself is moving around the center of our galaxy, and our galaxy is drifting through the expanding Universe. Even the atoms inside your body are vibrating and moving endlessly.

Motion is not something that happens out there.

Motion is the default state of existence.

Because of this constant movement, there is no center of the Universe. Everywhere is moving away from everywhere else, like raisins in a baking loaf of bread. Whichever raisin you choose, everything else moves away from it — and from its perspective, that raisin could believe, "I am the center."

The second idea is about light.

Light moves incredibly fast — 300,000 kilometers per second — yet it is not instantaneous. Light takes time to travel. And because it takes time, everything we see in the sky is already in the past.

When you look at the Moon, you see it as it was 1.3 seconds ago.

When you look at the Sun, you see it as it was eight minutes ago.

And when you look at distant galaxies, you are seeing light that began its journey millions — sometimes billions — of years before humans existed.

That means every telescope is also a time machine.

When we observe the universe, we are looking into memory.

The third idea is one of the most beautiful to me:

Space bends.

Einstein showed that space is not an empty, rigid stage where things simply happen. Space can stretch. It can curve. It can ripple like water.

If you place something massive — like the Sun — into space, it bends the space around it. The Earth does not orbit the Sun because of an

invisible force pulling it. The Earth follows the curve that the Sun creates.

Gravity isn't a mysterious pulling force.

Gravity is geometry.

And when black holes collide, they send ripples through space itself — gravitational waves — vibrations in the fabric of reality.

Think about that:

Space can vibrate.

And since time is part of the same fabric as space, time can stretch as well.

Time does not pass at the same rate everywhere. A clock on a satellite ticks faster than a clock on Earth. Astronauts return to Earth having aged slightly less than the people who stayed behind. GPS works only because we constantly correct for these tiny differences. Without Einstein's equations, your navigation system would be wrong by kilometers every single day.

We don't notice it in everyday life, but the Universe keeps its own time.

Temperature is another cosmic rule. Temperature is simply motion — the motion of atoms. The hotter something is, the faster its particles move. There is no upper limit to how hot something can become; you can always add more energy. But there is a lower limit: absolute zero, minus 273.15 degrees Celsius. At that point, motion nearly stops. Not completely — because quantum mechanics tells us that nature never sits perfectly still — but as close as nature allows.

And then we come to one of the most profound ideas humans have ever discovered:

Energy and matter are two forms of the same thing.

Einstein expressed it in five characters:

$$E = mc^2.$$

The equation tells us that matter — anything with mass — can become energy, and energy can become matter. Inside the Sun, hydrogen fuses into helium, and in the process, a tiny amount of mass disappears. That missing mass becomes light — sunlight — which travels through space and lands on your face on a summer day.

You are literally feeling mass turning into energy.

The Universe has only four fundamental forces that shape everything — from the fall of an apple to the dance of galaxies.

Gravity, which shapes the cosmos.

Electromagnetism, which gives us light, chemistry, and life.

The strong nuclear force, which holds the nucleus of every atom together.
And the weak nuclear force, which allows stars to create new elements.
Everything that has ever happened — from supernovae to candle flames
— is these four forces expressing themselves.

And then, the final piece:

The ingredients.

Everything you see — stars, planets, oceans, trees, and your own body —
is made from just three small building blocks: protons, neutrons, and
electrons.

Hydrogen is simply one proton with one electron.

A proton inside a hydrogen atom is just a proton; it has no idea that we
call it a hydrogen proton.

Add one more proton and two neutrons and you have helium.

Add more, and you build carbon, oxygen, nitrogen, iron — all the
elements of life.

And here is the poetic part:

These atoms were not made on Earth.

They were forged inside stars.

Every atom in your body was once inside a star that lived, burned, and
died long before our Sun was born.

So when you look at your hand, you are looking at stardust.

When you think a thought, your brain uses electrons — particles that
have existed since the beginning of time.

The more we learn about the Universe, the more we realize something
astonishing:

The Universe is simple.

Elegant.

Connected.

And perhaps the most beautiful idea of all:

We are the Universe looking back at itself.

5 – Everything on the Move

Sometimes when I stand outside at night and look up, it feels as if the world is perfectly still. The trees are quiet, the air is calm, and the stars seem frozen in place.

But that calm is an illusion.

We are moving — constantly — and far faster than anything we normally associate with motion. We just don't feel it, because everything around us is moving together.

Right now, as you read these words, the ground beneath you is spinning. Earth rotates once every 24 hours, and at the equator that rotation means we are traveling at about 1,674 kilometers per hour — faster than the speed of sound. Yet we feel nothing, because the atmosphere moves with us, and we share Earth's motion.

Sometimes I imagine what would happen if Earth suddenly stopped — not slowed down, but stopped. Everything not firmly attached to the ground — including us, the oceans, and the atmosphere — would continue moving eastward at that original speed.

Fortunately for us, the universe doesn't have emergency brakes.

But that's only the beginning of our journey.

While Earth spins, it is also racing around the Sun, completing one full orbit every year at a speed of 30 kilometers per second. We travel millions of kilometers without taking a single step.

Our planet is not simply a place we live on — it is a ship we are traveling in.

Every night, while you are asleep in your cozy bed, you travel about 858,000 kilometers around the Sun. During the same night, you travel more than six million kilometers around the center of the Milky Way before you wake up.

And that ship has a captain — the Sun.

But the Sun is not anchored to anything either.

It moves too, carrying Earth and the rest of the planets with it as it orbits the center of our galaxy. The entire solar system is hurtling around the Milky Way at about 220 kilometers per second.

One complete revolution takes the Sun about 230 million years.

The last time our solar system was in this part of the galaxy, dinosaurs had only just begun to appear on Earth.

We are passengers on a star that has been traveling for billions of years.

But even the Milky Way is not standing still.

Our galaxy is moving toward the Andromeda Galaxy, and one day — about four billion years from now — the two galaxies will merge into a single giant galaxy. Astronomers have even given it a name:

Milkomeda.

The universe, it seems, has a sense of humor.

And beyond our future merger, something even larger is happening — something far more astonishing.

Space itself is expanding.

Not the way a car drives down a road, but the way dots on the surface of a balloon move apart as the balloon inflates. Galaxies are not simply traveling through space at incredible speeds — space itself is stretching between them.

Some galaxies are already receding from us faster than the speed of light. That does not violate Einstein's laws, because nothing with mass is moving through space faster than light.

Instead, space itself is expanding.

Driving this mysterious expansion is something we cannot touch, cannot see, and do not yet understand — dark energy.

Whatever it is, it makes up about 70 percent of the universe and is causing the expansion to accelerate.

The universe is not slowing down.

It is speeding up.

Think about that.

Without taking a step, without even noticing it, we are moving through the universe at speeds beyond anything we can truly imagine — spinning, orbiting, drifting, carried along on the currents of space and time.

And yet, when we stand outside at night and look up, everything feels peaceful.

The silence of the stars hides the motion beneath us.

We are not standing still.

We are riding on a planet that spins, orbits a star, races through a galaxy, and drifts with billions of other galaxies as space itself expands.

We are passengers on a journey we were born into — moving through the universe without ever having asked for a ticket.

The next time you look up at the night sky, remember:

You are not just looking into space.

You are traveling through it.

6 - The Ultimate Powerhouse — The Sun

Every morning, the Sun rises. We hardly think about it. We wake up, drink coffee, and begin our routines — and yet, that ordinary sunrise is one of the most extraordinary events in our lives.

A star — a real star — pours its energy across 150 million kilometers of space and lands gently on our skin.

We live in the light of a star, and somehow we forget.

What we see as calm and steady is anything but. The Sun is a living thing — not alive like a tree or a bird, but alive in motion, in power, and in constant transformation. Deep inside, in a place we will never see, hydrogen atoms are being forced together under unimaginable pressure and heat.

In that furnace, a tiny amount of matter vanishes, and in exchange we get warmth, light, oceans, forests, laughter — life.

Four million tons of matter disappear every second, transformed into energy.

Light is a by-product of fusion.

And we live on that loss.

People often say that sunlight takes eight minutes and twenty seconds to reach us. That's true, but it isn't the whole story.

The sunlight on your face today was born in the Sun's core long before there were humans on Earth. A single photon created in that chaos may spend hundreds of thousands — perhaps even a million — years being tossed around inside the Sun before finally escaping into open space.

And then, suddenly, its last eight minutes are effortless.

It travels across emptiness, crosses the void, touches Earth, and lands on you.

A million years to escape.

Eight minutes to arrive.

One instant to touch your skin.

If that doesn't humble us, what will?

Even that isn't the whole truth. Everything is relative — and everyone is related, as Darwin taught us.

Photons have no mass, and they travel at the speed of light. If a photon could carry a clock, that clock would never tick. From the photon's point of view, its journey would take no time at all.

The Sun looks peaceful when we glance at it, but if we could watch it up close, we would see storms.

We would see boiling plasma.

We would see magnetic fields twisting and snapping like rubber bands under tension.

We would see dark sunspots — cooler regions where magnetic fields hold energy locked beneath the surface.

We would see loops of hot gas larger than Earth, arcing into space and falling back again.

If the Sun had a heartbeat, it would be magnetic.

And there is a mystery I love.

The farther you move away from something hot, the cooler it should become.

But that isn't what happens with the Sun.

Its surface is about 5,500 degrees Celsius — unbelievably hot — yet its outer atmosphere, the corona, reaches temperatures of more than a million degrees.

That is as if you walked away from a fire and became warmer.

We still don't fully understand why.

Perhaps magnetic fields release energy through countless tiny explosions called nanoflares.

Perhaps waves rising from the surface carry heat outward.

Spacecraft such as SOHO, Solar Orbiter, and Parker Solar Probe are trying to answer that question right now.

Think about that.

We are sending delicate, human-made machines toward a star just to understand why its outer atmosphere is hotter than its surface.

Every eleven years, the Sun changes its mood.

It becomes restless.

Sunspots were observed and documented by Arab and Chinese astronomers long before the invention of the telescope. Some historians suggest that giant dust storms over the Gobi Desert occasionally acted as natural filters, allowing ancient observers to glimpse large sunspots with the naked eye.

More spots appear.

Storms build.

And enormous arcs of plasma leap into space.

Sometimes those storms reach Earth.

Our magnetic field bends and redirects those particles toward the poles,
and suddenly the sky begins to glow with color.

Aurora Borealis in the north.

Aurora Australis in the south.

Perhaps the most beautiful and mind-blowing dance in the night sky.

If you have never seen the aurora, I hope you will one day. Travel close
to the Arctic Circle during the dark season and you may witness nature
dancing before your eyes.

The aurora is not poetry.

It is an interaction between Earth and the Sun — a silent conversation
across the emptiness of space.

The Sun is not simply a distant object we observe.

It is the reason we exist.

Every tree, every blade of grass, every bird, every heartbeat is powered
by sunlight.

The food we eat is sunlight stored in chemical bonds.

The air we breathe exists because ancient plants learned to use sunlight to
transform water and carbon dioxide.

We are solar-powered beings.

Sometimes I stand outside, close my eyes, and feel the warmth on my
face.

And I think:

This light began its journey before there were humans.

Before there were cities.

Before history.

The Sun shines without knowing we are here.

And yet, without it, we would not be.

We are not just living in the universe.

We are living in the light of a star.

7 - The Moon — Our Constant Companion

We look at the Moon so often that we forget how extraordinary it truly is. It hangs in our sky like a quiet witness to everything humanity has ever done. Empires have risen and fallen under its soft glow. Poets have written about it, lovers have sworn oaths beneath it, and scientists have chased its mysteries for centuries. Yet for most of our history, we knew almost nothing about it. The Moon was familiar but unknowable — a distant light that guided our nights while keeping its secrets out of reach.

Today, we understand that the Moon is far more than a bright circle in the sky. It shapes our oceans, stabilizes our planet, and may have played an important role in making life on Earth possible.

The Moon is our closest cosmic neighbor, and without it, our world would be a very different place.

How Was the Moon Born?

The story of the Moon's birth begins with a catastrophe.

About 4.5 billion years ago, when Earth was young and molten, a Mars-sized body — which scientists call Theia — collided with our planet. It was a violent, unimaginable impact. Rock and vapor blasted into space, forming a glowing ring of debris around Earth. Over time, that debris cooled, came together, and formed the Moon.

This is known as the Giant Impact Hypothesis, and it remains the best explanation we have for the Moon's origin.

The clues are written in the rocks:

- The Moon's composition is remarkably similar to Earth's mantle.
- Its lack of iron suggests that it formed primarily from the outer layers of Earth rather than from a separate iron-rich body.
- Its orbit matches what we would expect from such a colossal collision.

Without that ancient impact, Earth might not have the same climate, the same oceans — or the same life.

What Is the Moon Made Of?

The Moon is a world of extremes. It has no air, no weather, no sound, and only a weak magnetic field. Its landscape has been shaped by billions of years of asteroid impacts and is, in many ways, frozen in time.

The lunar crust is covered by a dusty, cratered layer called the regolith.

This dust is sharp, dry, and older than any rock found on Earth.

Below the crust, a thick mantle of silicate rock stretches down to a small, partly molten core — much smaller than Earth's, which is one reason the Moon possesses only a weak magnetic field.

One of the most fascinating things about the Moon is the difference between its near side and far side.

- The near side, which always faces us, contains large dark plains formed when ancient lava flooded enormous impact basins. These regions are called maria.
- The far side, hidden from human eyes until 1959, is rugged, heavily cratered, and mysterious — almost like a completely different world.

For all of human history, half of the Moon remained a secret.

Only in the last century did we finally see its hidden face.

How the Moon Shapes Life on Earth

Most people think the Moon simply lights up our nights.

But its influence on Earth is far deeper — and far more profound.

Tides — The Moon's Silent Rhythm

The Moon's gravitational pull creates high and low tides. This constant movement stirs nutrients, shapes coastlines, and creates tidal habitats that are home to some of Earth's oldest forms of life.

Tides may even have played a role in helping early life make the transition from sea to land.

The Length of a Day

Because of tidal forces, the Moon is slowly moving away from Earth — about 3.8 centimeters each year. As it drifts outward, Earth's rotation gradually slows.

Billions of years ago, one day on Earth may have lasted only six hours.

The Moon has been acting like a brake ever since, gradually slowing our spin and lengthening the day.

Stabilizing Earth's Tilt

Perhaps the Moon's greatest gift to our planet is something we cannot see.

Earth is tilted on its axis, giving us seasons. Without the Moon, that tilt would wobble much more dramatically over time, leading to extreme climate changes.

The Moon acts as a stabilizer, helping to keep Earth's tilt relatively steady.

This stability may be one reason why complex life was able to flourish here.

In a very real sense, the Moon helps make Earth livable.

The Moon and Humanity

The Moon has always belonged to our imagination.

Long before telescopes or rockets, ancient cultures used its phases to measure time. Stories of gods and goddesses were written across its glowing face. For thousands of years, people wondered what it was made of — cheese, crystal, mist, silver — almost anything except what it truly was:

Another world.

A Giant Leap

In 1969, humanity touched the Moon for the first time.

When Neil Armstrong stepped onto the lunar surface, it was more than a scientific achievement — it changed our sense of what was possible.

For the first time in history, human beings stood on another world.

They looked back at Earth — small, fragile, blue — and everything changed.

Looking Forward

Now, more than fifty years later, we are returning.

- NASA's Artemis program and China's lunar program aim to land humans on the Moon again.
- Astronauts will learn how to live and work there, making use of lunar resources.
- The Moon may become a stepping stone to Mars and beyond.

The next giant leap may begin on that same quiet, ancient surface.

The Moon Is Part of Us

The Moon is more than a companion in the sky.

It has shaped our oceans, guided our tides, stabilized our world, inspired our stories, and led humanity to its first steps into space.

We often think of the universe as distant, unreachable, impossibly far away.

But the Moon reminds us of a deeper truth:

The universe begins right above our heads.

8 - Energy: The Power Behind Everything

When we talk about energy, we usually think of electricity, fuel, or the strength in our muscles. But energy is far more profound than anything we can plug into a wall or measure on a fitness watch.

Energy is the quiet force that makes everything in the universe happen.

It is motion and heat and light, but it is also possibility.

Energy is what allows change.

But what is energy, really?

Energy is the ability to do work.

The universe began in energy. Not stars, not atoms — just pure, raw energy, overflowing with potential. As the universe expanded and cooled, that energy took form. It condensed into the first particles, into matter, into atoms, into stars.

Today, that same energy flows through the light that warms your skin, through the food you eat, and through every electrical signal firing inside your brain right now as you read.

And yet, for something so universal, energy is invisible.

We never truly see energy — we only see its effects.

A falling apple.

A burning star.

A moving planet.

Without energy, the universe would be cold, dark, and motionless.

Nothing would ever change.

There is a law — a beautiful, elegant law — that says energy cannot be created and cannot be destroyed.

It can only change form.

I love that idea.

It means that the warmth from the Sun touching your face today is ancient.

That energy was born in the heart of the Sun long before humans existed, and now it has traveled across 150 million kilometers of empty space just to reach you.

In the core of the Sun, hydrogen atoms fuse under enormous pressure. In that process, a tiny fraction of mass disappears — but it does not vanish.

It becomes energy.

Einstein captured this miracle in the most famous equation in physics:

$$E = mc^2.$$

A small amount of mass becomes an enormous amount of energy.

A star shines because mass is being transformed.

I always find that beautiful.

Every sunrise is mass turning into light.

The reverse can happen too.

In giant particle accelerators such as CERN's Large Hadron Collider, we create matter from pure energy. We smash particles together, and energy condenses into mass — into something that did not exist before.

If that doesn't make you pause in wonder, nothing will.

Energy became matter.

Matter became stars.

Stars forged the elements that make our bodies.

And here we are, billions of years later —

matter thinking about the energy that created it.

Almost all of the energy we use on Earth is sunlight in disguise.

The warmth that stirs the wind, the weather, the waves — sunlight.

The food we eat — sunlight captured by plants through photosynthesis.

Even fossil fuels are ancient sunlight, trapped by plants and animals millions of years ago.

Every time we light a candle or turn on a lamp, we are releasing energy that once belonged to a star.

We are constantly borrowing energy from the universe, using it for a moment, and then returning it in another form.

Energy never disappears.

It moves.

It transforms.

It travels on.

And one day, billions of years from now, the energy stored inside our Sun will be exhausted.

Stars will fade.

Galaxies will dim.

And the universe will become quieter.

Some scientists call that final chapter "the heat death of the universe" — not because it is hot, but because energy will be spread so evenly that nothing new will happen anymore.

If that sounds sad, consider this:

That future is not today.

Right now, stars are still burning.

Galaxies are still forming.

Energy is still transforming into new possibilities.

And we are alive in the middle of that miracle.

When I think about energy, I don't just think about physics.

I think about connection.

The sunlight that reaches Earth began in the heart of a star.

It became plants.

Became food.

Became thoughts.

Became dreams.

We are walking sunlight.

We are the universe expressing energy in the form of curiosity.

And that, to me, is one of the most beautiful truths of all.

9 - Dark Matter & Dark Energy: The Invisible Majority

Most people believe that when they look at the night sky, they are seeing the universe.

They're not.

Even if you could see the entire observable universe, you would still be seeing only five percent of it.

Everything we know — every planet, star, nebula, and galaxy — all the things that fill astronomy books and telescope images — together make up just a tiny fraction of the cosmos.

The rest — an overwhelming ninety-five percent — is invisible.

We don't see it.

We don't touch it.

And yet, it shapes everything.

Every time I tell this to a group of students, there is a moment when the room falls silent. It feels as though everyone suddenly becomes aware of how little we truly know.

And I love that moment.

Because it reminds us that curiosity is still alive.

We gave names to our ignorance.

We call them dark matter and dark energy.

Dark matter is the first whisper of mystery.

We cannot see it because it does not interact with light. It does not reflect it, scatter it, or absorb it.

It is completely invisible.

Yet its presence is undeniable.

It holds galaxies together, keeps stars from flying apart, and shapes the cosmic architecture on the grandest scales.

It reveals itself only through gravity, as if the universe is saying:

"You cannot see me, but you can see what I do."

Vera Rubin first noticed something strange while studying galaxies.

Stars far from the center were moving far too fast.

They should have been flung into space.

Imagine swinging a stone tied to a string. If the stone moves too fast, the string breaks.

In galaxies, the string never breaks.
Something unseen is holding everything together.
That unseen something is dark matter.
Once you realize this, every picture of a galaxy looks different.
You no longer see a flat disc of stars.
You see a vast halo of the invisible, holding the luminous part together
like a mother supporting a sleeping child.
Dark energy is something else entirely.
If dark matter holds the universe together, dark energy pushes it apart.
In the late 1990s, astronomers studying distant exploding stars —
supernovae — discovered something no one expected.
The expansion of the universe is accelerating.
Not slowing down.
Accelerating.
Space itself is stretching faster and faster.
Galaxies are not simply drifting apart.
The space between them is growing.
Imagine tossing a ball into the air and watching it not slow down, but
speed up and disappear into the sky.
That's what the universe is doing.
Something — some kind of energy woven into the fabric of space — is
driving galaxies apart.
We don't know what this energy is, so we call it dark energy.
Whatever it is, it dominates the universe.
Seventy percent of everything — not stars, not planets, not dust — but an
unknown, invisible presence that pushes space outward.
It is incredible to think:
We live inside a universe that refuses to reveal itself fully.
And yet, there is something beautiful in that.
Our not-knowing is not a failure.
It is an invitation.
A reminder that our journey is not finished.
That the universe still holds secrets.
That we are not done learning.

Sometimes, when I look up at the night sky, I think about this:

We are made from the five percent that the universe allowed itself to show.

We are beings of light, living inside a cosmos made mostly of darkness.

But darkness, in this case, is not emptiness.

It is possibility.

It is the promise that there is more to discover.

And perhaps that is the most human part of all this —

that even when we cannot see something,

we still reach for understanding.

10 - The Cosmic Microwave Background: The Echo of Creation

Every story leaves an echo — a trace of where it began.

The universe is no different.

Hidden behind the stars and galaxies we see today is a faint whisper from the beginning of everything — the Cosmic Microwave Background, or simply the CMB.

It is the oldest light in the universe, a fragile afterglow from a time when there were no stars, no planets, no galaxies.

Just a newborn universe, hot and glowing.

To reach that moment, we must travel back almost 14 billion years.

In the first moments after the Big Bang, everything was pure energy. Temperatures were so high that matter and antimatter appeared and vanished in a furious dance of creation and destruction. Then, as space expanded, it cooled. In the blink of an eye, the fundamental forces separated — gravity, electromagnetism, and the nuclear forces — and the first particles formed: quarks, protons, and electrons.

Within minutes, the first elements appeared: mostly hydrogen, some helium, and a tiny amount of lithium, along with only about one atom of beryllium for every billion atoms created.

Then came a long pause.

The universe was still too hot for atoms to exist. Free electrons scattered light in every direction.

Light could not travel freely.

Imagine being inside a deep fog.

I have experienced such conditions during my training as a pilot. I often flew through clouds to learn to trust the instruments in the cockpit. There was nothing around me but a white fog, and at times it could be unsettling.

Light was there, but it could not find a way out.

The entire universe was like that — glowing, dense, and opaque.

Then, after about 380,000 years, the temperature dropped enough for protons and electrons to combine and form the first neutral atoms.

Suddenly, the fog cleared.

For the first time, light was free to travel across space.

That moment marked the birth of the first light — the moment the universe became transparent.

And that ancient light has been traveling ever since.

As space expanded, the light stretched, losing energy and shifting from visible radiation into the microwave region of the spectrum.

Today, it fills the entire universe as a faint, uniform glow — invisible to our eyes, but detectable with the right instruments.

It is everywhere.

It passes through you right now, as you read these words.

We are literally bathed in the afterglow of creation.

The discovery of this ancient light was, fittingly, an accident.

In 1965, two radio engineers, Arno Penzias and Robert Wilson, were trying to eliminate an annoying hiss in their antenna system. They removed loose wires. They checked every circuit. They even climbed inside the antenna to clean out pigeon droppings.

But the noise remained.

Constant.

Gentle.

Coming from every direction.

They weren't hearing interference.

They were hearing the birth of the universe.

That faint hiss became one of the greatest scientific discoveries of the twentieth century — direct evidence that the universe had a beginning.

When we map the CMB with modern satellites such as COBE, WMAP, and Planck, we find tiny variations in temperature.

Tiny —

but monumental.

Those minute ripples are the first fingerprints of structure.

They are the seeds from which every galaxy, every star, every planet — and ultimately every living being — grew.

We are here because, 13.8 billion years ago, the universe was imperfect.

A universe that began perfectly smooth would still be smooth.

No stars.

No galaxies.

No life.

Imperfection is the reason we exist.

Every time I think about this, I feel humbled.

This faint light — stretched thin by time, softened by distance — carries the memory of everything that followed.

It is not merely a relic of the past.

It is a message from the universe to anyone willing to listen:

You are part of this story.

When we detect the CMB, we are looking not at stars,
but beyond the stars.

Beyond galaxies.

Almost to the beginning of time itself.

We are seeing the oldest light the universe has ever released.

And that light is still here.

Still traveling.

Still echoing.

Still reminding us that the universe began with brilliance —
and that we, somehow, are part of that brilliance.

11 - The Big Bang and the Multiverse: The Origins and Fate of the Universe

When we look up at the night sky, we are not just seeing stars.

We are seeing the past.

Every photon of starlight is a memory — a message that began its journey long before we were here to receive it.

And that journey traces all the way back to one extraordinary event:

The birth of the universe.

The story of everything — every galaxy, every planet, every atom — begins with the Big Bang.

The name makes it sound like an explosion, but that is not quite right.

There was no noise.

No bang.

No fireball expanding into empty space.

Space itself began to expand.

Time came into existence.

Energy emerged.

The universe did not explode into space.

It created space.

In the beginning, everything that would eventually exist was compressed into an unimaginably hot and dense state.

No stars.

No galaxies.

No atoms.

Only possibility.

Then something happened — we still do not know why — and the universe began to expand.

Not slowly, but with astonishing speed.

During the first fraction of a second, space itself underwent an extraordinary burst of expansion called cosmic inflation.

That brief moment set the stage for everything that followed.

The universe was pure energy.

As it expanded and cooled, energy transformed into matter.

Quarks formed.

Then protons.

Then atomic nuclei.

Hydrogen and helium became the first elements, along with tiny traces of lithium and beryllium.

That was all.

And yet hidden within that simplicity was the potential for galaxies, planets, and life.

After about 380,000 years, the universe cooled enough for atoms to form.

Light, which had previously been trapped in a hot fog of charged particles, was finally able to travel freely.

That ancient light still surrounds us today.

We call it the Cosmic Microwave Background.

It is the oldest light we can observe — a relic from the infancy of the universe.

As the universe continued to expand, tiny imperfections in the distribution of matter began to grow.

Gravity amplified those small differences.

Clouds formed.

Stars ignited.

Galaxies emerged.

Galaxies assembled into enormous filaments and clusters stretching across space like a cosmic web.

From three simple ingredients —

Hydrogen.

Helium.

And gravity.

The universe built complexity.

Everything you and I are made of — the carbon in our cells, the oxygen we breathe, the calcium in our bones — was forged inside stars that lived and died long before our solar system existed.

We are not outside observers of the universe.

We are made from it.

We are part of it.

And yet, even after all we have learned, one question remains so profound that it almost feels forbidden:

What came before the Big Bang?

For decades, the answer seemed simple.

Nothing.

Time itself began with the Big Bang.

Asking what came before was like asking what lies north of the North Pole.

But science advances by refusing to assume that we have reached the final answer.

Today, physicists are exploring possibilities that sound almost like science fiction.

Some theories suggest that the Big Bang was not the beginning, but a transition.

Perhaps a previous universe collapsed and bounced, giving birth to ours.

Others suggest that our universe may be one bubble among countless others in a vast cosmic ocean — a multiverse — each with different physical laws, different histories, and perhaps even different forms of life.

Roger Penrose imagines the cosmos as an endless sequence of cycles.

In his vision, one universe ages, fades, and eventually gives rise to the next.

An infinite story with no true beginning and no final end.

The multiverse may prove impossible to test.

Perhaps we will never see beyond our cosmic horizon.

Or perhaps one day, with new ideas and new tools, we will.

But one thought always stays with me.

We are living inside a universe that can think.

Atoms forged inside stars somehow learned to build telescopes, ask questions, and search for meaning.

The universe created stars.

Stars created elements.

Elements created life.

And life became curious enough to ask where it all came from.

We are the universe trying to understand itself.

The Big Bang is not the end of the story.

It is the first sentence.

And the multiverse — if it exists — is not an answer.

It is an invitation.

An invitation to keep wondering.

To keep exploring.

To keep looking up.

12 - Riding on a Beam of Light: Relativity, Time, and $E = mc^2$

Some of the greatest discoveries in science did not begin in laboratories.

They began with imagination.

One day, a young Albert Einstein asked himself a strange question:

What would I see if I could ride alongside a beam of light?

He was not performing an experiment. He had no telescope, no particle accelerator, no laboratory. He simply allowed his mind to wander.

That single question changed our understanding of the universe.

At the beginning of the twentieth century, physicists believed that space and time were fixed and absolute. Time flowed the same way everywhere, and distances were the same for everyone. Light was known to travel incredibly fast, but few imagined that it would force us to rethink reality itself.

Einstein discovered something astonishing:

The speed of light is always the same.

No matter how fast you move, light will always race past you at about 300,000 kilometers per second.

This simple fact has extraordinary consequences.

If the speed of light is constant, then space and time cannot be.

Time itself must be flexible.

For someone traveling close to the speed of light, time slows down. A clock moving through space ticks more slowly than a clock at rest. Two people may experience time differently depending on how they move.

Time is not universal.

There is no single cosmic clock.

Space and time are woven together into a single fabric called spacetime.

The faster you move through space, the more your experience of time changes.

This is not science fiction.

It is reality.

Astronauts age ever so slightly less than people on Earth. GPS satellites orbiting above us must constantly correct for these effects. Without Einstein's ideas, your navigation system would be wrong by several kilometers every day.

But Einstein was not finished.

Ten years later, he transformed our understanding of gravity itself.

For centuries, gravity had been described as a force pulling objects together. Newton's laws explained how planets moved, but Einstein asked a deeper question:

What if gravity is not really a force?

His answer was breathtaking.

Space is not empty.

It is not a rigid stage upon which the universe performs.

Space itself can bend.

Massive objects such as stars and planets curve the fabric of spacetime around them. The Earth does not orbit the Sun because it is being pulled by an invisible force. It follows the curves created by the Sun.

Matter tells spacetime how to curve.

Spacetime tells matter how to move.

Gravity is geometry.

Light itself follows these curves. During a solar eclipse in 1919, astronomers measured the bending of starlight by the Sun and confirmed Einstein's predictions. Suddenly, the universe became stranger—and more beautiful—than anyone had imagined.

Today we see gravity acting as a cosmic lens, magnifying distant galaxies and revealing invisible matter. We detect ripples in spacetime itself—gravitational waves—created when black holes collide billions of light-years away.

Space can vibrate.

Time behaves strangely near strong gravity as well. Clocks closer to massive objects run more slowly. Near a black hole, time stretches dramatically. If you could stand safely near one, you would experience time differently from someone far away.

The universe keeps many clocks.

And they do not all tick at the same rate.

Then came perhaps the most famous equation ever written:

$$E=mc^2$$

Five symbols.

Yet within them lies one of nature's deepest truths.

Mass and energy are not separate things.

They are different forms of the same reality.

Matter can become energy.

Energy can become matter.

Inside the Sun, hydrogen nuclei fuse together. A tiny amount of mass disappears, transformed into energy. That energy becomes sunlight, which crosses 150 million kilometers of space and warms your face on a summer day.

Every sunrise is matter turning into light.

The reverse is also possible.

In powerful particle accelerators such as CERN, energy can be converted into matter. The universe itself performed this transformation shortly after the Big Bang, when pure energy condensed into particles and atoms.

Everything around us is the result of that ancient conversion.

Stars.

Planets.

Life.

You.

Einstein once imagined riding on a beam of light.

He never performed the experiment.

He simply asked a question.

And that question changed our understanding of reality.

Perhaps that is the greatest lesson he left us.

Curiosity is more powerful than certainty.

Imagination is not the opposite of science.

Imagination is where science begins.

We live inside a universe where space can bend, time can stretch, and matter can become light.

Strange as these ideas seem, they are not science fiction.

They are nature.

And perhaps the most astonishing fact of all is this:

A species living on a small planet around an ordinary star has learned to understand them.

We are not merely spectators.

We are participants.

We are the universe becoming aware of itself.

And all because a young man once dared to ask:

"What would happen if I rode on a beam of light?"

13 - Walking With Giants

All my life, I have walked with giants.

Not in reality — I met only one of them — but in every important way that matters. They shaped how I think, how I dream, and how I look at the universe. These were not just scientists in books; they became voices in my mind, companions in my solitude, and guides whenever I felt lost.

Sometimes I still feel them looking over my shoulder, gently nodding when I follow a thought wherever curiosity leads.

They never asked me to understand everything.

They only asked me to wonder.

Einstein — My First Light

Einstein is not simply someone I admire.

He is my hero.

He revealed the universe using nothing but imagination. He didn't work in a laboratory. He didn't use expensive instruments. He sat alone in a small office at the patent bureau in Bern and thought — daydreamed — until the structure of the universe unfolded in his mind.

His solitude was his superpower.

Perhaps I borrowed that from him.

Years later, when I visited Bern, I walked the same streets he walked. I climbed the narrow staircase to his tiny apartment. I touched the desk where he kept his papers — the desk he jokingly called "the physics department."

Then, without thinking, I went to a corner, sat down on the floor, closed my eyes, and simply existed.

For a moment, I felt as if we were breathing the same air, as if the walls remembered him and welcomed me.

Outside that same window, Einstein once watched a window cleaner suspended from a rope and suddenly had what he later called "the happiest thought of my life":

What if someone were falling freely? Would they feel gravity at all?

That thought became general relativity.

Visiting his home was not tourism.

It was a pilgrimage.

Carl Sagan — The Voice in My Ear

Carl Sagan has touched my life more than any person I never met.

His voice shaped my relationship with the cosmos — not only as a science communicator, but as a human being. He taught me that astronomy is not just about stars.

It is about connection.

Once, in Botswana, I spent days with the San people, one of humanity's oldest cultures, living in the Kalahari Desert. Their language is full of clicks. We spoke without words, and yet we understood each other perfectly.

They taught me how to make fire by friction.

A city boy, on his knees, creating fire with his bare hands.

And guess what?

I succeeded.

Months later, while watching one of Carl Sagan's lectures, I discovered that he had visited the same people, on the same land, and with the same sense of wonder.

I felt an invisible thread connecting us.

Swedish autumn is beautiful, and I often take long evening walks. Sometimes, during those walks, I feel as though Carl Sagan is walking beside me. In those moments, it feels as if he answers — not in words, but in feeling.

Once, in my imagination, we held hands while walking beneath the autumn leaves, listening to their gentle crunch under our feet.

I said,

"You speak, and I will listen."

He said,

"No.

You speak.

I will listen."

Years later, at the MUDIC Science Museum in Spain, after spending the day showing children the Sun through a telescope, a young guide smiled and said:

"You look like Carl Sagan.

You speak like Carl Sagan.

It feels as if Carl Sagan visited us today."

I drove home glowing with pride.

Abdus Salam — The Handshake That Changed Everything

He is the only giant I have actually met.

Professor Abdus Salam — Nobel laureate, theoretical physicist, and the first scientist from Pakistan to receive the Nobel Prize.

I was a new student at Stockholm University, a foreigner with barely enough money for food, let alone proper winter clothes. I had paid most of my expenses in advance before coming to Sweden.

That year, students were randomly selected to attend the Nobel ceremony.

Somehow — miraculously — I received an invitation.

After the ceremony at the Concert Hall, I saw him outside waiting for a car.

Tall, dignified, dressed in traditional Pakistani clothing and a turban.

I walked toward him nervously, introduced myself, and extended my hand.

He took my hand in both of his —
and held it.

No rush.

No pretense.

Just presence.

We spoke briefly, not about physics, but about life.

He invited me to join him in the VIP lounge at the airport so we could continue talking.

And I couldn't go.

I had no winter shoes.

I had borrowed a woman's winter coat because I couldn't afford one of my own.

And a taxi to the airport was unimaginable.

I still think about that moment —

not with regret,

but with gratitude.

Those few minutes were enough to change my life.

A great man spoke to me as an equal.

A giant looked into my eyes,

not over my head.

The Giants Within

These three men — Einstein, Sagan, and Salam — are not just names in history to me.

They are part of me.

Einstein taught me to imagine.

Sagan taught me to feel wonder.

Salam taught me humility.

When I teach students or speak to strangers through a telescope on a cold night, perhaps something of them speaks through me.

When I daydream about light, walk beneath autumn leaves, or hold a stranger's hand while guiding them toward a distant galaxy, perhaps I am borrowing the best parts of all three.

I never walked alone.

I walked with giants.

14 - Black Holes: Where the Universe Breaks Its Own Rules

Every black hole begins with a star.

Not a gentle star like our Sun, but a giant — a star so massive that it burns with extraordinary intensity for millions of years, holding itself up against its own gravity. Inside its core, nuclear fusion pushes outward, balancing the inward pull of gravity.

That outward pressure is all that keeps the star from collapsing.

But there comes a moment when the fuel runs out.

And when it does, gravity wins.

In an instant, the core collapses, and the outer layers rebound in one of the most violent events in nature — a supernova.

For a brief moment, that dying star can shine brighter than an entire galaxy.

What happens next depends on the mass of the leftover core.

If it is small enough, it becomes a quiet, cooling white dwarf.

A bit more massive, and the collapse forces electrons and protons together to form neutrons, creating a neutron star — so dense that a teaspoonful of its material would outweigh a mountain.

But if the core exceeds a certain limit, something far more dramatic unfolds.

Gravity becomes unstoppable.

It collapses beyond atoms.

Beyond the familiar structure of matter.

Beyond the imagination of physics.

A black hole is born.

One of my favorite stories in all of astronomy begins not in a laboratory, but aboard a ship.

A 19-year-old student named Subrahmanyan Chandrasekhar traveled from India to England carrying little more than notebooks and a pencil.

During the voyage, surrounded by nothing but the sea, he calculated that there must be a maximum mass a star can have before gravity crushes it beyond salvation.

That limit — now known as the Chandrasekhar limit — is about 1.4 times the mass of our Sun.

Above it, collapse becomes inevitable.

When I first learned that a teenager had discovered the boundary between survival and collapse while crossing an ocean, I smiled.

The universe reveals itself not to the powerful,
but to the curious.

But what is a black hole, really?

It is not an object in the usual sense.

There is no surface.

No shell.

No solid form waiting in the darkness.

A black hole is a region where spacetime itself curves inward so severely that the escape velocity exceeds the speed of light.

Around it lies the event horizon —
the ultimate one-way door.

Cross it, and you can go in,
but never return.

Time behaves strangely near a black hole.

If you watched someone falling toward one, you would see their motion slow down, their image freeze, and gradually fade away, as though time itself were hesitating.

But from their own perspective, nothing unusual happens.

They simply continue inward, unaware of the exact moment they crossed the point of no return.

Inside, gravity stretches objects in a process that astrophysicists — with dark humor — call spaghettification.

And deeper still lies something that makes even scientists uncomfortable:
The singularity.

A place where density appears to become infinite and our laws of physics break down.

It is the edge of knowledge.

The place where the universe seems to whisper:

"Not yet."

For decades, black holes existed only on paper — elegant, terrifying mathematics without direct evidence that they were real.

Then we began to see their fingerprints.

Stars orbiting invisible masses.

X-rays emitted by matter spiraling into darkness.

And in 2015, the LIGO observatories detected gravitational waves for the first time — ripples in spacetime produced by colliding black holes.

Then, in 2019, humanity captured the first image of a black hole's shadow.

And in 2022, we photographed the supermassive black hole at the center of our own galaxy.

And yes, when I say "we," I mean humanity.

Exactly as we say,

"We walked on the Moon."

It felt like looking into the universe's eye —

and realizing that the universe was looking back.

But the story grows stranger.

At the centers of galaxies, including our own Milky Way, reside giants — supermassive black holes millions or even billions of times more massive than the Sun.

They influence star formation.

They shape galaxies.

And when actively feeding, they become quasars, launching jets across space at nearly the speed of light and shining brighter than entire galaxies.

There is something wonderfully ironic about that.

The darkest places in the universe can outshine everything else.

Yet black holes do not merely destroy.

They sculpt.

They regulate.

They influence the birth and death of stars.

They help galaxies evolve.

Without black holes, galaxies — and perhaps life itself — might not exist.

And then comes the deepest mystery of all.

What happens to information?

Quantum mechanics tells us that information can never truly be destroyed.

General relativity seems to say that a black hole swallows it forever.

Both theories are among humanity's greatest triumphs.
Yet they cannot both be completely right.
Stephen Hawking showed that black holes are not entirely black.
They slowly radiate energy and eventually evaporate.
But if the black hole disappears —
where does the information go?
Some physicists think it remains encoded on the event horizon.
Others believe it escapes within Hawking radiation.
And a few dare to imagine that nature stores information in ways we
have not yet conceived.
Black holes are not merely astrophysical objects.
They are questions.
They remind us that the universe still keeps secrets.
That humility is necessary.
That mystery is healthy.
Black holes are where knowledge ends and wonder begins.
That thought has kept me awake many nights.
When we point our telescopes toward the heart of our galaxy, we are not
merely observing physics.
We are touching the edge of reality —
and asking it to reveal more.
And perhaps that is the lesson black holes offer us:
There is still so much left to learn.
Keep looking.
Stay curious.

15 - Hawking Radiation: When Darkness Learns to Let Go

Black holes fascinate me.

They feel like the universe's final answer — the place where everything ends. A star collapses, space folds, time slows, and beyond that invisible boundary called the event horizon...

nothing returns.

Light disappears.

Information vanishes.

Even imagination hesitates.

For the longest time, scientists believed that a black hole was the ultimate one-way door.

And then along came Stephen Hawking, one of my many heroes.

In 1974, using nothing but mathematics, his extraordinary mind, and the courage to challenge accepted ideas, Hawking discovered something astonishing:

Black holes are not entirely black.

They glow.

That idea changed everything we thought we knew about the universe.

To understand Hawking's insight, we need to imagine something surprising:

Empty space is not empty.

Quantum mechanics tells us that even the quietest vacuum is seething with activity. The universe is never perfectly still. Tiny particle-antiparticle pairs appear and disappear constantly, borrowing energy from the quantum vacuum and then giving it back.

They emerge like sparks from nothing —
and vanish just as quickly.

It is a delicate dance:

Appear together.

Disappear together.

But near a black hole, that dance can be interrupted.

Imagine a pair of particles appearing just outside the event horizon. Normally, they would reunite and disappear.

But here — in the strongest gravitational fields in the cosmos — gravity can separate them.

One falls inward.

The other escapes into the universe as real radiation.

One partner is lost to the darkness.

The other becomes light.

That escaping particle is Hawking radiation.

It is not something climbing out of the black hole.

It is something born just outside it —

at the border between the known and the unknowable.

Every time a particle escapes, the black hole pays for it by losing a tiny amount of mass.

It shrinks.

Slowly.

Patiently.

Relentlessly.

Black holes can evaporate.

Even the universe's most powerful prisons have an exit clause.

There is another beautiful layer to this story — something called the Compton wavelength.

I like to think of it as a whisper from quantum physics saying:

"You cannot trap me forever."

The Compton wavelength tells us the scale below which quantum uncertainty becomes important. Near a black hole, in a tiny region just outside the event horizon, quantum fluctuations become part of the story.

Quantum mechanics tries to create.

Gravity tries to separate.

And the black hole is forced to surrender a little piece of itself.

That is Hawking radiation.

What I love most about this idea is not only the physics.

It is the poetry.

The darkest objects in the universe —

places where not even light can escape —

still emit a faint glow of radiation.

Even a black hole cannot hold on to everything forever.
Even the universe's strongest grip must eventually learn to let go.
There is a quiet lesson in that.
Hawking showed us that black holes are not the eternal prisons we once imagined.
They are temporary.
They fade.
They slowly return what they have taken.
Light finds a way back into the universe.
And for me, that is deeply human.
Because somewhere in that faint whisper of radiation coming from the edge of spacetime is a reminder that nothing is permanent.
Not stars.
Not black holes.
Not even darkness.
And perhaps that is why I find hope in Hawking's idea.
Because even in the deepest darkness,
there is always a path toward light.

16 - Life in the Universe: Are We Alone?

Every time I look up at the night sky, the same quiet question rises inside me — a question I think has lived within human beings since the first time we became aware of ourselves:

Are we alone?

Not alone as in lonely, but alone as in unique.

Alone as in...

is there anyone out there who also wonders?

When I lie beneath a dark sky, far from cities and noise, I feel the universe becoming very close.

One of my most unforgettable experiences happened in Australia, when I traveled to see Uluru — Ayers Rock — a magnificent formation almost 500 million years old.

My guide had arranged a tent with a comfortable bed, but he offered me another choice.

I could sleep inside the tent,

or I could borrow his swag — a traditional Australian canvas sleeping bag — and sleep beneath the stars.

There was no decision to make.

I chose the swag.

For three nights I barely slept.

Not because I was uncomfortable —

but because I was overwhelmed.

The sky was completely different from the one I knew in Sweden.

The Southern Cross was easy to recognize.

So were the Large and Small Magellanic Clouds.

Everything else was a mystery.

Never before had I seen so many stars.

The cosmos felt close.

I felt part of it.

I thanked my guide for lending me his swag.

The stars do not merely shine.

They whisper.

And in those whispers, I imagine the possibility that somewhere, around another star, someone is looking back —

wondering the same thing.

Life on Earth is astonishingly resilient.

It refuses to give up.

We find it clinging to volcanic vents deep beneath the oceans, frozen inside Antarctic ice, and floating high in the atmosphere.

Wherever there is liquid water, life tries.

It adapts.

It persists.

And that tells us something extraordinary:

Life does not require perfection.

It requires opportunity.

Hydrogen, the simplest element, is the most abundant in the universe.

Oxygen, the third most abundant, combines with hydrogen to form water.

If water forms naturally, and life appears wherever water persists, then the universe may be far more welcoming to life than we once imagined.

The ingredients are everywhere.

Astronomers have found amino acids in meteorites.

Organic molecules drift between the stars.

Carbon chemistry — the chemistry of life — exists throughout the cosmos.

For centuries, we believed Earth was special.

Now we understand that Earth may be fortunate —

but not unique.

And then came the revolution.

For most of human history, we knew only one planetary system:

our own.

Then, in 1995, astronomers discovered the first planet orbiting a Sun-like star.

Today, we know of thousands.

And we now believe that nearly every star has planets.

Many are rocky.

Some orbit at just the right distance from their stars, where liquid water might exist.

The universe did not make just one Earth.

It made many attempts.

And perhaps the greatest surprise of all is this:

The most promising places for life may not even be planets.

Europa, one of Jupiter's moons, hides an ocean beneath its icy surface containing more water than all of Earth's oceans combined.

Enceladus, a moon of Saturn, sprays water and organic molecules into space.

Titan possesses lakes — not of water, but of liquid methane — beneath a thick and fascinating atmosphere.

Life does not require blue skies or warm beaches.

It requires chemistry,

energy,

and time.

On Earth, once conditions became favorable, life appeared surprisingly quickly.

Simple molecules became amino acids.

Amino acids became proteins.

Proteins became cells.

Cells became organisms.

It was not magic.

It was chemistry obeying the laws of physics.

And if life emerged here as soon as it could...

why not elsewhere?

To help us think about this question, astronomer Frank Drake proposed a famous equation — not to solve the mystery, but to organize our thinking.

Stars must form.

Planets must exist.

Life must emerge.

Intelligence must evolve.

Civilizations must survive long enough to communicate.

For the first steps, we now have numbers rather than guesses.

Stars are everywhere.
Planets are everywhere.
Water is everywhere.
Organic chemistry is everywhere.
And yet...
The universe remains silent.
No signals.
No messages.
Nothing that unmistakably says:
"We are here."
This silence is known as the Fermi Paradox:
"If life should be everywhere, where is everybody?"
Perhaps life is common, but intelligence is rare.
Or intelligence is common, but wisdom is rare.
Or perhaps civilizations exist, but the distances are too vast and time too short for our paths to cross.
Sometimes, after a lecture, when everyone has gone home and the telescope stands quietly beside me, I remain there for a while.
Alone with the stars.
I let that silence wash over me.
And in those moments, I feel something like longing —
but also a deep peace.
Because here is a thought that has changed how I see everything:
Maybe we are early.
Perhaps the universe is still young.
Galaxies are still forming.
Stars are still being born.
And we may be among the first sparks of consciousness.
Perhaps others exist, but they have not yet learned to speak across the stars.
We are not waiting for someone to talk to us.
We are waiting for someone to arrive.
And then another thought follows —

even more humbling.
If life is rare,
if intelligence is fragile,
then we carry a responsibility unlike any other species we know.
To protect this Pale Blue Dot.
To preserve the miracle of consciousness.
To ensure that life —
this universe trying to understand itself —
survives.
When we search for life elsewhere, we discover something about
ourselves.
We were born curious.
We need to ask.
We need to wonder.
We are not separate from the universe.
We are the universe becoming aware of its own existence.
The atoms in our bodies were forged inside ancient stars.
The iron in our blood was once part of a supernova.
The calcium in our bones once drifted through space as cosmic dust.
We are stardust learning to look back at the stars.
As Lawrence Krauss once said,
many stars had to die
so that we could shine.
And somewhere, perhaps far beyond our reach, another being may one
day look up at its own night sky and feel the same longing.
The same question.
The same wonder.
Are we alone?
For now,
the universe answers with silence.
But silence is not emptiness.
Silence is possibility.
And until we know the truth,

we keep looking.
Because looking,
searching,
dreaming —
is what makes us human.

17 - Journey to Mars: The Journey Starts on Earth

Human beings have always walked toward the unknown.

Long before rockets, satellites, or space programs, we built courage. We crossed oceans in fragile boats with no guarantee of land on the other side. We climbed mountains simply because they existed.

When we went to the Moon, we did not do it purely for science. The Cold War and the rivalry between two superpowers played an important role. But perhaps something deeper was also at work.

We are the kind of species that looks up and whispers,

Why not?

Now our gaze has shifted again.

To Mars.

Engineers sketch designs for habitats.

Rockets rise on pillars of fire.

For the first time in history, the idea of setting foot on another planet no longer feels like fantasy.

It feels like a countdown.

And yet, whenever I talk about Mars, another question rises quietly inside me:

Should we go?

Getting to Mars is not the hardest part.

Becoming a species that deserves to go —
that is the real challenge.

To reach Mars, astronauts must travel for six to nine months inside a spacecraft smaller than most living rooms.

Radiation will attack their DNA.

Microgravity will weaken their bones, their muscles, and even their hearts.

If something breaks, there is no rescue mission.

Only silence.

And even if they arrive safely, Mars will not welcome them.

There is almost no air to breathe.

Almost no atmospheric pressure.

Almost no magnetic field to shield them from radiation.

Temperatures can fall below -90°C .

Dust storms can engulf the entire planet for weeks, turning day into rust-colored twilight.

And yet —

we are making progress.

We have already produced oxygen from the Martian atmosphere.

We know how to extract water from buried ice.

We are learning how to build shelters from Martian soil.

Technically, we are getting closer every year.

But the greatest barrier has never been technology.

The greatest barrier is us.

Human history is filled with exploration.

But it is also filled with conquest.

We claimed lands already inhabited.

We justified exploitation with the language of discovery.

We extracted resources not because we needed them, but because we could.

We turned fellow human beings into property.

We drew borders and defended them with weapons.

And we often confused power with greatness.

Do we really believe that traveling to Mars will automatically make us wiser?

Mars will not save us from ourselves.

If we carry the same greed and entitlement with us —

if we see Mars as something to conquer rather than something to understand —

then we will simply repeat our history on another world.

There will be new borders.

New conflicts.

New forms of exploitation.

Sometimes people say,

"We need Mars because we are destroying Earth."

But what does that say about us?

That our answer to damaging our planet is not to change —

but to leave?

Carl Sagan once looked at a photograph taken by Voyager 1.

Earth, seen from billions of kilometers away.

A tiny pixel suspended in a sunbeam.

He called it the Pale Blue Dot.

From that distance, there are no countries.

No borders.

No us and them.

Just one world.

Fragile.

Finite.

Irreplaceable.

I simply call it home.

If you stood on Mars and looked back at Earth,

you could hide our entire world behind your thumb.

That is how small we are.

And yet, how enormous the responsibility resting upon our shoulders.

Maybe the real purpose of going to Mars is not escape.

Maybe it is perspective.

Maybe Mars is the mirror in which we finally see ourselves clearly.

If traveling to Mars teaches us humility...

If it teaches us to use resources wisely...

If it teaches us to protect the world that gave us life...

Then it will be a journey worth taking.

But if we go to Mars without learning those lessons,

then Mars will simply inherit our mistakes.

The hardest distance to cross is not the 55 million kilometers between Earth and Mars.

It is the distance between who we are
and who we need to become.

One day, a human being will stand upon the red soil of Mars and look up
into the night sky.

They will see Earth —

a blue dot glowing quietly in the darkness.
And I hope — sincerely —
that instead of planting a flag,
they place a hand over their heart and whisper:
"We finally learned to care for the one home we were given."
Only then
will we truly deserve to explore others.

18 - The Future of the Universe: The Long Tomorrow

When we look up at the night sky, we are not seeing the universe as it is.

We are seeing it as it was.

Every star is a message from the past. Some of that light began its journey before humans existed, before Earth had oceans, before life itself.

It is easy to think of the universe as ancient and unchanging.

But it isn't.

It has a history, shaped by time, motion, and transformation.

And just as it has a past, it also has a future —

a long tomorrow.

We live at an interesting moment.

The universe is already 13.8 billion years old, yet we are still at the very beginning of its story.

If the entire lifetime of the cosmos were a book, humanity would appear somewhere in the opening sentences.

We arrived early enough to still see the nearby galaxies,
and late enough to understand what we are seeing.

And now we ask:

How will this story end?

For centuries, we imagined the universe as eternal and unchanging.

Then, in 1929, Edwin Hubble — who in his younger days was a boxer, then a lawyer, before finally finding his way into astronomy — discovered something extraordinary.

Galaxies are rushing away from one another, not because we occupy a special place in the universe, but because space itself is expanding.

The distances between galaxies are growing, like dots painted on the surface of an inflating balloon.

For decades, scientists assumed that gravity would eventually slow that expansion.

Perhaps, we thought, gravity might one day halt the expansion and reverse it, causing the universe to collapse inward in a final event called the Big Crunch.

But the universe had a surprise waiting for us.

In the late 1990s, astronomers studying distant supernovae discovered something no one expected.

The expansion of the universe is not slowing down.

It is accelerating.

Something unseen —

something mysterious —

is pushing space apart faster and faster.

We call it dark energy.

But the name is really a confession:

We do not know what it is.

With that discovery, our picture of the future changed.

Instead of collapsing, the universe appears to be heading toward stillness, emptiness, and silence —

a future often called the Big Freeze.

It sounds dramatic.

But the process is unimaginably slow.

Gentle.

Almost graceful.

Stars will continue shining for trillions of years, but one by one they will exhaust their fuel.

New stars will continue to form for a very long time, but eventually even that process will cease.

Galaxies will drift so far apart that their light will no longer reach one another.

Black holes — once the monsters of the universe — will slowly evaporate through Hawking radiation and eventually disappear.

And over unimaginable stretches of time, even protons themselves may decay, leaving behind little more than a faint sea of radiation in an ever-expanding darkness.

A universe that began in brilliance
may end in silence.

Sometimes when I describe this to students, the room becomes very still.

Someone will quietly whisper,

“That’s sad.”

And I understand.

The idea of a universe without stars feels like a story without a final page.

But I always remind them:

This is not a story about loss.

It is a story about transformation.

Whenever I think about it, I feel a moment of silence inside myself.

Not sadness exactly.

But awe.

We often think of endings as tragedies.

Yet the universe teaches something different.

Transformation is not loss.

It is the nature of existence.

The carbon in your cells and the iron in your blood were forged inside stars that lived and died long before the Sun was born.

One day, those atoms will return to the cosmos.

Nothing truly stands still.

Everything changes form.

In that sense, the future of the universe is not a story of fading,
but of continuation.

Matter becomes energy.

Energy changes form.

And we —

for just a moment —

are the universe becoming aware of itself.

We are temporary,

but our curiosity is not.

We are fragile,

but our wonder is vast.

When we look up at the night sky, we are not merely witnessing the universe's past.

We are participating in its future.

We are part of its story.

Perhaps that is the most beautiful thought of all.

Long after the last star has faded,
the universe will still carry the memory of having once contained beings
who looked up,
wondered,
and tried to understand.
And maybe that is our role in the universe:
to notice it,
to love it,
and to learn from it while we can.
And perhaps that is what gives the universe meaning.
Not how long it lasts.
But that,
for one brief and beautiful moment,
it was awake.

19 - The Nobel Prize: Legacy, Inspiration, and Imperfection

Science is a human story.

It is the story of people who look at the world, feel a question growing inside them, and decide to follow that question wherever it leads.

Sometimes it leads to a new understanding of nature.

Sometimes it changes everything we thought we knew about the universe.

Over the years, humanity has tried to honor those moments of discovery.

We celebrate the people whose work expands our knowledge and improves our lives.

And no award has become more symbolic of that recognition than the Nobel Prize.

For many, the Nobel Prize represents the ultimate acknowledgment — a moment when the world pauses and listens to a scientist, a writer, or a peacemaker.

It carries a weight unlike any other award.

But like all things created by human beings, its history contains brilliance and flaws, triumphs and controversies.

The Nobel Prize is not only a celebration of achievement.

It is also a reflection of who we are.

The Legacy of Alfred Nobel

To understand the significance of the prize, we must begin with its creator.

Alfred Nobel was a chemist, inventor, businessman — and a man troubled by the legacy he might leave behind.

When his brother died, a French newspaper mistakenly published Alfred Nobel's obituary instead.

Its headline read:

"The merchant of death is dead."

He was condemned for inventing dynamite and accused of profiting from destruction.

Nobel read his own obituary and was deeply shaken.

He decided he did not want to be remembered for weapons.

He wanted to be remembered for uplifting humanity.

So in his will, he instructed that his fortune be used to reward those who had "conferred the greatest benefit to humankind" in physics, chemistry, medicine, literature, and peace.

It was a profoundly human decision —

a desire to rewrite the story of his life.

The Nobel Prize was born from a wish to turn darkness into light.

The Nobel Prize and the Universe

In physics, chemistry, and medicine, the Nobel Prize has honored discoveries that transformed our understanding of existence.

Astronomy has a particularly close relationship with the Nobel legacy.

Among the discoveries recognized are:

- The discovery of the Cosmic Microwave Background — evidence for the Big Bang.
- The detection of neutrinos, revealing how stars generate energy.
- The first observation of gravitational waves — a new way of listening to the universe.
- The study of black holes, both theoretical and observational.
- The discovery of the accelerating expansion of the universe, revealing dark energy.

These awards did more than honor individuals.

They brought cosmic discoveries into public consciousness.

Suddenly, people everywhere were talking about black holes, dark matter, and the age of the universe.

The Nobel Prize often acts as a bridge between science and society.

It symbolizes something larger:

the idea that a single human being can reshape our understanding of reality.

Every December, in my hometown Stockholm, when winter softens the streets and snow quiets the city, something extraordinary happens.

Inside the golden light of the Concert Hall, the world pauses —

not to celebrate wealth or status,

but to celebrate ideas.

Ideas that changed us.

Ideas that stretched the limits of human imagination.

Einstein.

Curie.

Bohr.

Mandela.

King.

Malala.

Names that remind us of the best we can be.

The Nobel Prize is more than a ceremony.

It is a message.

Knowledge matters.

Compassion matters.

Courage matters.

At its best, the Nobel Prize is a lighthouse —

illuminating a future where human brilliance serves human good.

But this shining legacy is only one side of the story.

Because wherever human beings gather,

imperfection follows.

Lise Meitner — The Woman the Nobel Forgot

Some names are absent from the Nobel archives for reasons that have nothing to do with merit.

Lise Meitner was an Austrian-Swedish physicist who helped explain nuclear fission — a discovery that changed science and history.

Otto Hahn performed the chemical experiments, but when the results made little sense, it was Meitner who solved the puzzle.

It was Meitner who, together with her nephew Otto Frisch, explained the released energy using Einstein's equation, $E = mc^2$.

It was Meitner and Frisch who gave the process its name:

fission.

And then her name disappeared.

When Nazi Germany expelled Jewish scientists, Meitner was forced to flee.

Carrying only a handbag and a small suitcase, she escaped across the border and eventually found refuge in Sweden —

stateless,

isolated,

and separated from the work she loved.

People who remembered her in Lysekil spoke of a solitary woman walking through the snow, carrying the weight of a discovery the world had failed to recognize.

In 1944, the Nobel Prize in Chemistry was awarded.

It went only to Otto Hahn.

Lise Meitner had been nominated forty-nine times.

She gave humanity the understanding of fission.

Humanity answered with silence.

Perhaps the snow of Lysekil remembers what Stockholm forgot.

The Peace Prize Dilemma — When Hope Receives a Prize

Peace is fragile, political, and deeply subjective.

Unlike the scientific prizes, where discoveries are measured by experiments and evidence, peace is judged through human values, hopes, and interpretations.

Over the years, the Peace Prize has honored remarkable achievements.

Yet some decisions have sparked debate.

Sometimes awards have been given more for hope than for proven accomplishment.

Some laureates later disappointed the world.

Others who changed the course of peace were overlooked.

This is not a criticism of peace itself.

It is simply a recognition that peace cannot be measured with the same precision as the mass of a neutrino or the spin of a pulsar.

Scientific discoveries do not change because opinions change.

Human beings do.

Hope is beautiful.

But hope alone is not peace.

The Literature Prize — A Window Too Narrow

The Nobel Prize in Literature seeks to honor the voice of humanity.

Yet for many decades, that voice reflected mainly one part of humanity.

European languages.

European traditions.

European perspectives.

Many extraordinary writers from Africa, Asia, Latin America, and the Middle East waited outside that window.

Not because they lacked brilliance,

but because institutions, like people, sometimes see the world through narrow lenses.

Then came scandals.

Conflicts of interest.

Leaks.

Failures of trust.

The institution entrusted with protecting literature discovered that it, too, was vulnerable.

A great prize should not only recognize excellence.

It should also embrace diversity.

The Economics Prize — The Nobel That Isn't

Few people realize this:

The Nobel Prize in Economic Sciences is not one of the original prizes established by Alfred Nobel.

It was created in 1968 by Sweden's central bank —
seventy-two years after Nobel's death.

Its official title is:

"The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel."

This raises an interesting question.

If economics was added later,

why not psychology?

Why not climate science?

Why not geology,

sociology,

or architecture?

Returning to Alfred Nobel's original vision would not diminish the Economics Prize.

It would simply clarify it.

Prestige should come from excellence —
not merely from association.

And perhaps that is the deeper lesson of the Nobel Prize.

Perfection is not what makes institutions great.

The willingness to recognize imperfections,
to learn from them,
and to move closer to justice —
that is greatness.

20 - The Universe Is Fair Even When We Are Not

People often ask:

"What matters more — recognition or discovery?"

The answer, to me, is simple:

The universe keeps perfect records.

Human institutions do not.

Committees may forget names.

Medals may go to the wrong people.

History may sometimes look the other way.

But the laws of nature never forget who revealed them.

A black hole does not care whose signature appeared on a paper.

A photon does not care whose name was omitted.

The universe rewards truth —
not applause.

Lise Meitner never received the Nobel Prize.

And yet, every time we split an atom,
every time a student learns her name,
every time her story inspires courage,
the universe remembers.

And so do I.

The Nobel Prize shines not because it is flawless,
but because every mistake teaches us humility
and pushes us a little closer to justice.

What truly matters
is not the applause that follows the work —
but the work itself.

Because long after medals have tarnished,
long after ceremonies have ended,
and long after names have faded from memory,
truth remains.

And the universe —

patient,
silent,
and impartial —
keeps perfect records.

21 - The Quiet Heroes of the Night Sky: Amateur Astronomers

Not every astronomer works in a mountaintop observatory. Not every discovery comes from a laboratory or from someone with a title, a grant, or a research team. Some of the most meaningful contributions to our understanding of the universe come from people standing alone in their backyards, on rooftops, or in open fields — people guided not by ambition or career, but by a quiet and unshakable love for the night sky.

I feel deeply connected to them.

I am one of them.

Long before astronomy became a profession, before satellites and computer models and billion-dollar telescopes, the sky belonged to ordinary people who simply couldn't stop looking up. They had no instruments except their eyes and their patience. They drew maps of the stars by hand, tracked the motions of planets, sketched Jupiter's bands and Saturn's rings, and carefully recorded the brightness of stars night after night.

They weren't trying to build a legacy.

They simply cared.

And in our modern age, that spirit has not disappeared.

It is still the amateurs who sometimes see things first.

The universe is too vast and too unpredictable for professionals to watch every corner of the sky. A supernova flares without warning. An asteroid passes silently. A star fades for reasons unknown.

And more often than people realize, the first alert to the scientific world comes not from a space agency, but from someone standing in a backyard.

One of them is my friend, Grzegorz Duszanowicz, a Swedish-Polish amateur astronomer. He built his own observatories — one in Sweden and another beneath the pristine skies of Namibia.

Not funded.

Not sponsored.

He simply built them because he wanted to see deeper.

From those observatories, he has discovered nine supernovae.

Nine exploding stars, discovered not by NASA or the European Southern Observatory, but by someone who still calls himself an amateur.

When people ask him why he does it, he smiles and says:

"Because I love the sky."

Professionals expand knowledge.

Amateurs expand wonder.

I remember one day when wonder pulled me into the heart of Stockholm.

Completely spontaneously, I carried my refractor telescope onto the subway and brought it to Sergels torg, the busiest square in the city. I set it up and pointed it at the Moon.

No signs.

No announcements.

Then I stepped aside.

Within minutes, people began gathering.

Businessmen in suits.

Teenagers with skateboards.

Mothers with strollers.

Elderly couples holding hands.

Everyone patiently waiting for a turn to look into the unknown.

And my greatest fear that day wasn't that someone might steal the telescope.

It was much more practical:

What would I do if I suddenly needed to go to the bathroom?

For two hours, I watched the same reaction unfold again and again.

A person would bend down, look through the eyepiece, inhale sharply, and whisper:

"Wow..."

Adults became children again.

Children jumped with excitement.

Even police officers stopped, looked through the telescope, smiled, and quietly disappeared back into the crowd.

Nobody cared about my name.

Nobody cared about my credentials.

All they cared about was what they saw.

A Moon filled with mountains and craters.

A universe suddenly personal and real.

That whisper —

"Wow..."

is where science begins.

Everything that has ever happened in science began with that sound.

Whenever I set up a telescope in a public place, I think of John Dobson.

A monk who built telescopes from scraps and wheeled them onto
sidewalks so strangers could see the Moon.

He believed the universe belonged to everyone.

Not only to those with access to observatories.

I knew him.

I even invited him to Sweden as a guest at one of the national astronomy
camps I helped organize.

When we discussed hotels, he said:

"I'd rather sleep on your sofa."

What a wonderful man.

Sadly, he passed away before he could make the journey.

And that is the truth about amateur astronomy.

We do not do it because we want to be first.

We do it because we want others to feel the same wonder we feel.

We buy our own equipment.

We lose sleep.

We freeze on winter nights.

Nobody asks us to do it.

Nobody pays us.

Nobody evaluates us.

We do it because we love the sky.

And because seeing someone else's eyes light up is worth every cold
night and every lost hour of sleep.

Professional astronomers push the boundaries of knowledge.

But amateurs do something equally important.

We remind people that the universe is not only something to be studied.

It is something to be felt.

And somewhere in that crowd —

perhaps a child who will one day become a scientist,

or an adult who forgot how to dream —

someone looks at the Moon,
or Saturn,
or a galaxy millions of light-years away,
and quietly whispers:
"Wow..."
And that is where astronomy truly begins.
Not in observatories.

22 - The Magic Age of Thirty: When Curiosity Outruns Experience

We tend to imagine that great breakthroughs are born from age and wisdom — that discovery is the reward of experience, patience, and long years of study.

But history tells a different story.

Many of the most revolutionary ideas in science did not come from grey hair or prestigious titles.

They came from youth.

From minds that had not yet learned what "cannot be done."

From people who approached the universe with the audacity of a question rather than the caution of an answer.

Before thirty, curiosity has not yet been fully restrained.

Confidence may be naïve —

but in the best possible way.

Unafraid.

Galileo, still in his twenties, was not trying to overturn two thousand years of accepted wisdom. He was simply curious enough to ask why falling objects behaved the way they did.

Curiosity made him dangerous to established ideas.

Galileo did not wait for permission to question.

He questioned because he could not help himself.

For that courage, he paid a heavy price. Tried by the Inquisition and condemned to house arrest for life, he reportedly murmured after his sentence:

"Eppur si muove."

"And yet it moves."

Isaac Newton was twenty-six when the plague closed Cambridge University and sent him back home.

While others hid from death, Newton sat beneath the trees and thought.

In little more than a year, he invented calculus, uncovered the laws of motion, imagined universal gravitation, and lit the fuse that would ignite modern science.

His greatest discoveries came not when he was famous,
but when he was young,

alone,

and free from expectations.

The pattern appears again and again.

Henrietta Swan Leavitt, hired merely to catalog stars, discovered the key to measuring cosmic distances.

Without her work, we would never have learned the true scale of the universe.

Blaise Pascal built the first mechanical calculator in his early twenties.

James Clerk Maxwell unified electricity, magnetism, and light before he was older than many students who now struggle to understand his equations.

Jocelyn Bell Burnell was only twenty-four when she noticed a strange repeating signal hidden in radio telescope data.

Others dismissed it as interference.

She persisted.

What she had discovered were pulsars —

the spinning lighthouses of dead stars.

Think of the courage in that moment:

a young woman pointing to something nobody had ever seen and insisting,

"This matters."

Ole Rømer, still in his twenties, dared to disagree with his powerful mentor Giovanni Cassini.

By studying the eclipses of Jupiter's moon Io, he noticed tiny delays that depended on Earth's distance from Jupiter.

From those few missing seconds, he reached an astonishing conclusion: light does not travel instantly.

Cassini rejected the idea.

But Rømer was right.

A young man measured the speed of light using nothing more than Jupiter, a notebook, and courage.

And then there is Subrahmanyan Chandrasekhar.

Nineteen years old.

Alone on a ship sailing from India to England.

While the ocean rolled beneath him, Chandrasekhar sat with pencil and paper and calculated the fate of dead stars.

His conclusion was extraordinary.
Above a certain mass, gravity becomes unstoppable.
Stars collapse into something far more extreme.
Today, we call them black holes.
Arthur Eddington, the most respected astronomer of the day, publicly dismissed the idea.
But Chandrasekhar refused to surrender.
Decades later, he received the Nobel Prize.
Today, astrophysicists speak his name with reverence.
A teenager on a ship corrected the world.
And then there was Einstein.
Working not in a university but in a patent office, he published four papers in one miraculous year when he was twenty-six.
One explained the photoelectric effect.
One proved the existence of atoms.
One introduced special relativity.
And then, almost casually, he wrote:
 $E = mc^2$.
Relativity was born not from authority,
but from imagination.
From a young man asking:
"What would I see if I rode on a beam of light?"
That is not a question of experience.
It is a question of wonder.
When I speak to students, I tell them:
Science is not a ladder you climb.
It is a window you open.
And sometimes the window opens most easily for those who have not yet been told that it is locked.
Experience is valuable.
It gives structure.
Discipline.
Refinement.

But wonder —
wonder is unstoppable.
The magic age of thirty is not really about a number.
It is about a mindset.
The willingness to challenge the obvious.
To upset the comfortable.
To be wrong without fear.
The universe has revealed many of its secrets to people who were too young to know they were supposed to be intimidated.
The world tells young people:
"You lack experience."
But the universe whispers:
"Good.
Experience often teaches limits."
As we grow older, we accumulate knowledge.
But sometimes we also accumulate hesitation.
We learn what is reasonable.
We learn what is expected.
And without realizing it, we stop asking the questions that only youth dares to ask.
The magic age of thirty is really an invitation.
An invitation to keep that daring part of ourselves alive.
To remain willing to say:
"I don't know...
yet."
Curiosity outruns experience whenever we allow ourselves to remain young in spirit —
unafraid of wonder,
unafraid of being wrong.
Reflection
If I could speak to every curious young person —
and to the younger person still living inside each of us —
I would say this:

Never trade your sense of wonder for the comfort of certainty.
Never let experience silence the part of you that still wants to ask
impossible questions.
The discoveries that shape our world rarely begin with someone saying,
"I know."
They begin with someone whispering,
"I wonder..."
The universe still has secrets.
And it is always willing to reveal them —
to those who remain young enough to ask.

23 - A Journey Without End

Every discovery we make about the universe opens a new question — a doorway into a larger horizon. The more we learn, the more we realize how much remains unknown. And perhaps that is the greatest beauty of astronomy: it never allows us to feel finished.

The universe does not hand us answers.

It invites us into a lifelong conversation.

There is always something more to see, something deeper to understand, some new wonder waiting just beyond the reach of our curiosity.

Astronomy has never been a destination.

It has always been a journey.

I often call myself a traveler — both around the globe and around the cosmos.

That journey began long before telescopes or satellites. It began when the first humans looked up at the night sky and felt something move inside them. They knew no mathematics, no physics, no theories. They had only their eyes and their wonder.

Wonder was their compass.

They traced patterns among the stars not because they understood them, but because they longed to understand. Perhaps the stars were also a gateway to understanding their gods and their place in the world.

Centuries later, Galileo pointed a handmade telescope toward Jupiter and noticed tiny moons circling it. In that moment, a curious young man looking through a piece of glass challenged thousands of years of certainty.

He wasn't trying to change the world.

He was simply curious.

And that curiosity changed the center of the universe — not the physical one, but the one inside the human mind.

Generation after generation has carried that same torch.

The Hubble Space Telescope showed us that our Milky Way is only one island in an ocean of galaxies.

Today, the James Webb Space Telescope is looking even farther back — almost to the dawn of the first stars.

We stand on the shoulders of those who looked up before us.

And one day, others will stand on ours.

We are not only travelers through space.

We are travelers through knowledge.
And this journey has no finish line.
For me, astronomy has always been more than science.
It has been a way of remaining curious.
It has taught me that wisdom does not begin with certainty.
It begins with the courage to say:
"I don't know — but I want to find out."
Every student, every amateur astronomer, every person who pauses
beneath the night sky becomes part of this silent classroom without walls.
We often speak of the universe as something distant — something "out
there."
But the universe is not separate from us.
It is within us.
The calcium in our bones, the iron in our blood, the oxygen we breathe
— all were forged inside stars that lived and died long before Earth
existed.
We are made of stardust.
We are not observers of the universe.
We are participants in it.
Once, while visiting CERN — the great laboratory where physicists
study the smallest building blocks of reality and where the Higgs boson
was discovered in 2012 — I found a T-shirt that made me laugh out loud.
It read:
"Person wearing this shirt is 13.8 billion years old."
Unfortunately, it was size XXL — three of me could have fit inside it.
But I loved the message.
We are not newcomers.
We are not outsiders.
Every atom in our bodies has traveled for 13.8 billion years to arrive at
this exact moment.
When we look up at the stars, we are looking at our own history written
across the sky.
People sometimes ask me:
"Will we ever reach the end of the universe?"
The answer is beautifully simple:

Probably not.

Because the universe is not something we travel through.

It is something we belong to.

Even if we mapped every galaxy and understood every law of physics,
new mysteries would appear.

That is the rhythm of discovery —

an endless dialogue between curiosity and the unknown.

The story never ends.

It only deepens.

Our exploration of the cosmos mirrors something deeply human:

the desire to go beyond what we know.

The first sailors who crossed unknown oceans, guided only by starlight,
were practicing astronomy in their own way.

The engineers designing spacecraft for Mars carry the same instinct.

Behind every great question lies the same emotion:

wonder.

And wonder belongs to everyone.

The universe does not care about titles, degrees, or professions.

It opens itself to anyone willing to look up and whisper:

"Wow."

You don't need a telescope.

You don't need equations.

You only need to care.

As long as there are eyes willing to look up,

as long as there are minds willing to question,

as long as there are hearts capable of wonder —

the journey will never end.

Because astronomy is not about reaching a destination.

It is about becoming someone different along the way —

more curious,

more humble,

more connected.

The universe is not something we conquer.

It is not something we complete.
It is something we learn to belong to.
And perhaps that is the greatest lesson of all:
we were never separate from the cosmos.
We were always part of it.
And somewhere, far in the future,
long after our names have been forgotten,
others will look up at the stars,
feel that same sense of wonder,
and continue the journey.
Because curiosity has no final chapter.
And neither does the universe.

24 - A Final Note Before You Look Up

I did not write this book to explain the universe.

I wrote it to share the feeling of standing beneath a dark sky and realizing that everything — every star, every galaxy, every atom in our bodies — is connected.

I wrote it for that quiet moment when a stranger looks through a telescope for the first time and whispers,

“Wow...”

Not because they learned something.

But because they remembered something.

Astronomy is not about information.

It is about perspective.

You don't need equations to feel wonder.

You don't need a telescope to feel small in the best possible way.

All you need is the willingness to look up.

I am not a professional astronomer.

I do not work in a great observatory, and I have never had research grants or laboratories.

I am simply someone who loves the sky so much that I cannot help sharing it.

Sometimes that means standing alone in a city square with a telescope, hoping that someone — anyone — will stop and take a look at the Moon.

And every time someone steps forward, bends down to the eyepiece, and suddenly becomes quiet, I am reminded why I do this.

The universe is not merely out there.

It is within us.

The atoms in your body have traveled for 13.8 billion years — from the birth of the universe, through the hearts of stars, and into the blood flowing through your veins.

You are not separate from the cosmos.

You are a continuation of it.

I hope this book does more than teach you something.

I hope it changes the way you feel when you look up.

I hope that the next time you stand beneath a clear night sky, you will pause for a moment and feel what generations before us have felt:

wonder.

Because the universe does not belong to scientists.

It does not belong to observatories or universities.

It belongs to everyone who looks up and asks,

"What is all this?"

And perhaps that is enough.

This is my universe.

Now,

make it yours.

And when you are finished reading,

do me one favor.

Step outside.

Look up.

And say hello to the stars for me.