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Study Guide for Protect the Planet!

Earth Science - Environmental Entertainment!

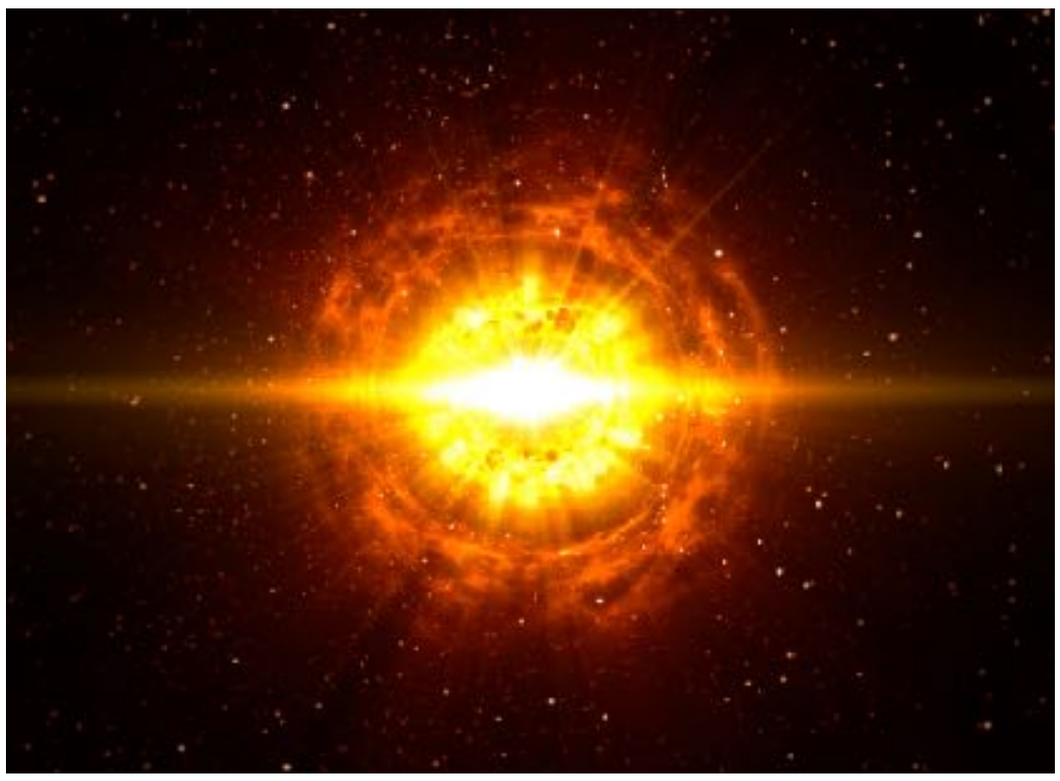
by Rob Thomas & Tanya Gerard, PTP Creators / Performers

Birth of the Universe

For thousands of years, humans have looked to the stars for guidance and insight to the world in which we live. In the last 100 years, we've had a series of breakthroughs in our understanding of the birth of the universe, the beginning of time, and where we came from.

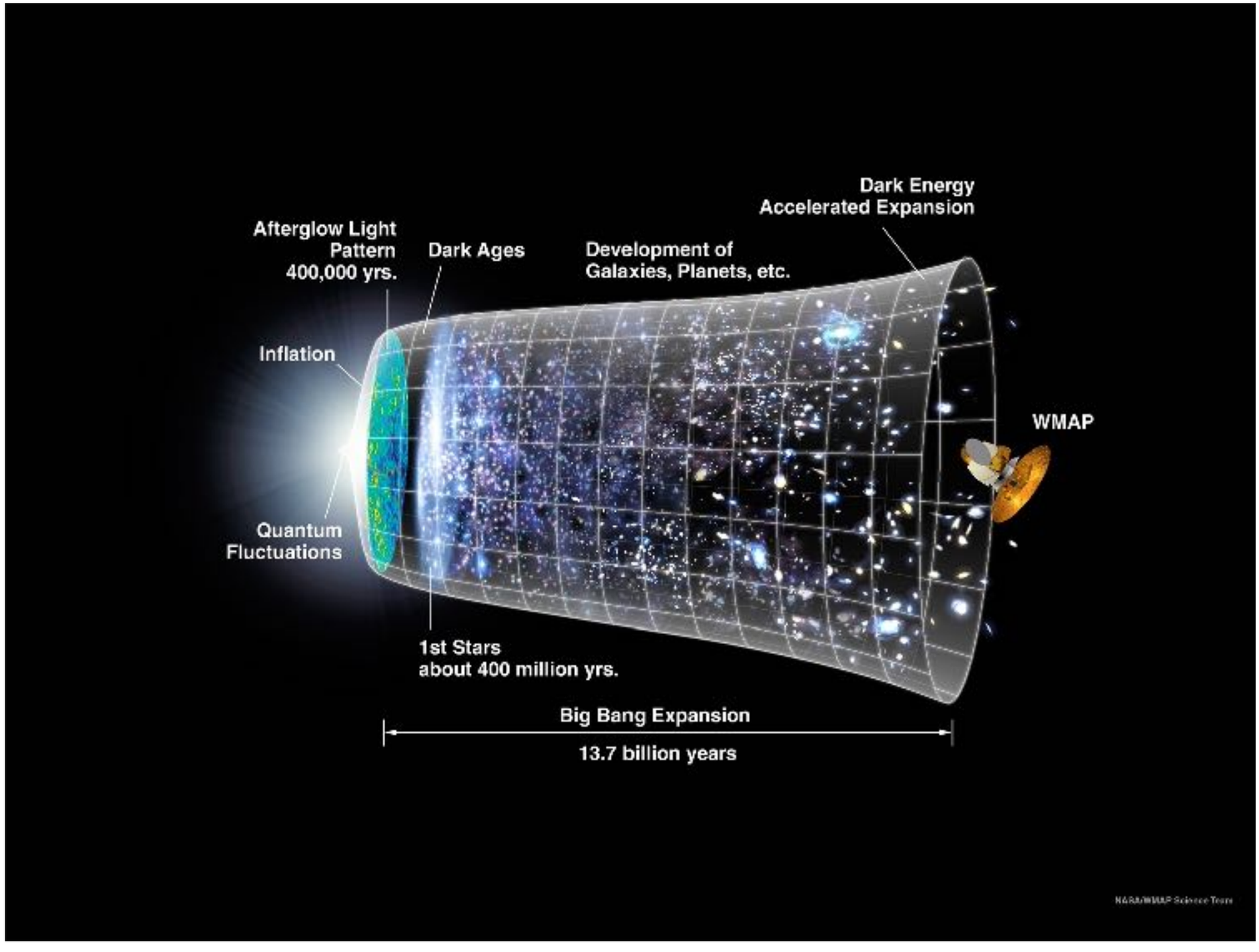
Birth of the Universe

Scientists now believe that our universe began 13.8 billion years ago, with one enormous explosion of energy and light, which we now call the Big Bang. It was an unimaginably hot, dense point.



Birth of the Universe

When the universe was just a hundredth of a billionth of a trillionth of a trillionth of a second in age — it experienced an incredible burst of expansion known as inflation, in which space itself expanded faster than the speed of light. This was the singular start to everything that exists - the beginning of the universe, the creation of space, and even the initial beginning of time itself.

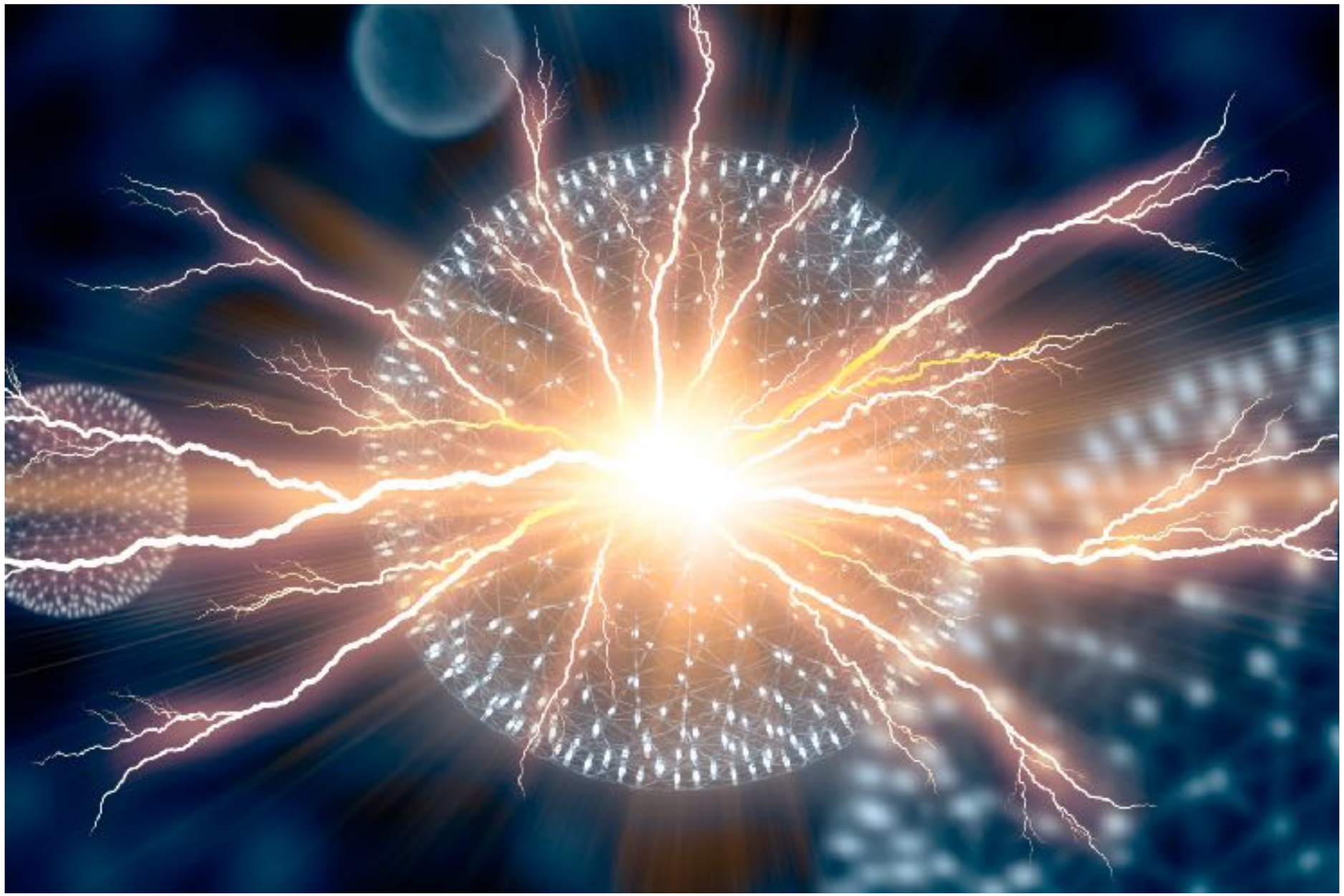


Birth of the Universe

Less than 15 minutes after the Big Bang- nuclear fusion took place that created hydrogen and helium the actual composition of stars. About 20 minutes after the big bang, the universe was no longer hot enough for nuclear fusion but far too hot for electrons to bond to atoms.

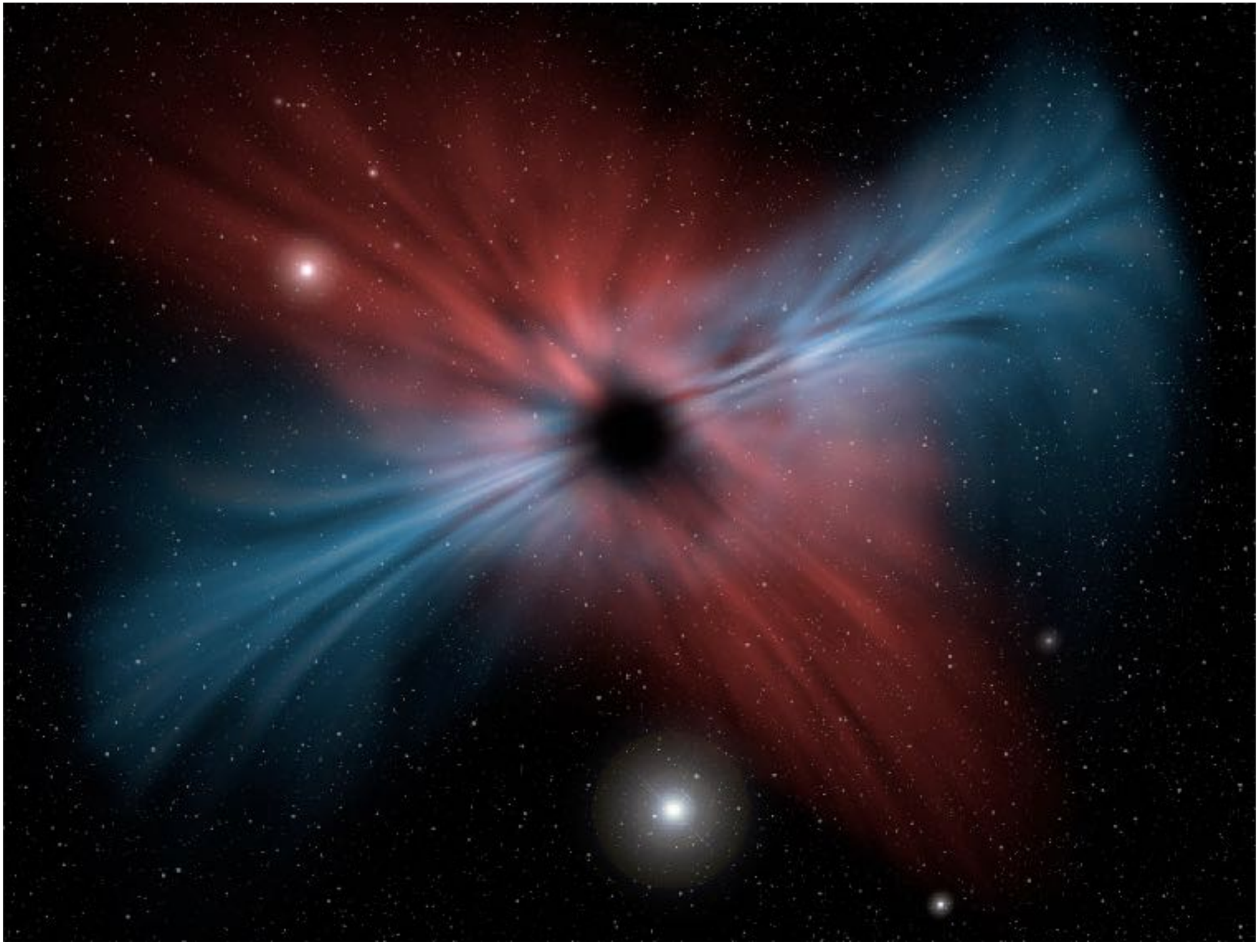
Birth of the Universe

(**Nuclear fusion** is the process of making a single heavy nucleus (part of an atom) from two lighter nuclei- the positively charged central core of an atom. This process is called a nuclear reaction and releases a large amount of energy)



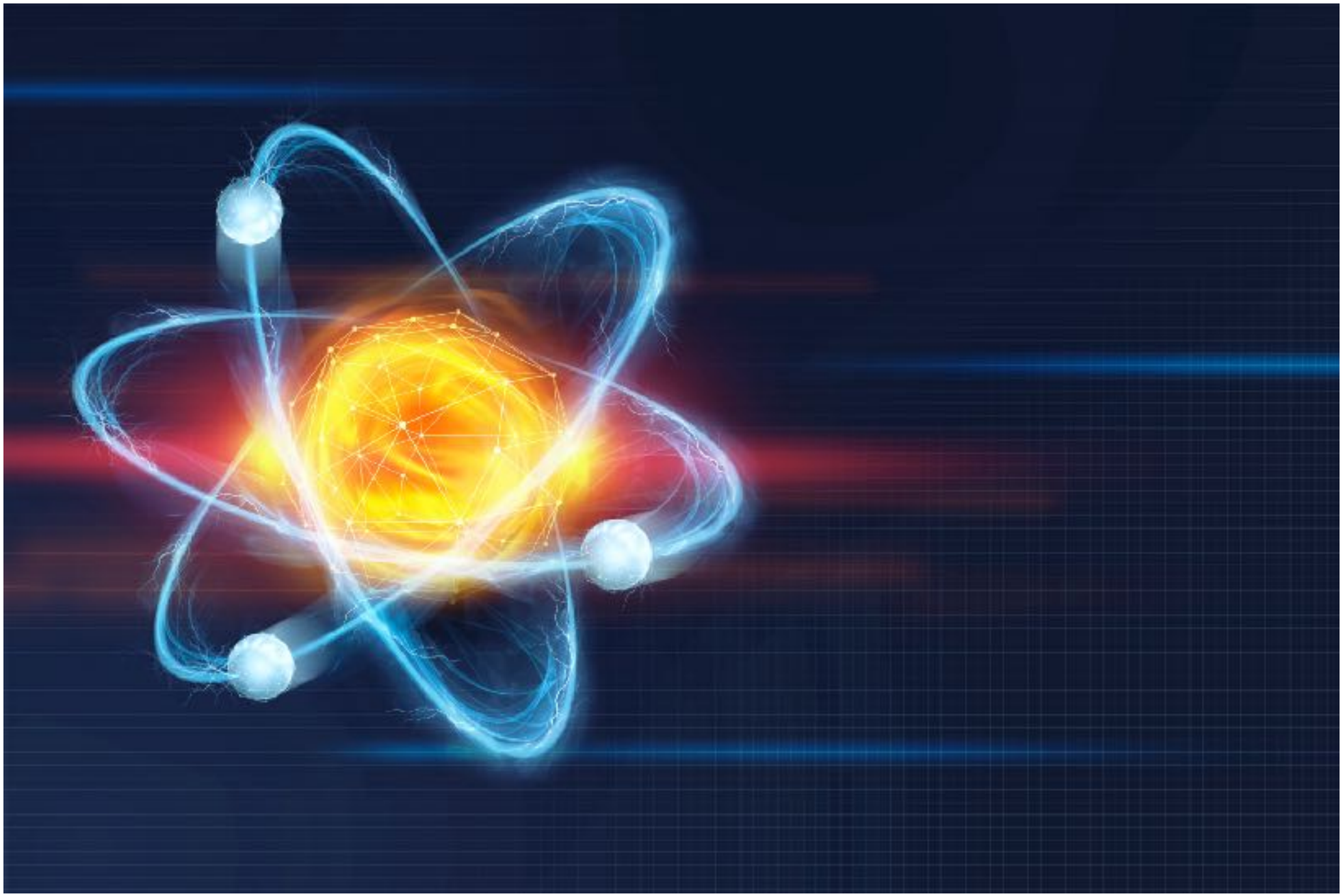
Birth of the Universe

According to NASA, after inflation, the growth of the universe continued, but at a slower rate. As space expanded, the universe cooled, allowing electrons to bond to atoms, and 200 million years later, matter began to form.



Birth of the Universe

These newly formed atoms—mainly hydrogen and helium with traces of lithium released photons- A photon is a bundle of electromagnetic energy that makes up all light. Photons behave like particles in that they can interact with matter. In some cases, the energy of the photon is absorbed by matter.



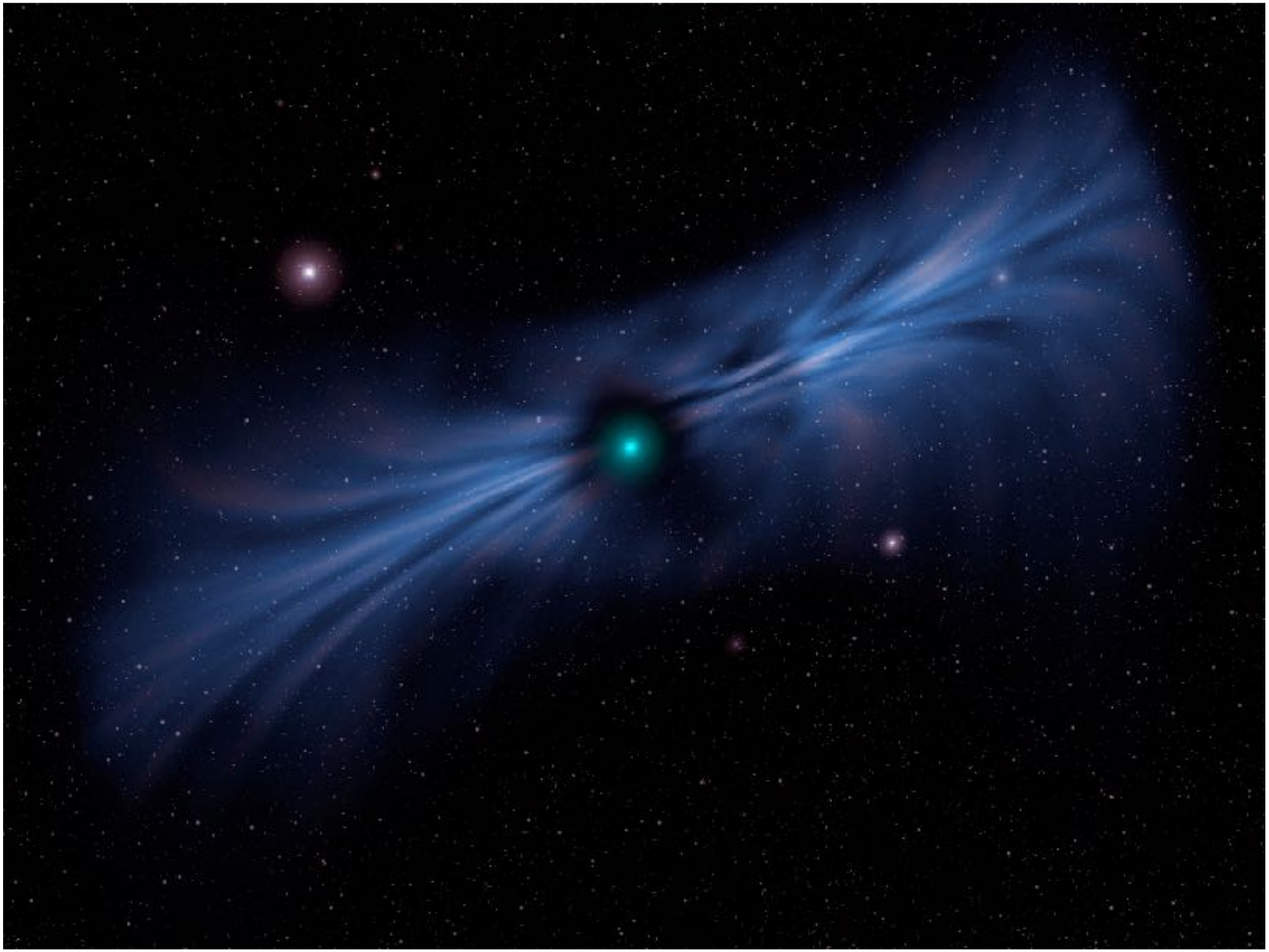
Birth of the Universe

From 300,000 years - 1 billion years in the life of our universe, there were no planets, no suns, no galaxies, no new sources of light - just a fog of hydrogen atoms. This period is known as the cosmic Dark Ages.

Clouds of hydrogen collapsed very slowly and would eventually, over a period of hundreds of millions of years through the process of gravity, pull in more matter which formed stars and galaxies.

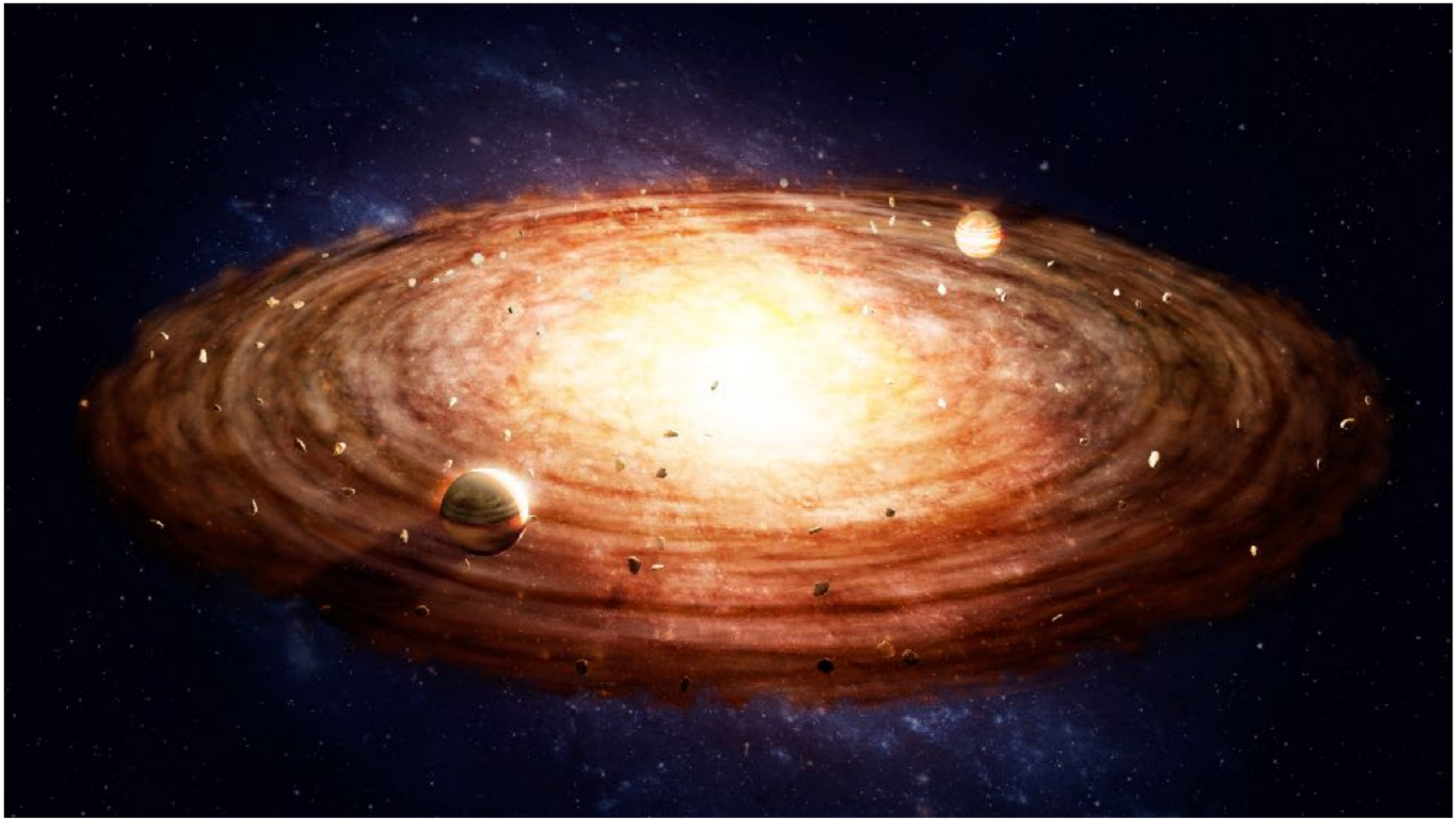
Birth of the Universe

Our solar system's formation and evolution began with the gravitational collapse of a small part of a giant molecular cloud that took place 4.6 billion years ago.

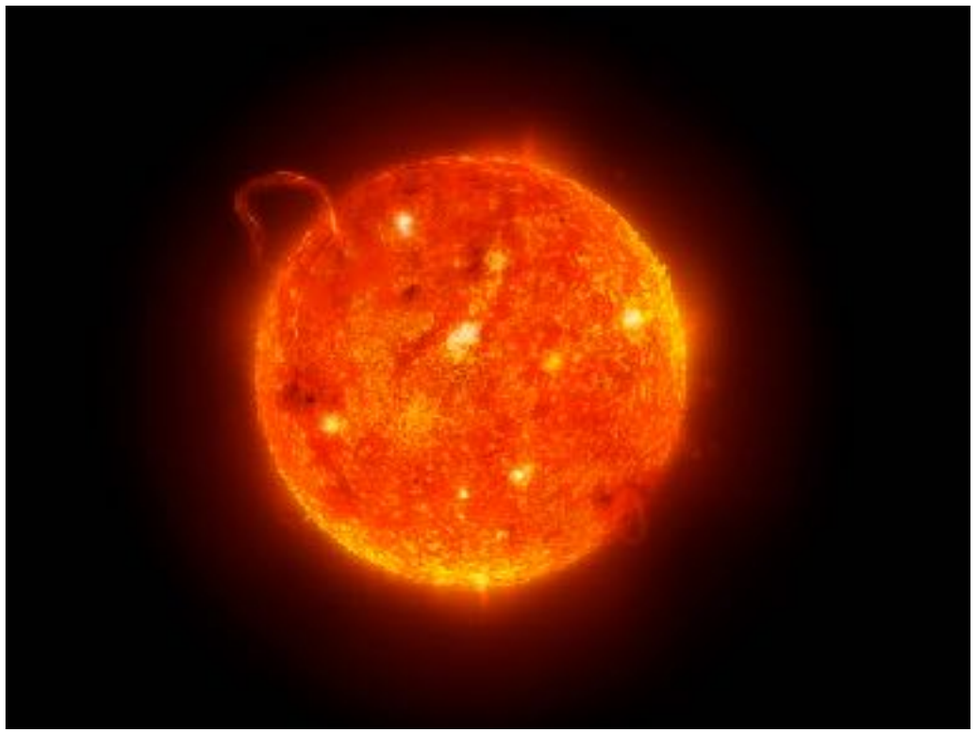


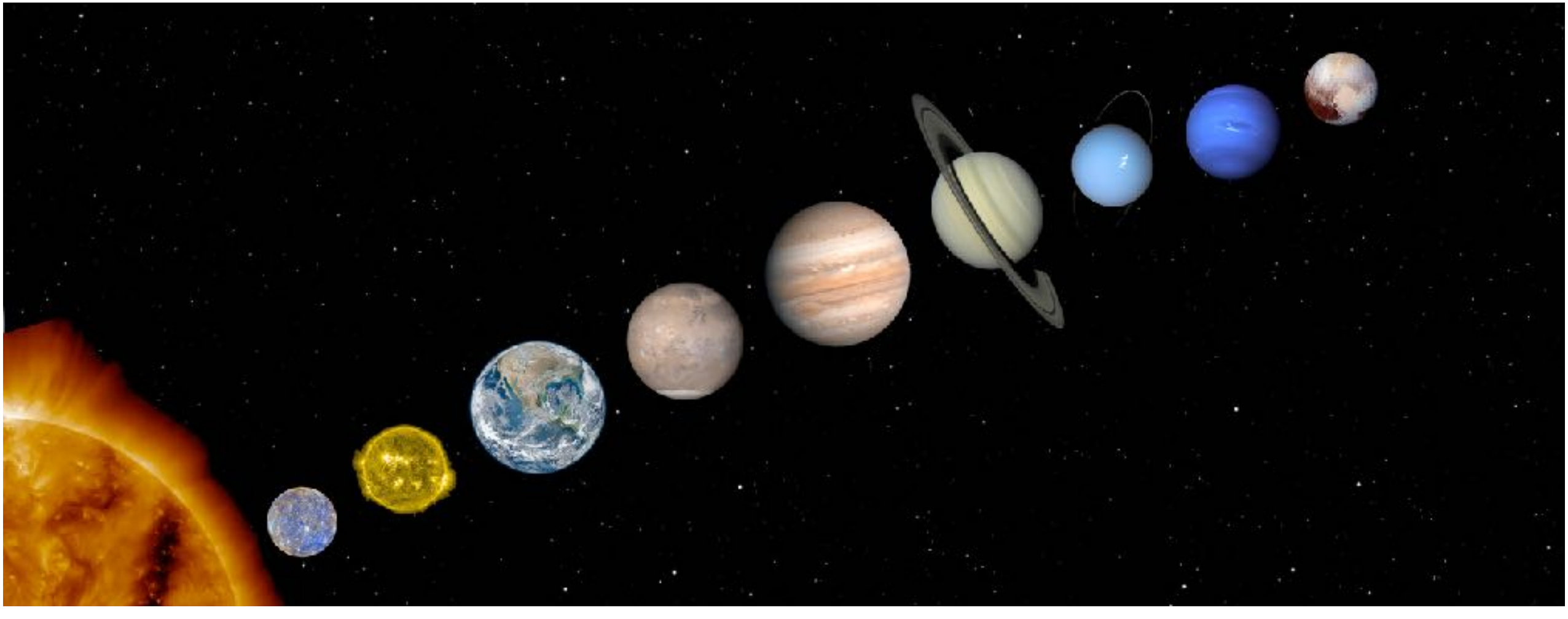
Birth of the Universe

Most of the collapsing mass collected in the center, forming the sun, while the rest flattened into a protoplanetary disk out of which the planets, moons, asteroids, and other small bodies in our solar system were formed.



Birth of the Universe





The Magic of looking back in time.

In 2003 NASA pointed their telescopes at the sky and looked back in time. Through their observations, they were able to see the beginning of the universe 13.7 billion years ago. They also saw the first stars that had formed tiny clumps of matter in the baby universe when it was only 200 million years old and the nuclear fusion from when the first stars began to glow.

The Magic of looking back in time.

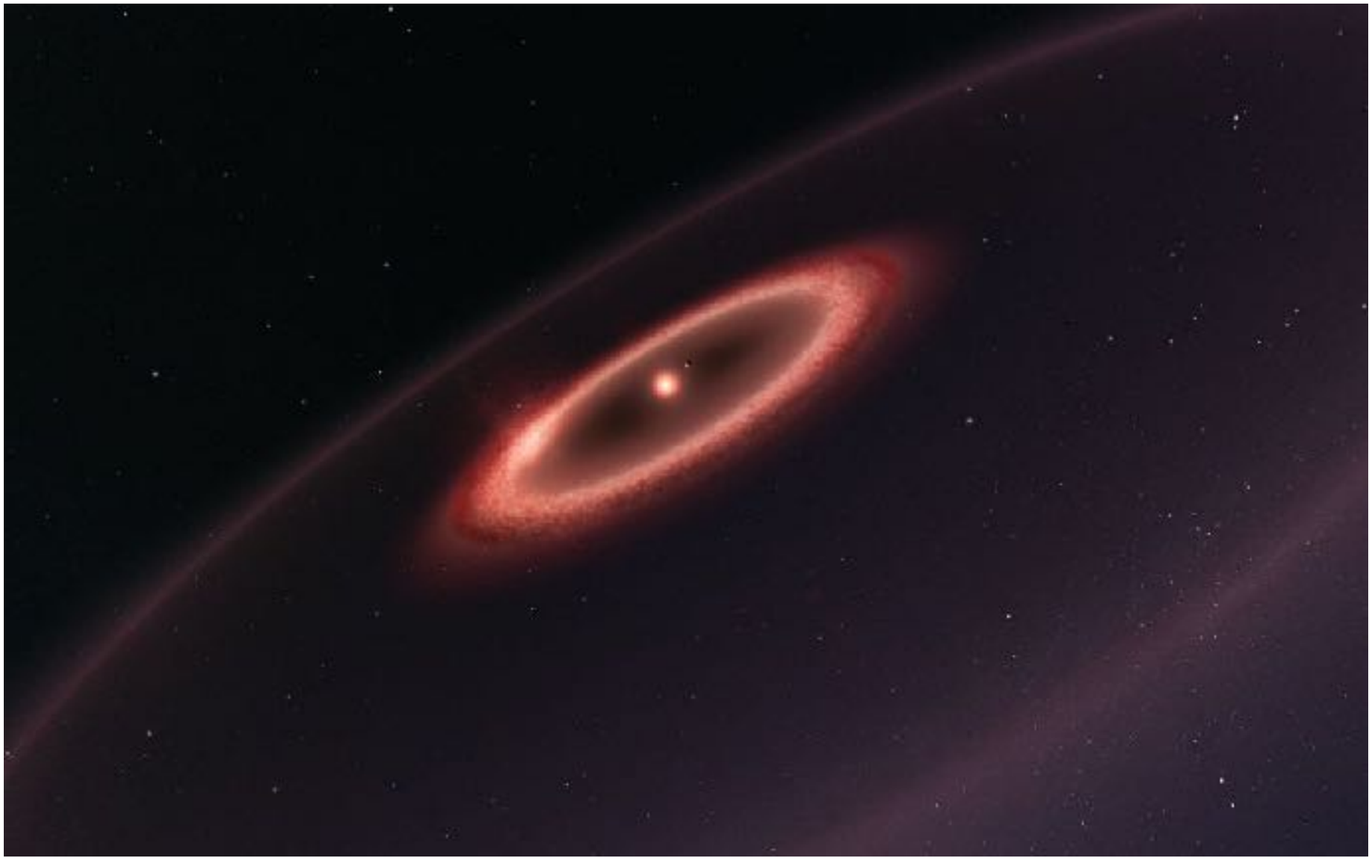
You see, the further out we look into the universe, the further back in time we are viewing. Because light takes time to travel from one place to another, we see objects not as they are now but as they were at the time when they released the photons of light that have traveled across the universe to reach our eyes.

When we look at the stars within our galaxy at night, we see the light that may have taken 20 or 30 or even a few hundred years to reach us. We are looking back in time.
The farther away an object is, the longer it's light takes to reach us.

When we look across the room, we see something as it was a few billionths of a second ago, and when we look at the moon, we see the light that left it a little more than 1 second ago. The light from the sun takes about 8 minutes to reach us here on Earth.

The Magic of looking back in time.

When scientists calculate distances of stars and galaxies from very far away, they use a light-year measurement. A light-year is the distance light travels in one year or 10 trillion kilometers. That's 1 followed by 13 zeros!



Proxima Centauri, which is the closest star to us (other than the sun), is about 4 light-years away- this means that the light we see from it now left the star about 4 years ago. So, if something catastrophic happened to that star, we wouldn't see it for 4 years. Again, that's how long it takes light to travel from Proxima Centauri to Earth.

The Magic of looking back in time.

Through the use of telescopes, we can see objects even further away than our eyes can see. When the telescope takes a picture of a galaxy 100 million light-years away, we are seeing that galaxy as it was 100 million years ago.

At the time that light left the galaxy, dinosaurs still roamed Earth, and humans would not appear for many millions of years! Because distant galaxies appear to us as they were millions or even billions of years ago, we can study how they change over time.

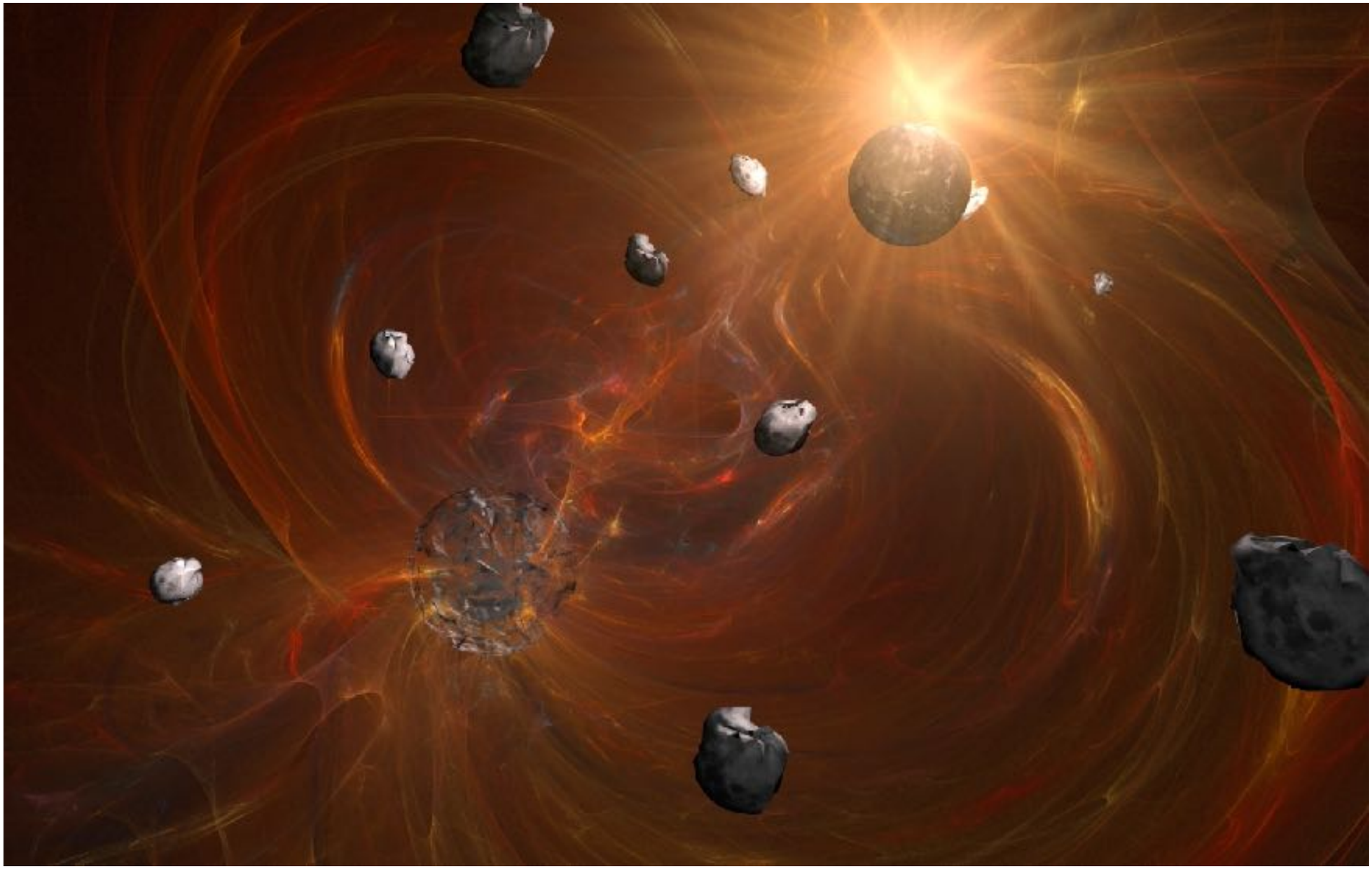
The Magic of looking back in time.

The speed of light is 186,282 miles per second, and in theory, nothing can travel faster than light. In miles per hour, light speed is, well, a lot: about 670,616,629 mph. If you could travel at the speed of light, you could go around the Earth 7.5 times in one second.

Nothing can travel faster than light, but as fast as it is, light still needs time to get anywhere, whether it's across a room or across the universe.

Earth and the Evolution of Plants

Earth formed when gravity pulled swirling gas and dust in to become the third planet from the Sun, and is about 1/3 of the universe's age, 4.5 billion years old. Like its fellow terrestrial planets, Earth has a central core, a rocky mantle and a solid crust. Several hundred million years after the Earth took form, an outer crust developed. The great bulk of our planet is composed of iron, silicon, and magnesium.



Earth and the Evolution of Plants

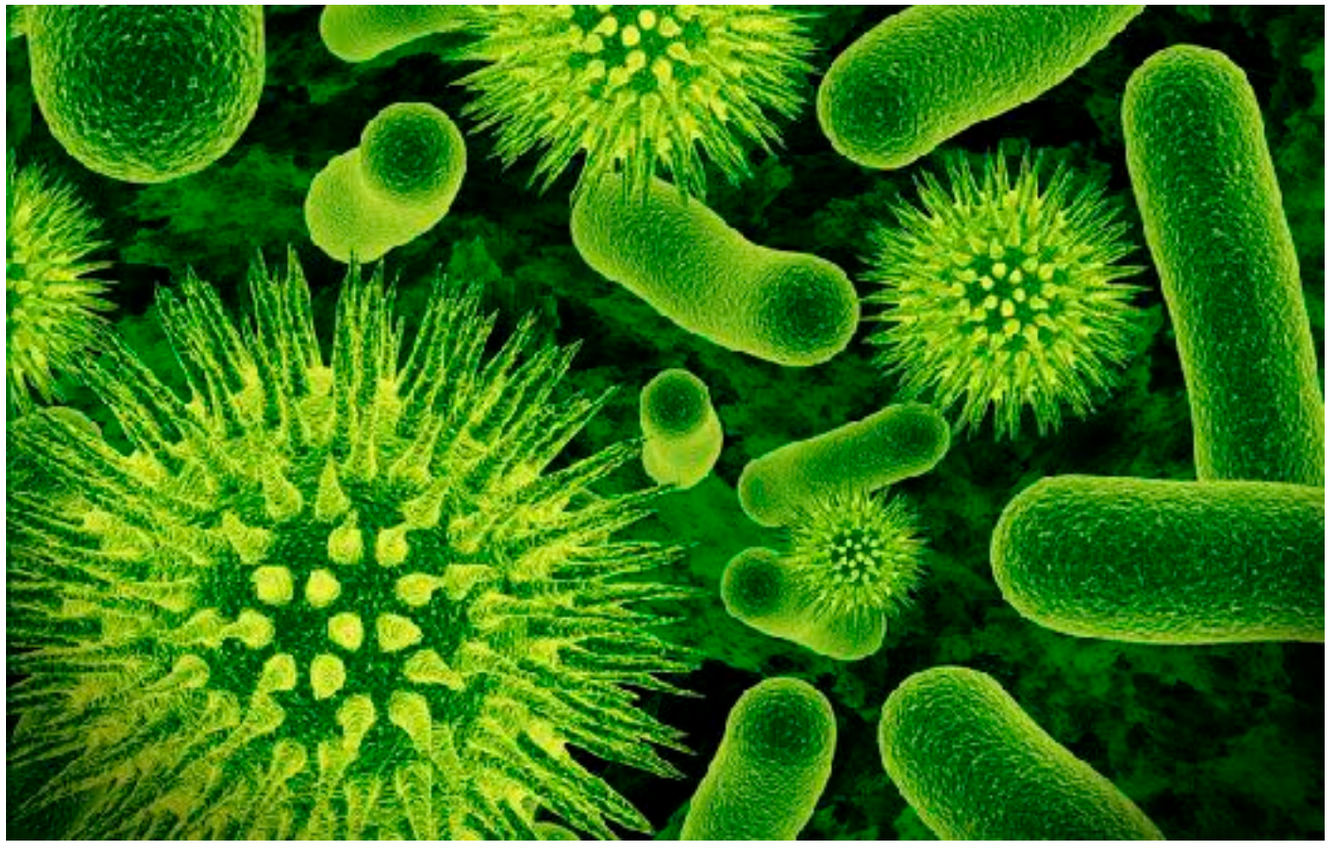
It was like an alien world in the early years of our planet, filled with toxic gasses like methane and sulfur dioxide. A lifeless planet with no atmosphere and the UV rays would burn us to a crisp.

Over time, volcanic outgassing probably created the primordial atmosphere and then the ocean, but the early atmosphere contained almost no oxygen.

Earth and the Evolution of Plants

About 3-4 billion years ago, the earliest life on Earth formed, they were ancient microbes in the oceans. Using a molecule other than chlorophyll to harness the Sun's rays gave the organisms a violet hue rather than green.

From these first life forms, much of the world's oceans were purple. If you were out in space looking back at Earth, you would have seen a purple planet. Imagine that? A purple Earth from space.



But these purple bacterias only harnessed part of the sun’s rays, so over time a different type of bacteria evolved deeper within the waters. Bacteria that lived off a spectrum of light that was not used by the purple bacteria, the green spectrum. Over time, this green bacterias came to inhabit the waters of the world and became the ancestors of all plants on Earth.

Earth and the Evolution of Plants

However, it wasn't just about color, for the green bacteria did something the purple bacteria could not; they produced oxygen. They would breathe life into a lifeless land. And without them, the story of Earth would be more like that of Mars.

Earth and the Evolution of Plants

It was the single most crucial turning point in the history of Earth and it was all brought about by the earliest ancestors of plants! With all that oxygen in the atmosphere it created ozone which blocked the harmful UV rays coming from the sun.

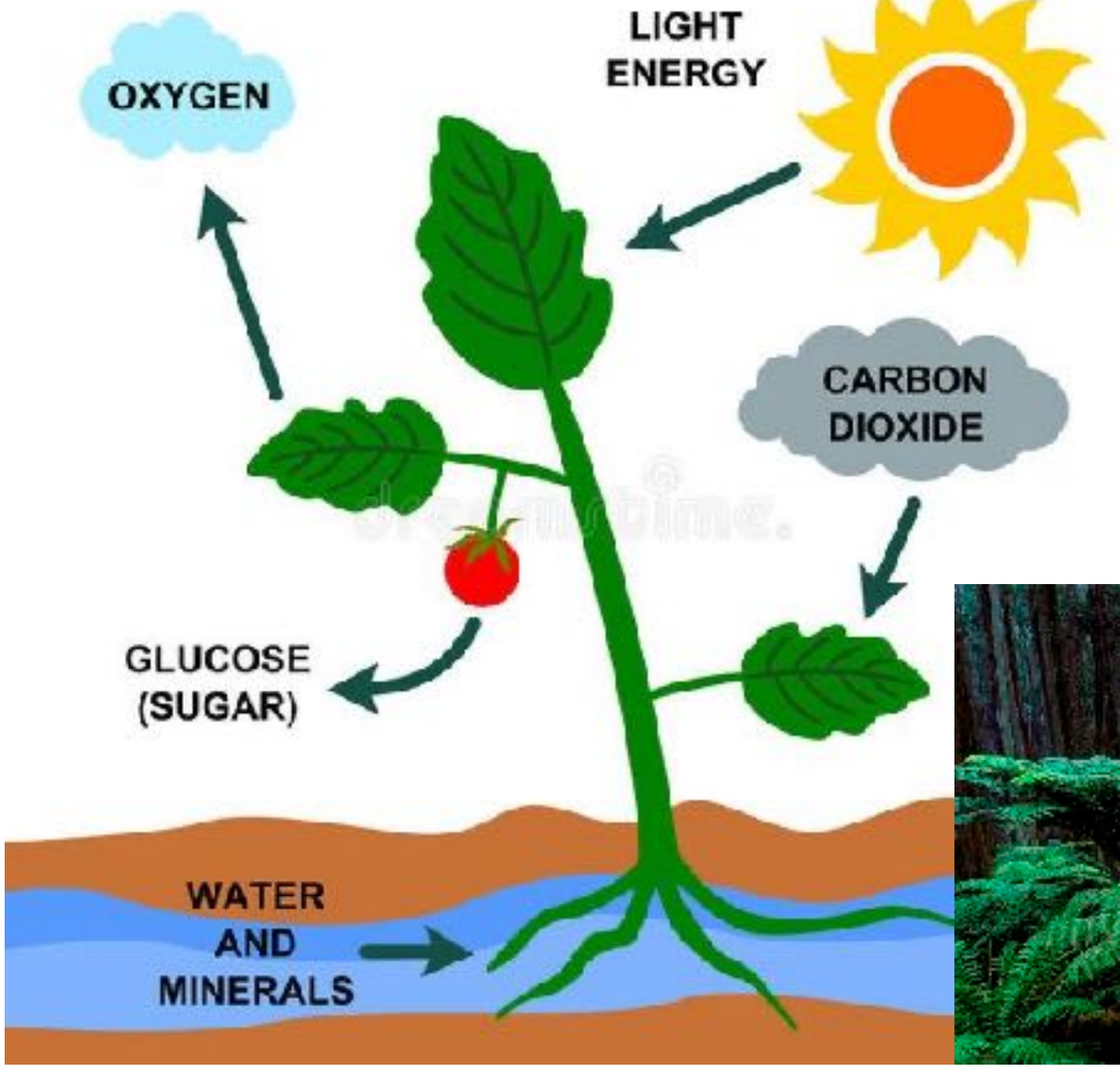
At that point, plants were able to move out of the oceans and onto land. Over time and through their evolution, they grew roots that broke up the hard rock landscape of our early planet and spread across the Earth. These plants cleaned out the toxic gases,

Earth and the Evolution of Plants

Photosynthesis is how green plants and some other organisms use sunlight to synthesize foods from carbon dioxide and water. Photosynthesis in plants generally involves the green pigment from chlorophyll and generates oxygen.

An irreversible change happened between two very different worlds. A planet with no oxygen became a planet full of oxygen.

For Plants sculptured the Earth's surface, created a life-giving atmosphere, and drove the evolution of all mammals by providing food. It was the greatest change in the history of life on Earth.



Dinosaurs & The Evolution of Mammals

Dinosaurs are a group of reptiles that lived on Earth for about 245 million years and were the largest animals ever to have walked on our planet. Dinosaur fossils have been found on all seven continents. All non-avian dinosaurs went extinct about 66 million years ago. Modern birds are a kind of dinosaur because they share a common ancestor with non-avian dinosaurs.

Everything we know about non-avian dinosaurs is based on fossils, including bones, teeth, footprints, tracks, eggs, and skin impressions. No one is entirely sure how dinosaurs became extinct. Still, most think it was caused either by a massive asteroid (a huge rock from space) crashing into the Earth, a gigantic volcanic eruption, or possibly both.

Dinosaurs & The Evolution of Mammals

For 100s of millions of years, throughout the time of the dinosaurs, forests ruled the land. It was so warm, trees extended over most of the Earth. The Arctic and Antarctica was without ice and carpeted in forests. It was then, ‘Planet of the trees.'

Dinosaurs & The Evolution of Mammals

We have been able to determine what plants were around during this period when dinosaurs walked the Earth because of the Fossilized Dinosaur's poo (coprolites). Did you know that dinosaurs share a surprising amount of DNA with modern-day chickens? That's right! Chickens are a relative of the most famous predator the world has ever known! The tyrannosaurus rex.

Earth and the Evolution of Plants

However, the end of dinosaurs was good news for mammals and sea life, whose numbers exploded in the aftermath. Life in the ocean and on land evolved a greater variety of forms in the first 10 million years after the dinosaurs went extinct, then in the previous 160 million years when dinosaurs ruled the earth.

Dinosaurs & The Evolution of Mammals

The reason we think this is that there were a lot of competitors and predators of mammals around back then. And with no more dinosaurs around, the pressure limiting what mammals and sea life could do was gone.

Some animals (besides the chicken), we all know of today, share connections with ancient dinosaurs or were around at the same time - sharks, bees, turtles, crocodiles, snakes, horseshoe crabs, which have blue blood, Australian platypuses, and the Aussie echidna.

The platypus and echidna are egg-laying mammals, known as a monotreme.

Dinosaurs & The Evolution of Mammals

Humans haven't really been around that long. We arrived onto the scene rather recently. Homo Erectus, our distant ancestors, were around 1.3 and 1.8 million years ago, while homo sapiens (that’s us) arrived about 300,000 years ago. That's more than 65 million years since the disappearance of the dinosaurs.

Geography & The Continents

CONTINENTAL DRIFT

Permian period
225 million years ago

Triassic period
200 million years ago

Jurassic period
150 million years ago

Cretaceous period
65 million years ago

Present days

Asia

Asia is the largest continent on planet earth

Within Asia you'll find Siberia, India, Korea, China, and the Plateau's of Tibet and Mongolia. From the Himalayas … location of the highest mountain in the world, Mount Everest. To the jungles and exotic islands of south east Asia.

Asia is the home of many wonderful and exotic creatures, such as the panda, orangutang, asian bears, tigers, the Asian Elephant, and chameleon reptiles, just to name a few.

Africa

The Motherland of all of us.

Fossilized human remains have been discovered in Africa that date back 7 million years.

Between 1500-2000 languages are spoken in Africa.

The Sahara is the largest desert on planet earth and is bigger than the entire continental United States. The Nile River which begins at Lake Victoria in Tanzania and winds past the pyramids in Egypt before flowing into the mediterranean sea is the longest river in the world.

Africa is the world's hottest continent with deserts and drylands covering 60% of its land surface and yet Africa also has tropical rainforests, wetlands and jungles.

Africa is home to the largest, tallest and fastest animals in the world.

North America

Location of the Grand Canyon

There are 23 countries in North America which not only includes the United States and Canada, but also the Central American countries, the Caribbean islands and Greenland. From the Rocky Mountains….. to the magical open spaces of its desert southwest, from the Pacific Ocean to the Atlantic Ocean.

In North America there are brown bears, wolves, coyotes, raccoons , moose, jaguars and many other amazing animals.

South America

Home of the Amazon Rainforest

There are 12 countries in South America. The geography of this continent is dominated by the Andes Mountain Range and the Amazon River.

The Amazon rainforest is one of the most important natural resources on our planet … because trees in the Amazon provide around six percent of the world's oxygen.

The Atacama Desert, the driest and oldest desert on Earth, located in northern Chile, has not recorded rain for the past 500 years, and yet … there is life.

The exotic animals of South America, include jaguars, sloths, Llamas, Toucans, Capybara, Tapir and so many more…….

Australia / Oceania

Land of Kangaroos & Koalas

A region made up of thousands of islands. Australia is the smallest continent but the largest Island in the world. In fact there are so many beaches in Australia that if you were to visit a new beach every day, it would take you 27 years to see every beach in Australia.

Australia has less humans than any other continent, except for Antartica. There are snow-capped Mountains and salt encrusted seas, rolling country side and turquoise seas and vibrantly colored fish that swim amongst the largest living organism on planet Earth: The Great Barrier Reef.

Australia has tropical rainforests rich in biodiversity and legendary billabongs that feed its thirsty interior. Australia has almost 400 mammal species and of those 140 are marsupials.

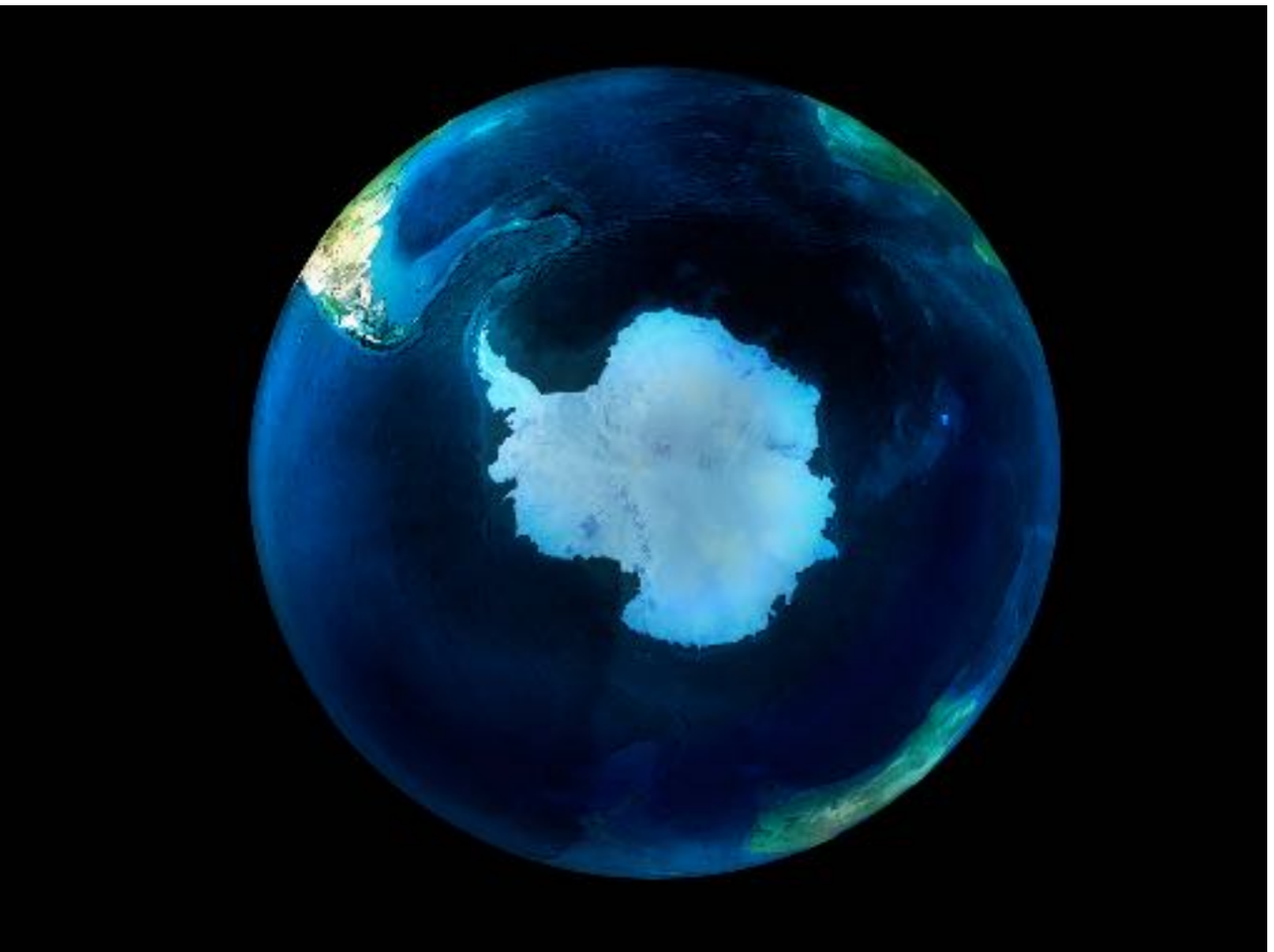
Europe

The Motherland of all of us.

Eastern Europe, Southern Europe, Western Europe, Northern Europe and British Isles. Forty six Countries in all. With the largest country being Russia.

The European continent has similar animals to North American as it was connected by land during the last ice age. During this time a considerable migration of plants and animals occurred between the two continents.

Europe has an incredible diverse climate … from the white sand beaches and crystal clear waters of Greece to the fjords, glaciers and hot springs of Iceland.



Antarctica

Land of Ice & Penguins

Antarctica is the coldest, driest, windiest continent.
Most of Antarctica is a polar desert .
Temperatures can plummet to -58 degrees

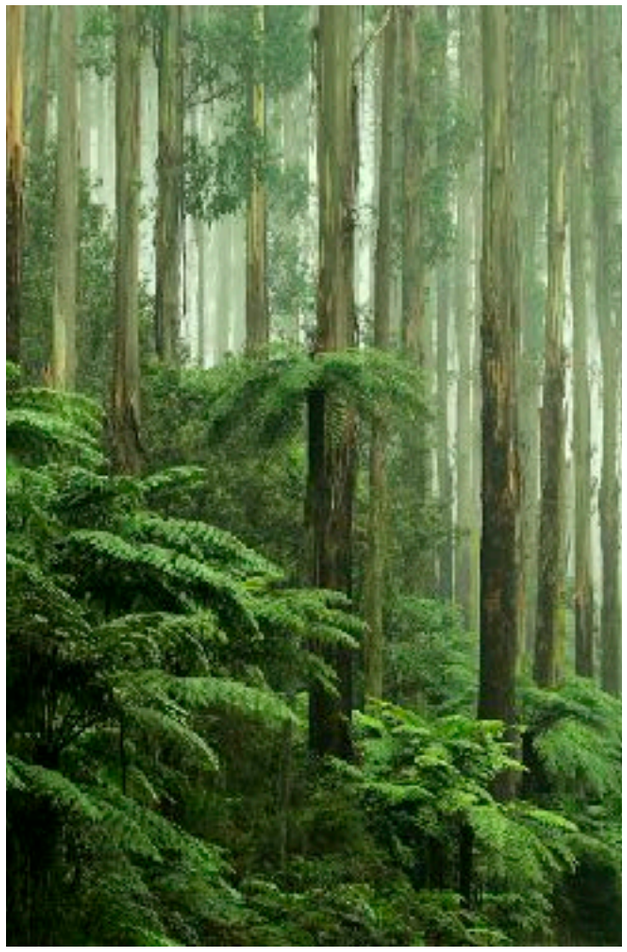
There are 17 penguin species on the planet … eight of the most iconic reside in Antarctica. The most famous of the penguin species is the Emperor Penguin. Many whales visit Antarctica every year. Killer Whales, Sperm Whales, Humpback Whales, the Southern Right Whale, Minke Whales and the Antarctic Blue Whale

Animals & Inter species Relationships

Many of us who have grown up with animals know they are far more intelligent than many people give them credit for. We know with our own dogs that they not only understand simple words in human language but comprehend entire sentences.

Scientists are finding that many animals know right from wrong and live according to a moral code. They have the same range of emotions as humans - the six emotions have been classified as basic: anger, disgust, fear, happiness, sadness, and surprise. As well as the complex emotions would include contempt, jealousy, and sympathy.


NOAHS
ARK



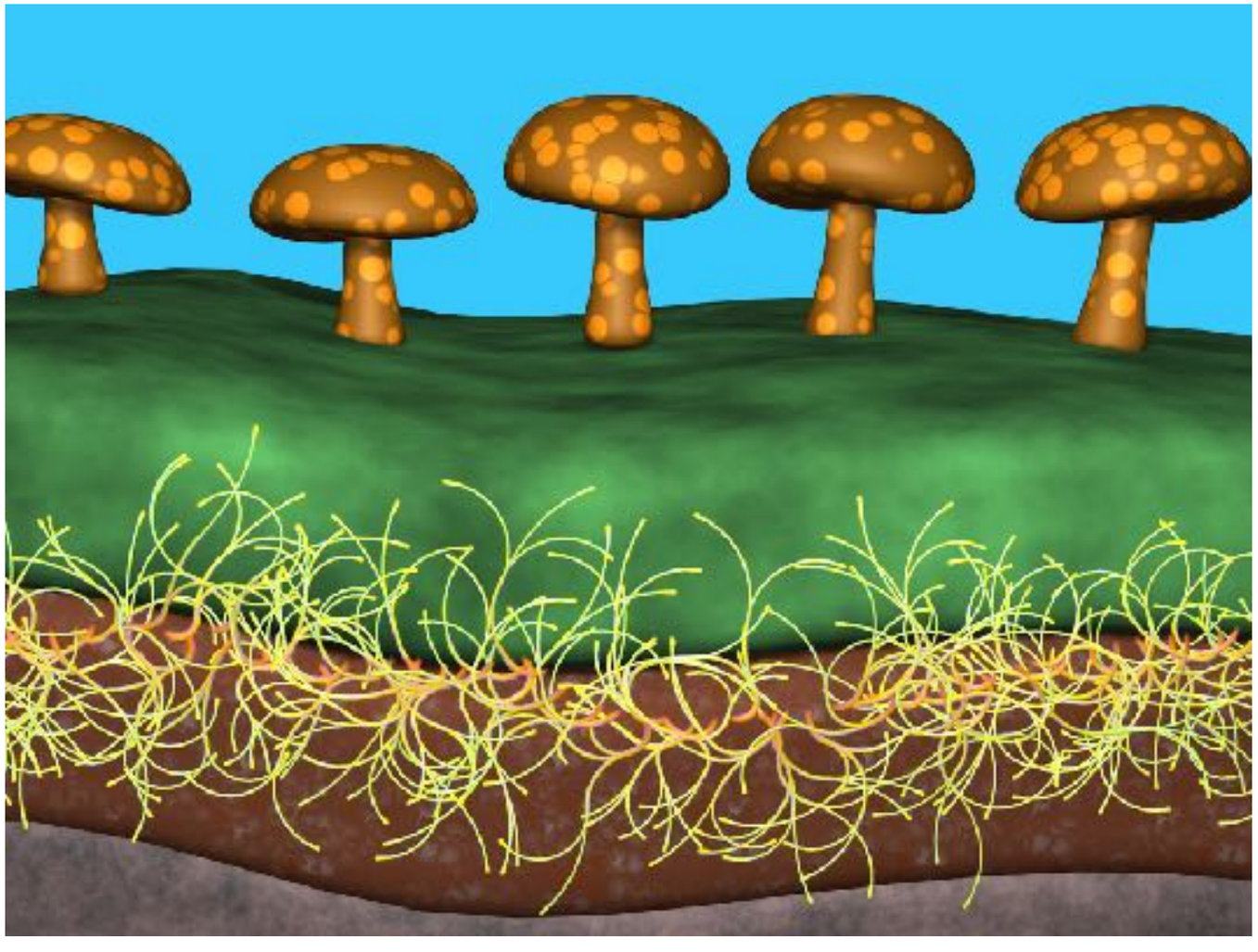
The Forest

Not only are animals amazing, but the plant kingdom will boggle your mind.

Now, imagine you're walking through a forest. We're guessing you're thinking of a collection of trees. But a forest is much more than what you see, and today, we're going to change the way you think about forests.

Most of the plants you can see are connected below ground, not directly through their roots, but via (what they call) mycelial connections.

Down below, underground, there is another world. A world of infinite biological pathways that connect trees and allow them to communicate which enables the forest to behave as a single organism.



The Forest

Check it out! Have you guys ever seen a mushroom growing in the forest?

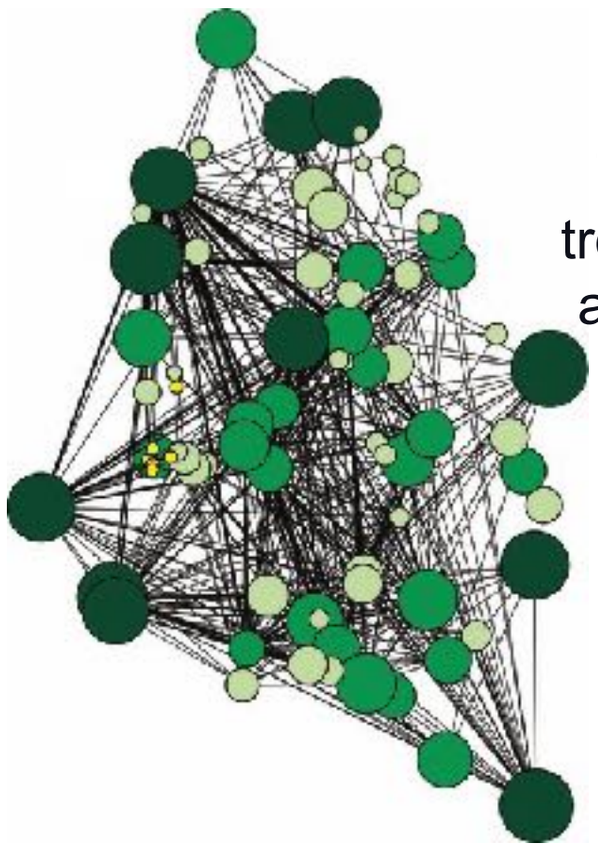
A mushroom is the flower and just the tip of the iceberg, because underneath the mushroom is an entire root system called mycelium. It spreads underground all through the forest.

What is Mycelium?

It's a fungus-like bacterial colony consisting of a mass of branching, thread-like substances. And those mycelium threads affect and colonize trees and plants. When the fungal cells interact with the tree's root cells, there's a carbon food trade. The web is so dense that there could be hundreds of miles of mycelium under a single footstep.

The Forest

It kind of works like the Internet. The biologist Dr. Suzanne Simard has coined the term 'The-Wood-Wide-Web.



Now the trees that are mostly feeding this wood-wide-web are the large mother trees.

The mother trees, the large full-grown trees, connect to hundreds of other trees and send excess carbon (food) through this network to younger seedlings.

What scientists have found is that it increases the survival success rate of small trees by four times.

(This diagram shows the connections between trees. The older and more connected trees are shown in dark green, while young trees just establishing themselves to the network are paler green)

The Forest

This fungus is amazing- it hunts, it mines, it fishes, and it strangles.
What the fungi does, it sends out these tubs, and it winds back and forth through the soil until it bumps into something like a pebble. Then it excretes an acid that starts to dissolve the rock and mines it, creating a tunnel through a pebble looking for minerals.

Not only that, but the fungus will hunt insects. When it comes across a bug, it will shoot a stain inside the insect to see if it's still alive and if it is, the fungus sends tubs into the insect and sucks the nitrogen out of the insects while they are still living. 25% of that food ended up in the trees.

Here' another example, Bears in Alaska, park themselves along a river to catch salmon and the parts of the fish they don’t eat, they throw to the ground. As the salmon breaks down into the soil, the fungi drink the salmon carcass and then send the nitrogen to the trees. In the areas where the bears live, they have found 75% of the nitrogen in the tree's rings was fish food directly from what the bears threw on the ground.

The Forest

So what does the fungus get from the tree for these services?

Tree sugar. 20 -80% of the tree's sugar goes to the microbial community. And when times are hard, the fungi will give the sugar back to the tree, almost like a loan.

What scientists are finding is there's an intelligence in the forest. Below-ground, the mycelium looks just like the brain of a mammal. There are so many parallels between a mammal's brain and the mycelium structure; acting as an organism, it's mind-blowing!!

We live on a fantastic planet with some incredible creatures, more biodiversity than we could imagine, and forests full of magic. But our planet is in deep trouble, and it's going to take all of us to make some big changes immediately to save it.

You may be asking yourself how we got into this trouble, so let's go back a bit in time to the industrial revolution.

The Forest

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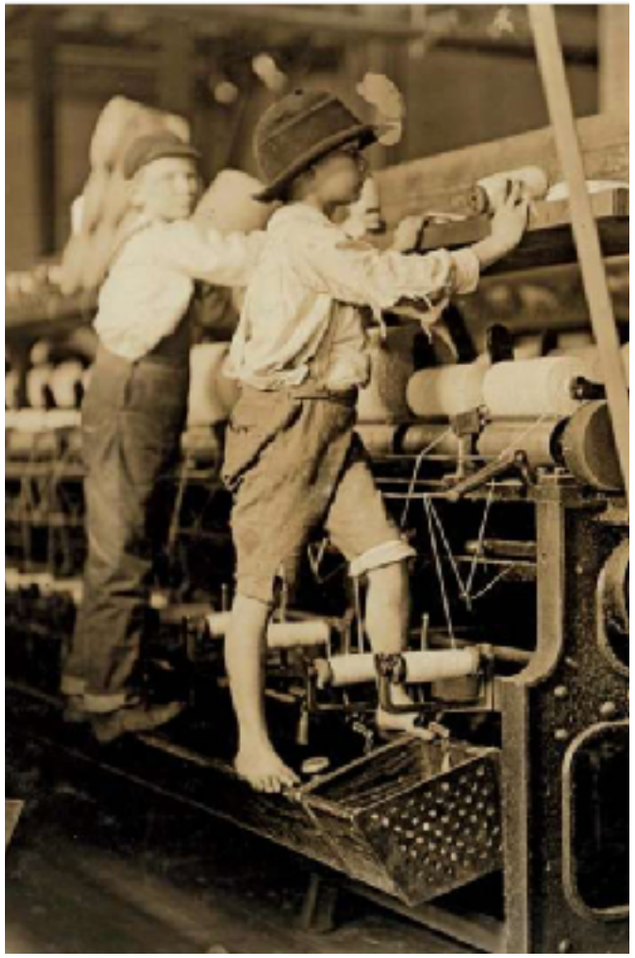

The Industrial Revolution

The Turning point …

The Industrial Revolution marked a major turning point in Earth's ecology and humans' relationship with the environment.

It started in the mid-1700s in Great Britain, when the world human population was only 360 million compared to the population of today which is close to 8 billion.

The burning of fossil fuels replaced wind, water, and wood as energy sources used primarily to manufacture textiles and iron-making processes.

The massive impact of the Industrial Revolution would come 100 years later. In the 1800s, when the use of machines for the first time in history replaced human labor and spread across Europe and North America.

The effects of the Industrial Revolution did not wane with time but have grown exponentially.

The Industrial Revolution

The Turning point …

Over the next three centuries, with the increase in the human population - the combustion of fossil fuels in cars, buildings, factories, and power plants-is drastically changing our climate and responsible for the warming, from the release of greenhouse gas, carbon dioxide, or CO2.

These gases remain trapped in the atmosphere and increase the Earth's temperature and acidification of the ocean's ecosystems, which is directly related to the dying coral reefs around the world.

Why does CO2 or carbon dioxide heat the Earth's temperatures?

According to NASA, Life on Earth depends on energy coming from the Sun. About half the light reaching Earth's atmosphere passes through the air and clouds to the surface, where it is absorbed and then radiated upward in the form of infrared heat.

The Industrial Revolution

The Turning point …

About 90 percent of this heat is then absorbed by the greenhouse gases and radiated back toward the surface, heating the Earth.

With the human population now at 7.8 billion (each billion = 1000 million) people on the planet today, that's a lot of folks!

So more than ever, we need to work together and respond swiftly to the dangerous effects of climate change by reducing and stabilizing the levels of heat-trapping greenhouse gases in our atmosphere.

So the question is, how? Right?

We could begin with the stopping of deforestation of old-growth forests and work on reforestation of our planet.

The Industrial Revolution

The Turning point …

Trees not only give us oxygen but absorb CO2, by removing and storing the carbon and at the same time releasing oxygen back into the air.

In one year, an acre of mature trees absorbs the same amount of CO2 produced when you drive your car 26,000 miles.

Other solutions would be going Solar, using wind power, driving Electric Cars, and reducing our consumption.

Reduce/Reuse/Recycle

Protect the planet!

So, here are a few ways we can help protect our planet.

1/ Use a refillable water bottle and reusable lunch containers.

We can't say enough about this one. Water bottles and paper coffee cups are an enormous waste. Buy a durable water bottle - stay hydrated and it’s a lot less wasteful.

2/ DITCH THE PLASTIC BAGS and the paper bag.

One of the best ways to decrease the amount of waste produced is to use reusable bags while shopping. Instead of relying on supermarket plastic or paper bags, bring your own cloth bags to pack groceries.

3/ SKIP THE STRAW.

Straws pose a massive danger to animals like sea turtles, albatross, fish, and land mammals who can get them stuck in their throats or noses. Did you know that we use 500 million plastic straws every day in the United States? That is 125 school buses filled to the top with plastic that never breaks down

5 - STOP THE STYROFOAM

Styrofoam is one of the worst forms of plastic pollution - like coffee cups, styrofoam plates, and fast food containers.
This foam never breaks down -- Every single bit of Styrofoam ever made is still out there, sitting on the Earth.

We influence friends and family members every day, and if together, we put our hearts and minds into protecting

Reduce/Reuse/Recycle

Protect the Planet