



Tomáš Tůma & Pavel Gabzdyl

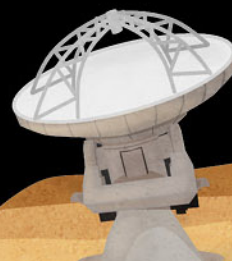
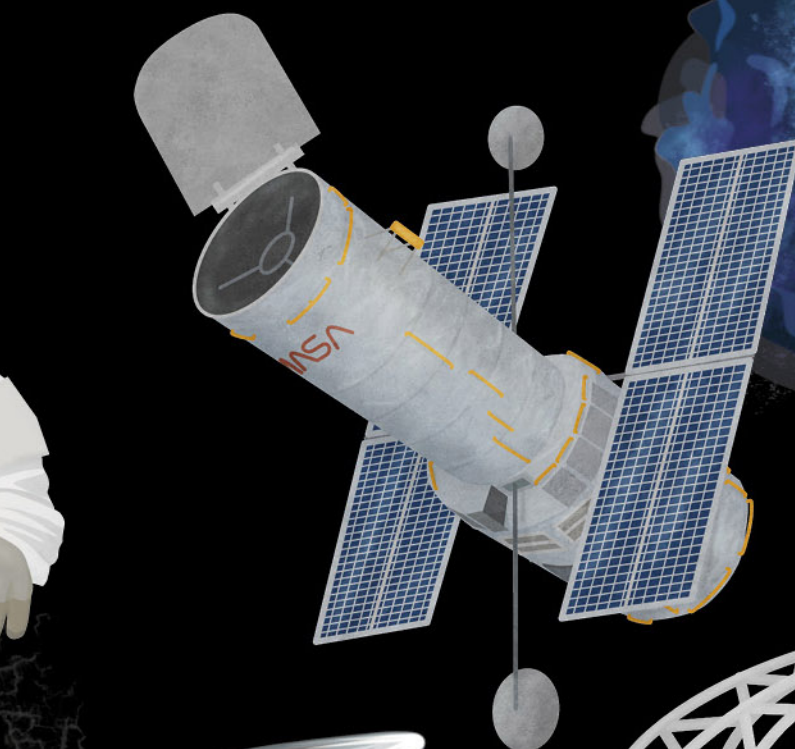


SPACEMANIA



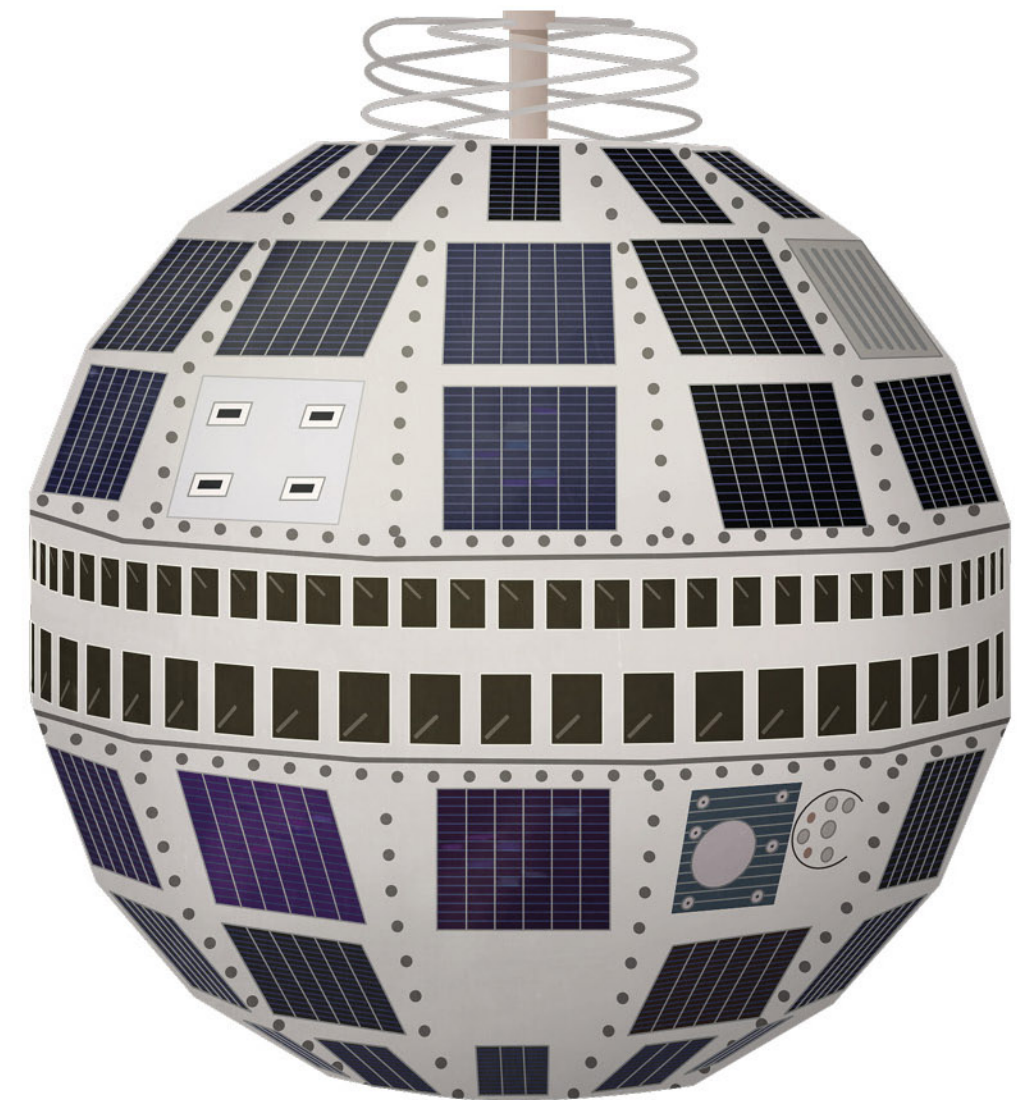
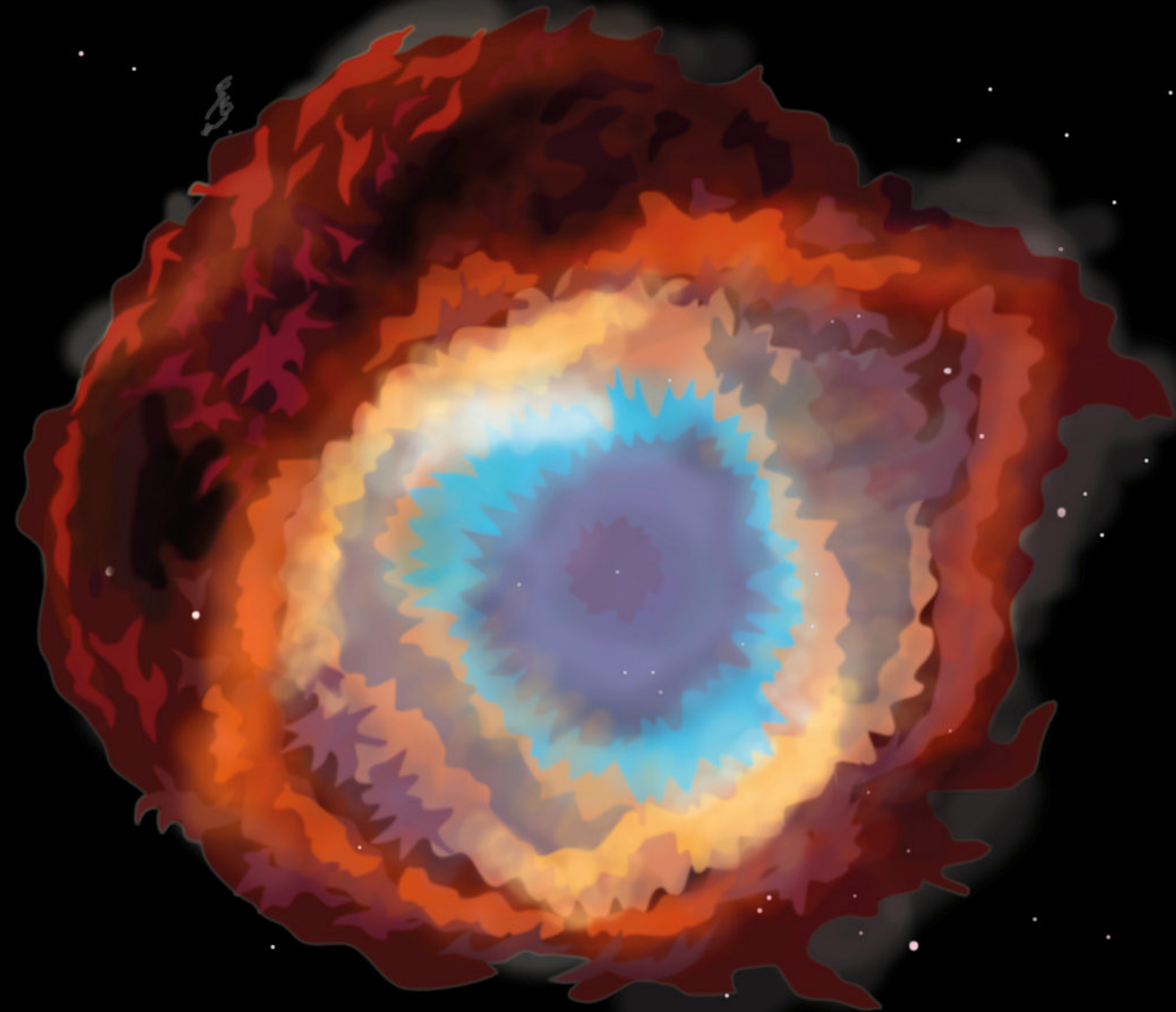
SPACEMANIA

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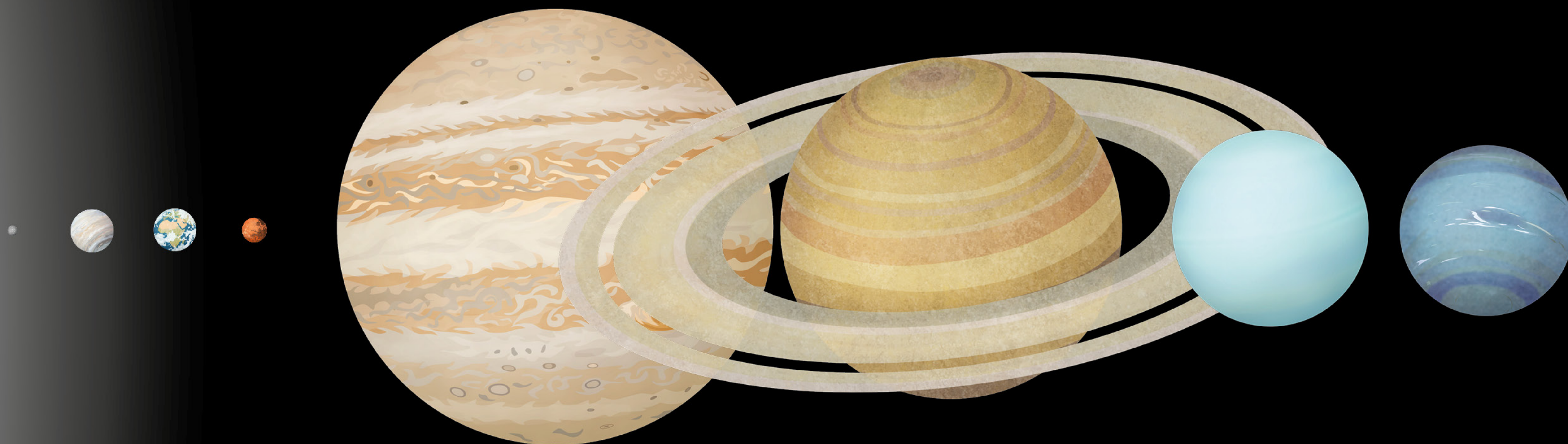


Written by Pavel Gabzdyl
Illustrated by Tomáš Tůma

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SOLAR SYSTEM

The distances of the planets from the Sun are not in the right proportion.



Sun / Mercury / Venus / Earth / Mars / Jupiter / Saturn / Uranus / Neptune

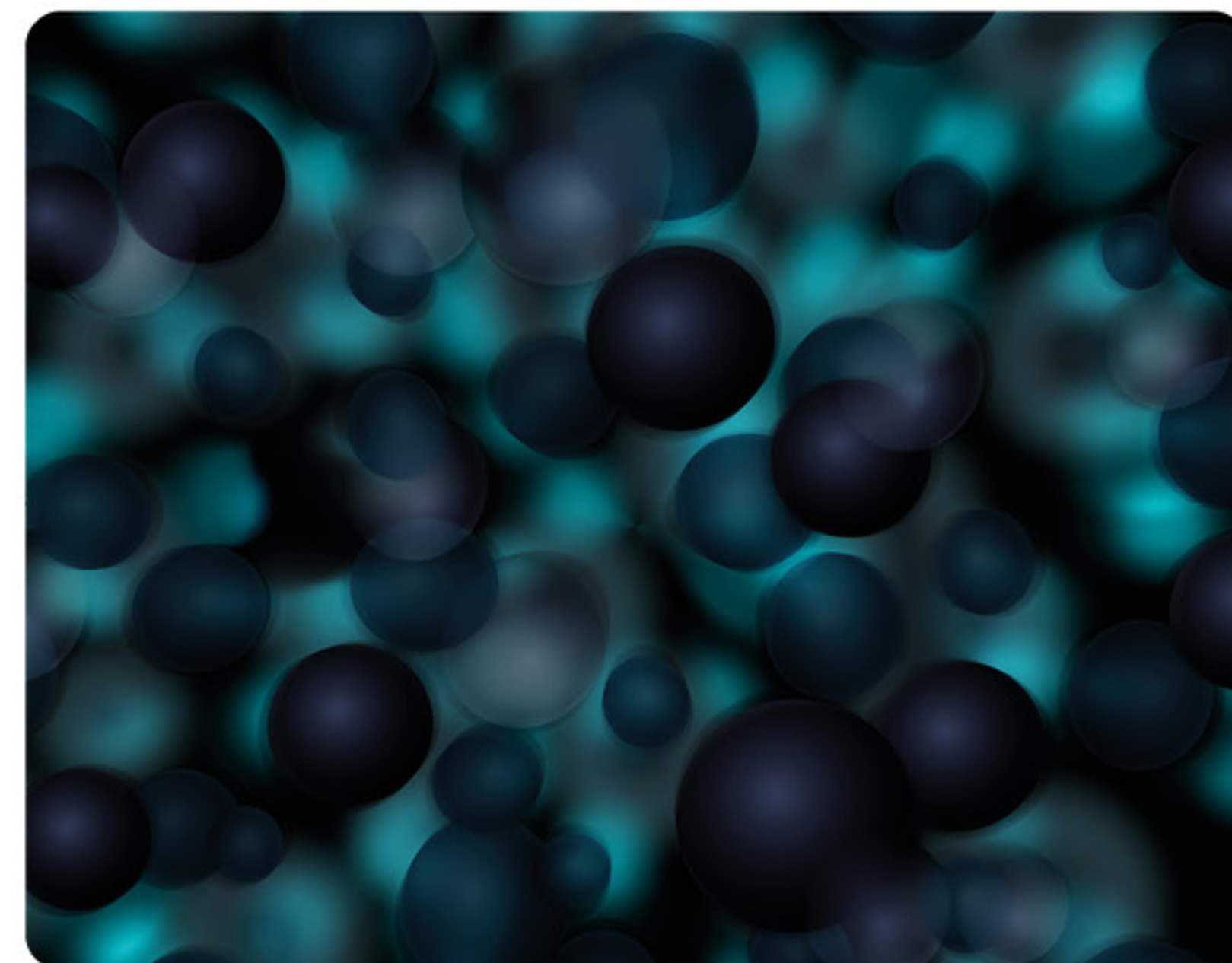
ORIGIN OF THE UNIVERSE

First second

Space and time came to be in a single solitary moment. It may be incredible but everything necessary for the universe to emerge appeared in the first second following the Big Bang.

Modern physics hasn't yet been able to meaningfully describe the period of 10^{-43} seconds following the Big Bang.

From 10^{-43} to 10^{-36} seconds after the Big Bang, gravity became a separate physical force.



First particles
▼



▲ Big Bang

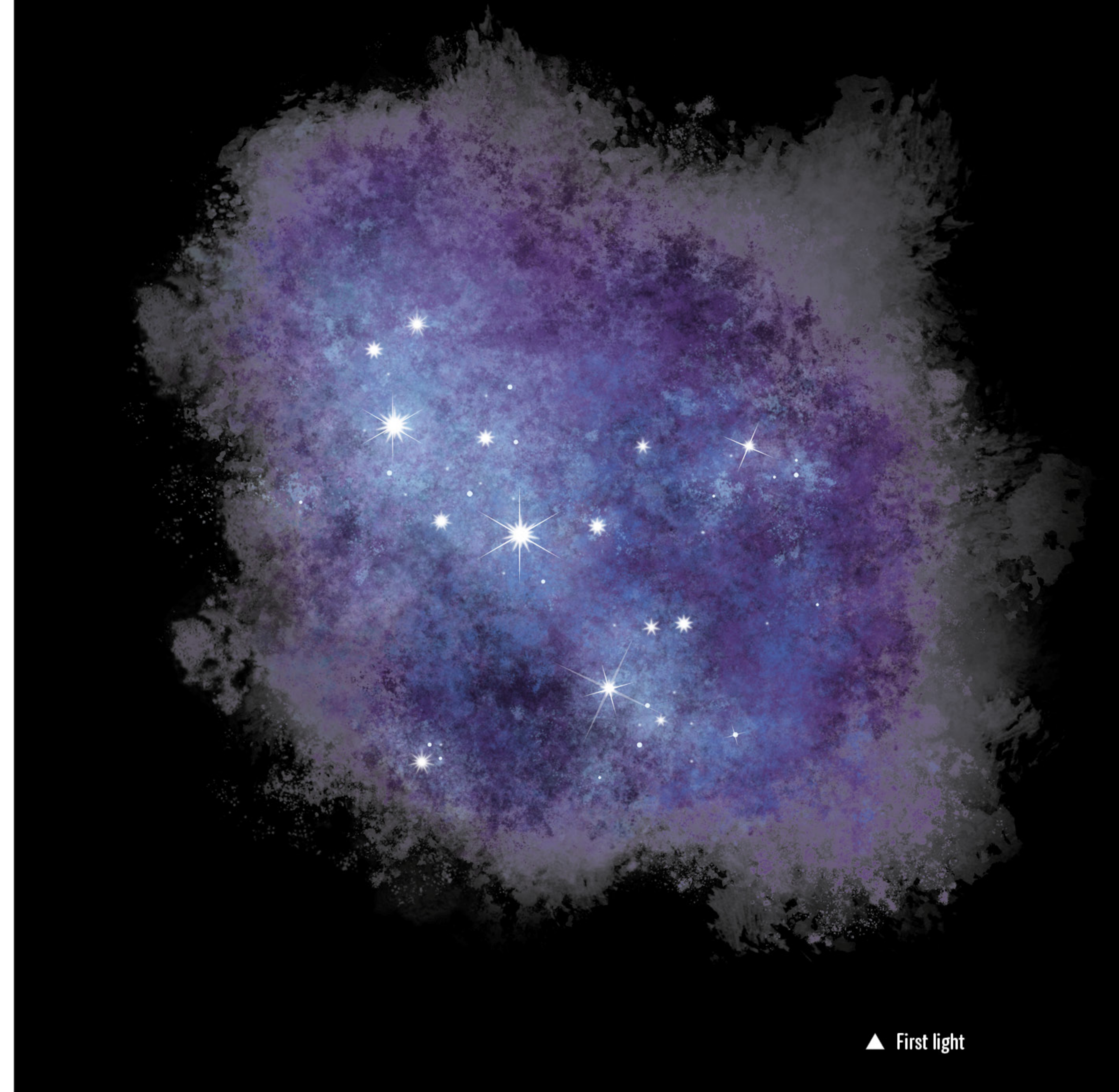
Big Bang

Thirteen billion 700 million years ago, what we now call the Big Bang occurred. This colossal explosion, however, didn't start at a specific place. It happened everywhere, all at once. In that single moment space came to be, as well as matter and time.

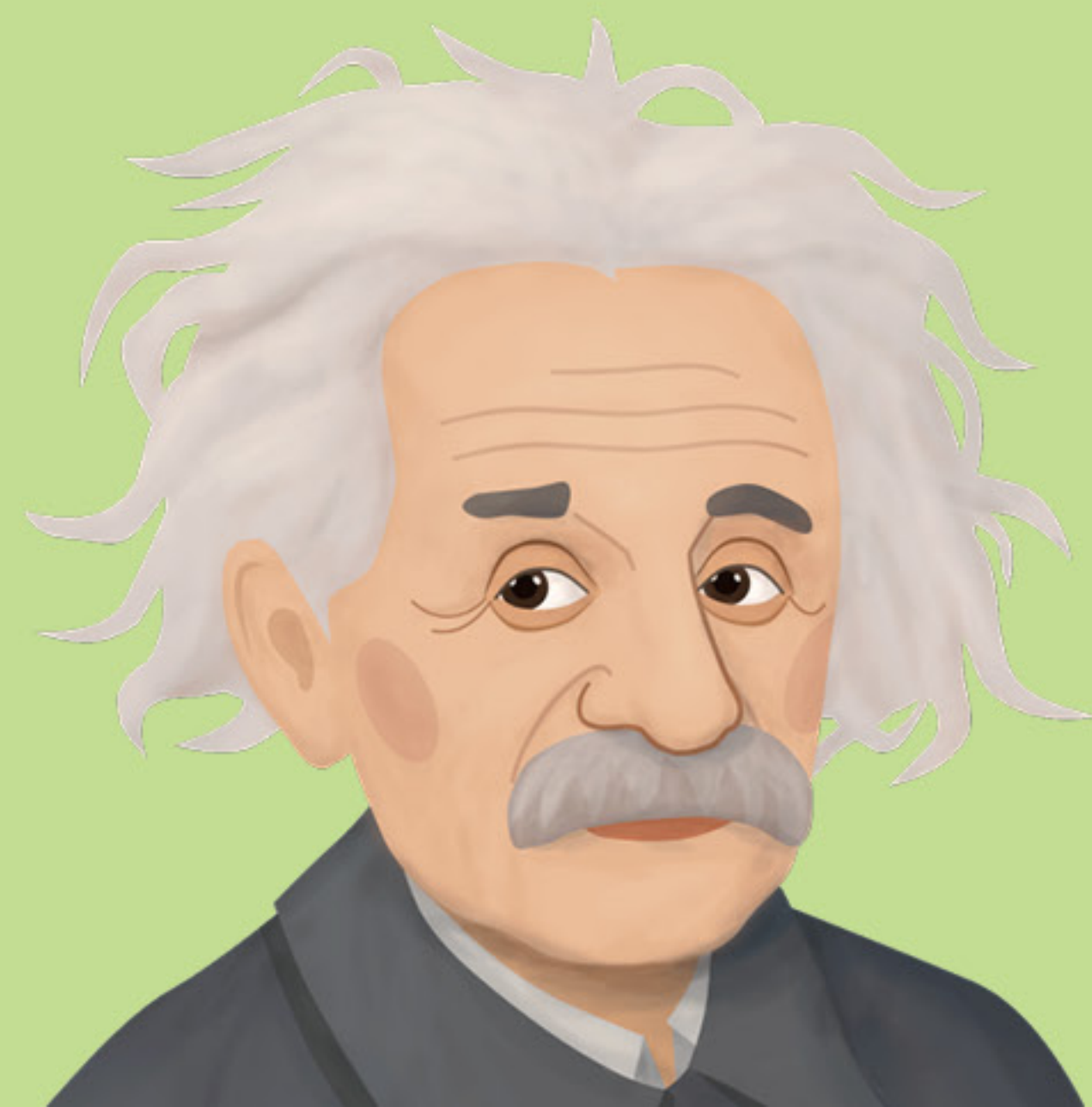
10^{-35} seconds after the Big Bang, the universe expanded rapidly.

At 10^{-32} seconds, the first particles appeared.

Originally, the universe was completely dark. After roughly 380,000 years, it turned transparent and was flooded with the gradually cooling relict radiation produced by the Big Bang.

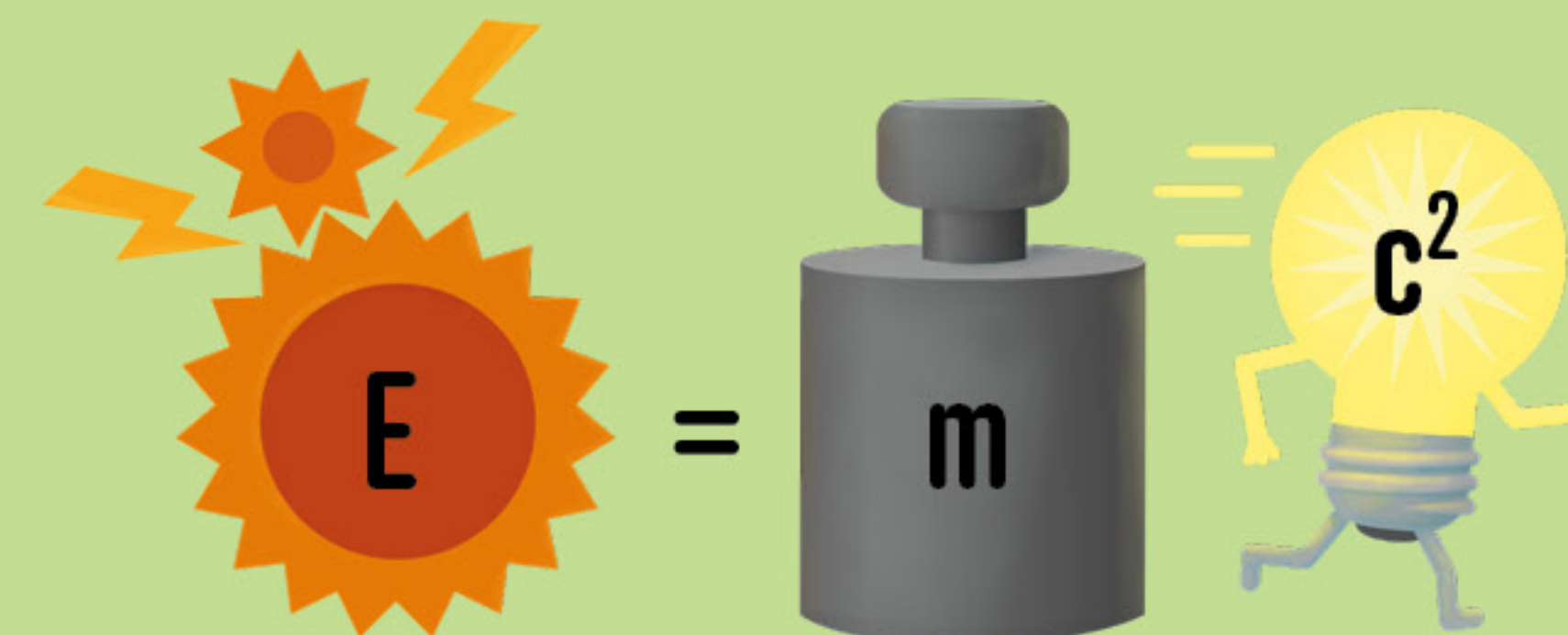


▲ First light



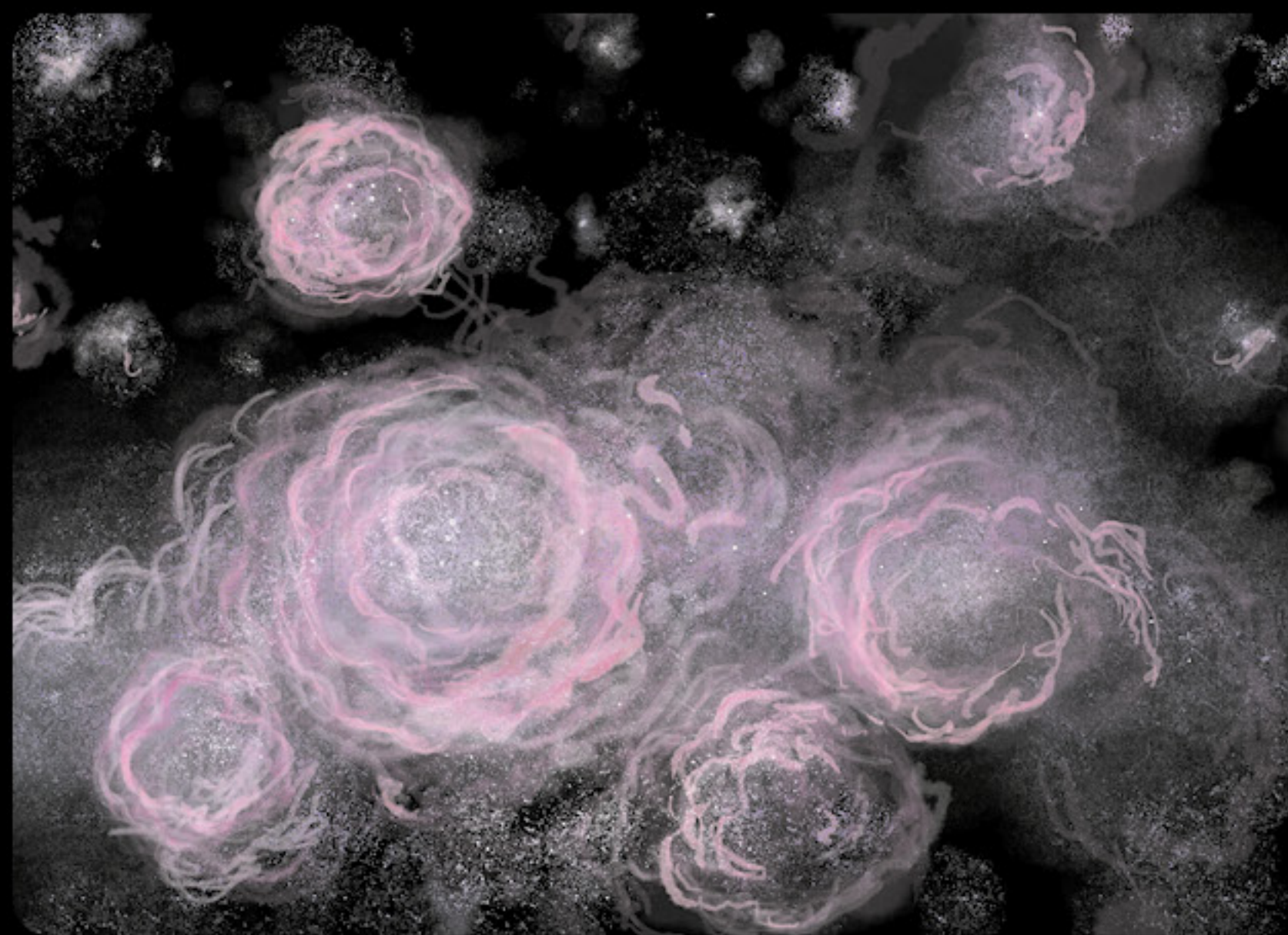
Albert Einstein

The genius physician Albert Einstein (1879–1955) originally believed the universe to be stationary, i.e. it wasn't either expanding, or shrinking. But his very own general theory of relativity ruled this out. Einstein handled it by including an auxiliary constant in his equations, though he later called this the greatest mistake he ever made.

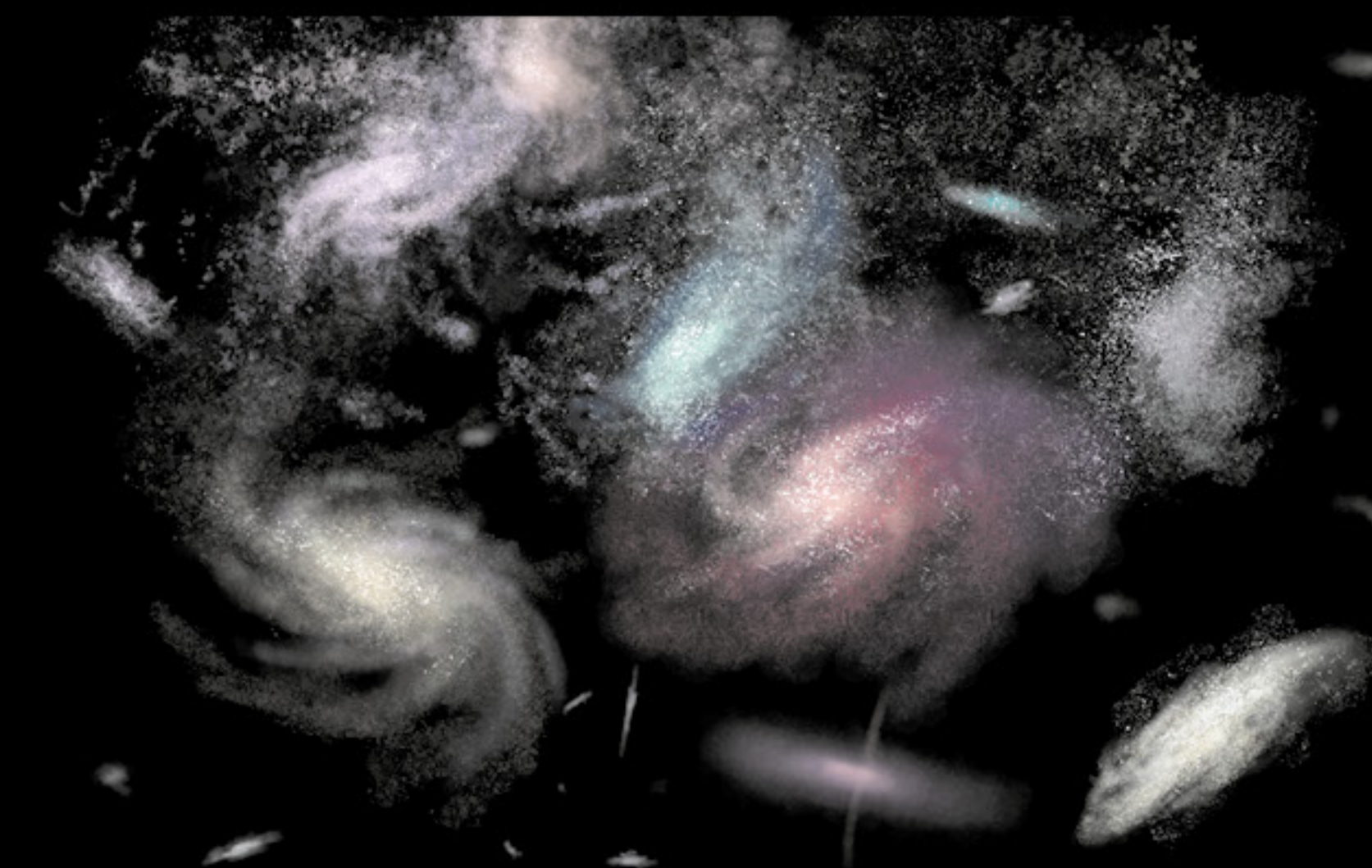


The famous equation

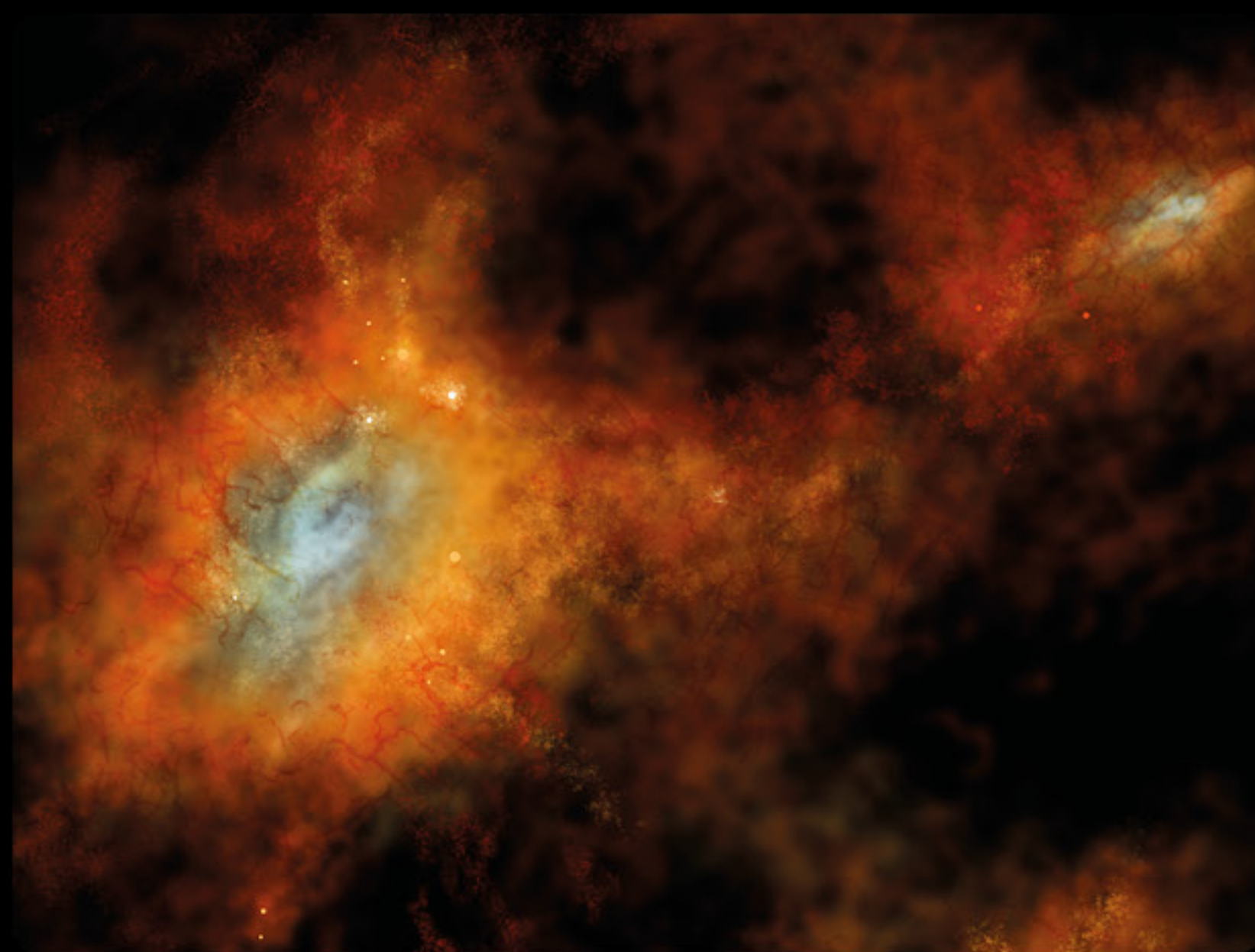
Einstein's special theory of relativity is expressed in this famous equation which states that the amount of energy contained in matter is directly proportional to its mass and the speed of light squared. And since the speed of light is quite large (300,000 km/s) it means that even the tiniest bits of matter contain huge amounts of energy.



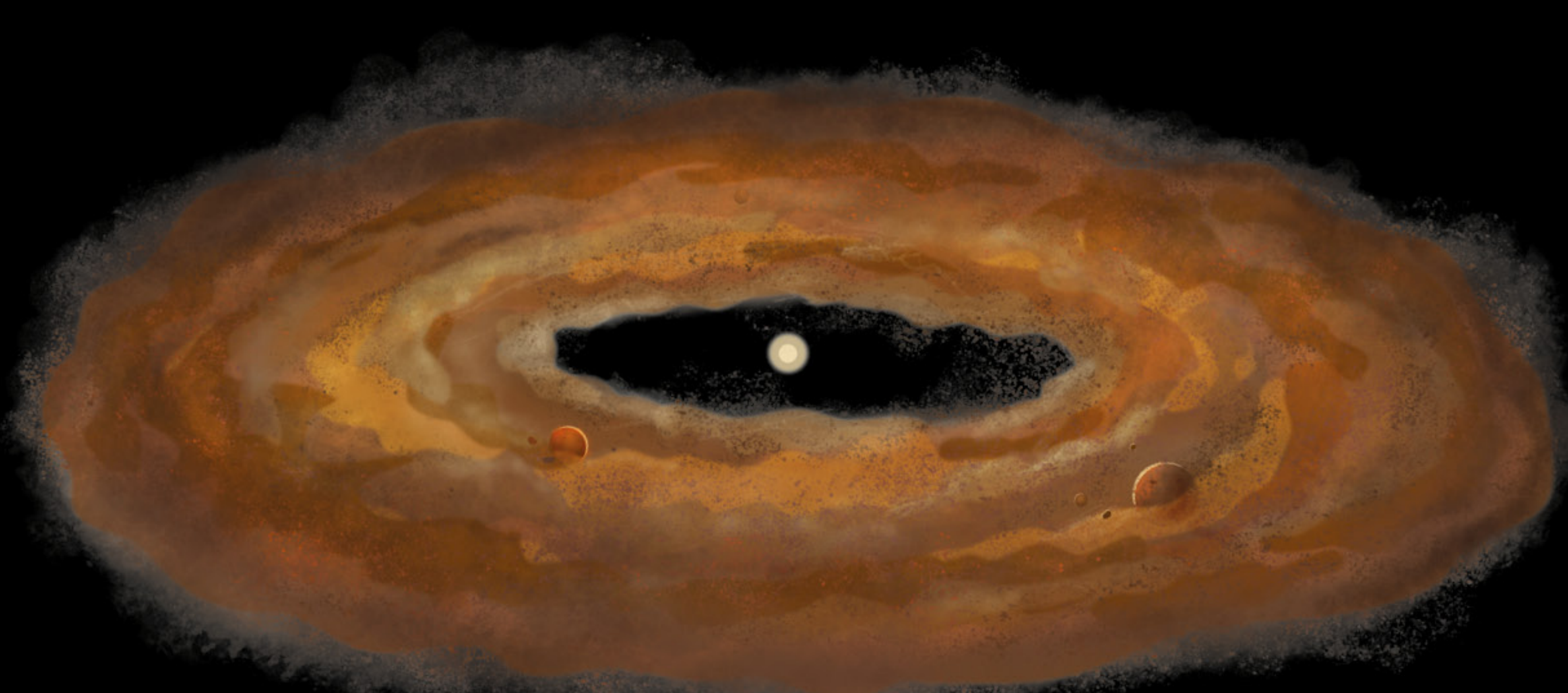
▲ **1. First stars**
Approximately 300 million years after the Big Bang, the first stars came on in the universe.



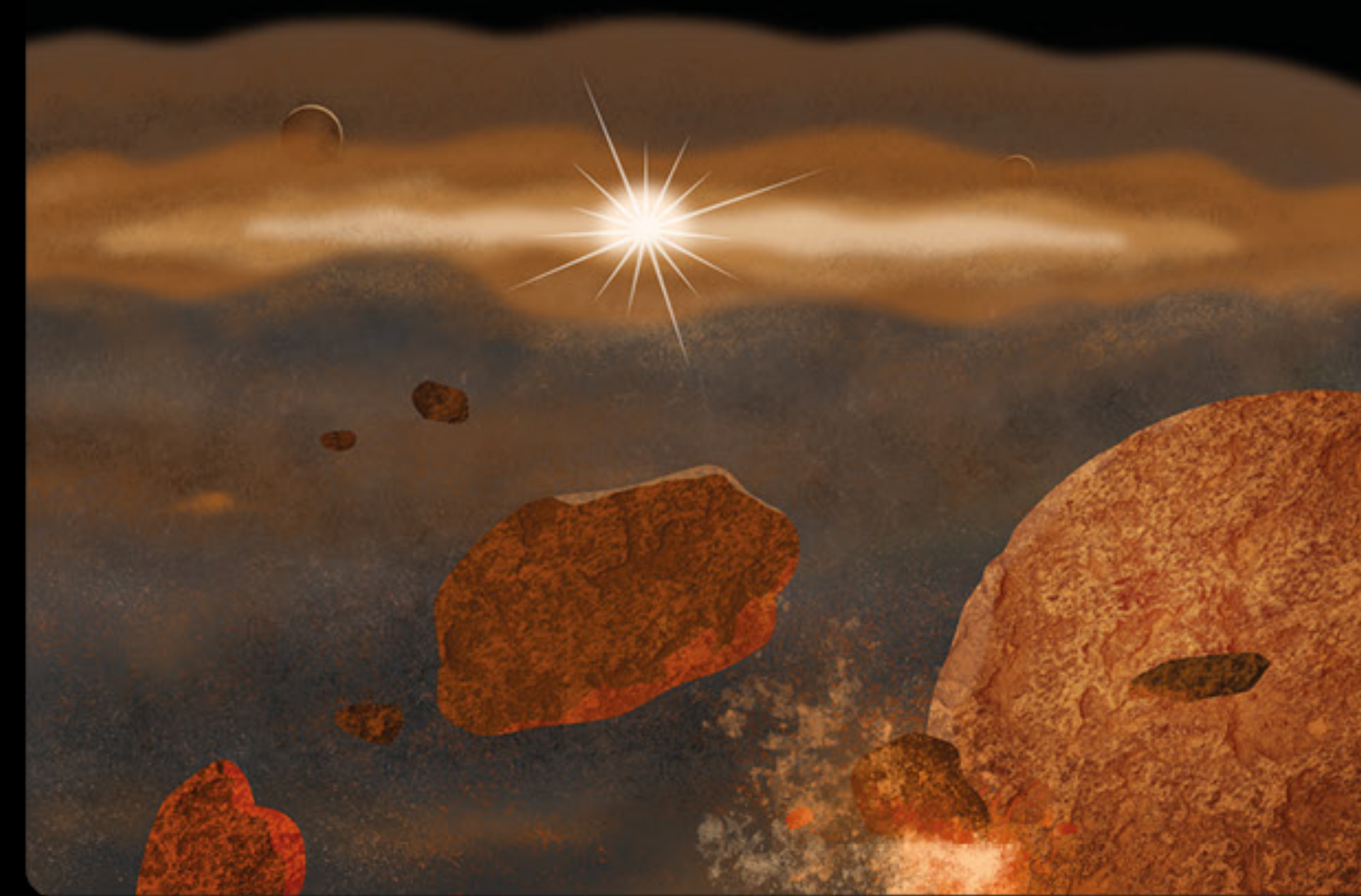
▲ **2. Birth of galaxies**
Just under a billion years after the Big Bang, the first galaxies began to form in the universe.



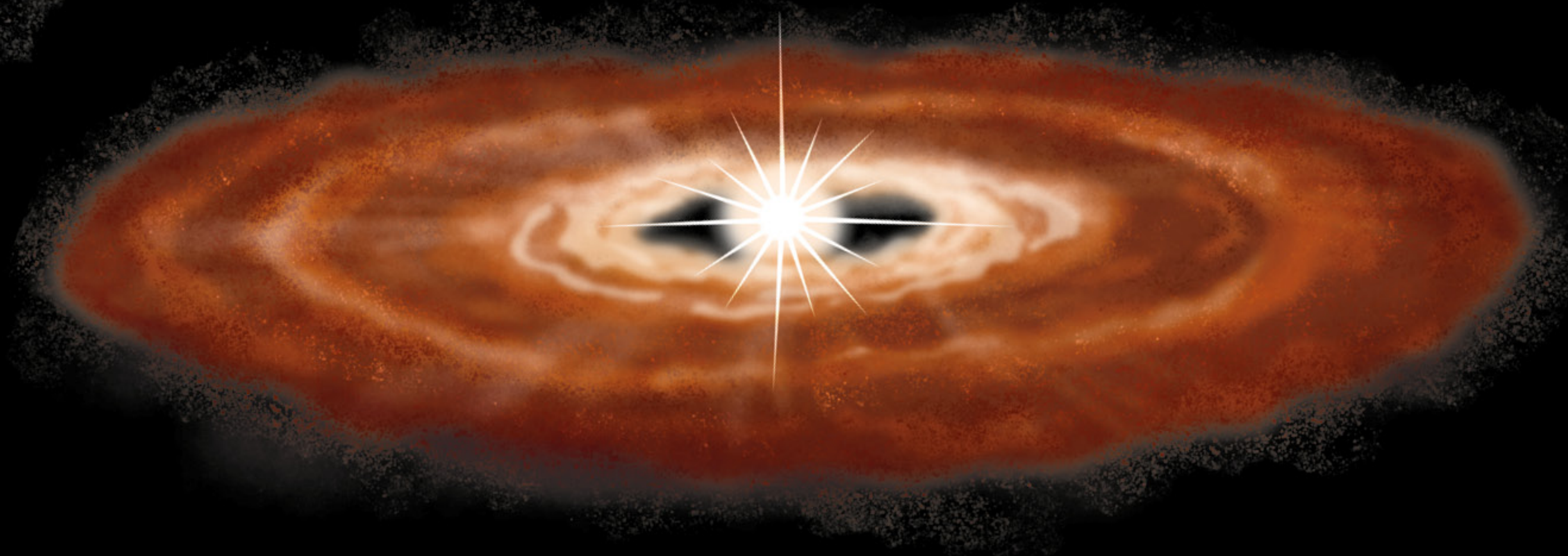
▲ **3. Formation of the Solar System**
In the circa 9.1 billion years old universe, a nebula of dust and gas formed and then went on to turn into our Solar System.



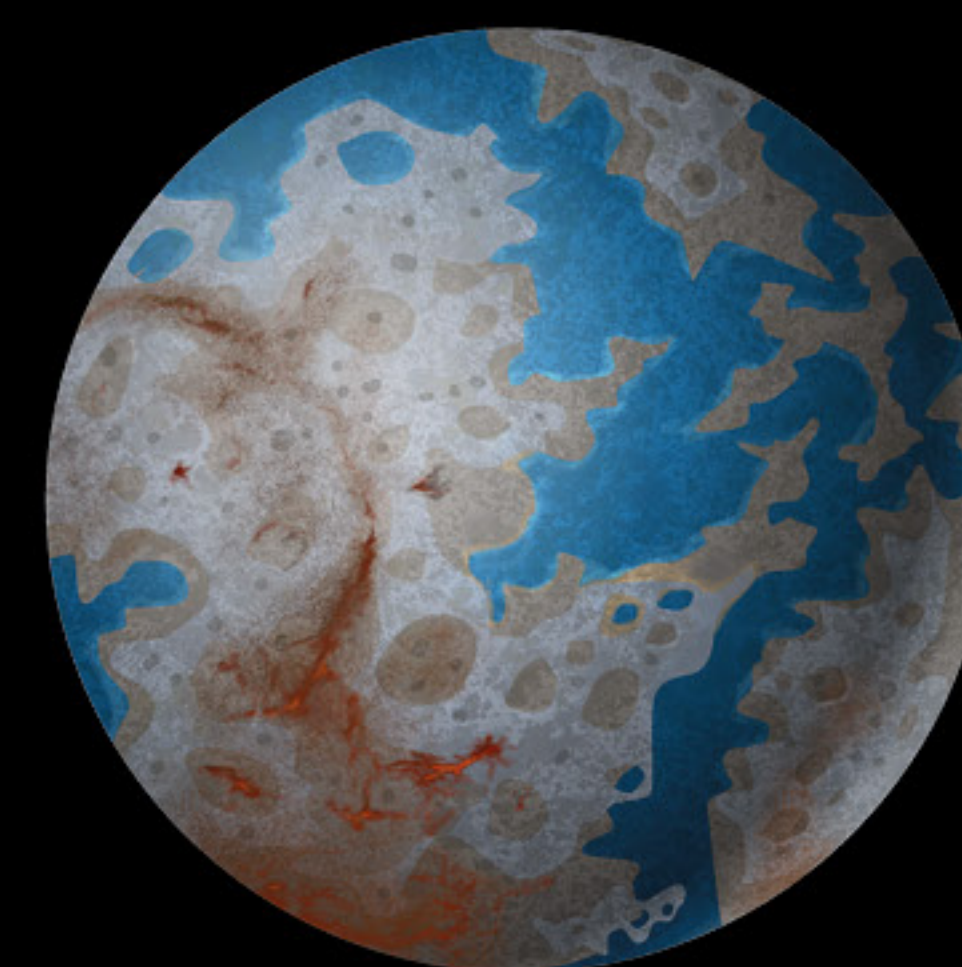
▲ **4. Seed of big planets is planted**
4.59 billion years ago, the seed of the future large planets was planted: Jupiter, Saturn, Uranus, and Neptune.



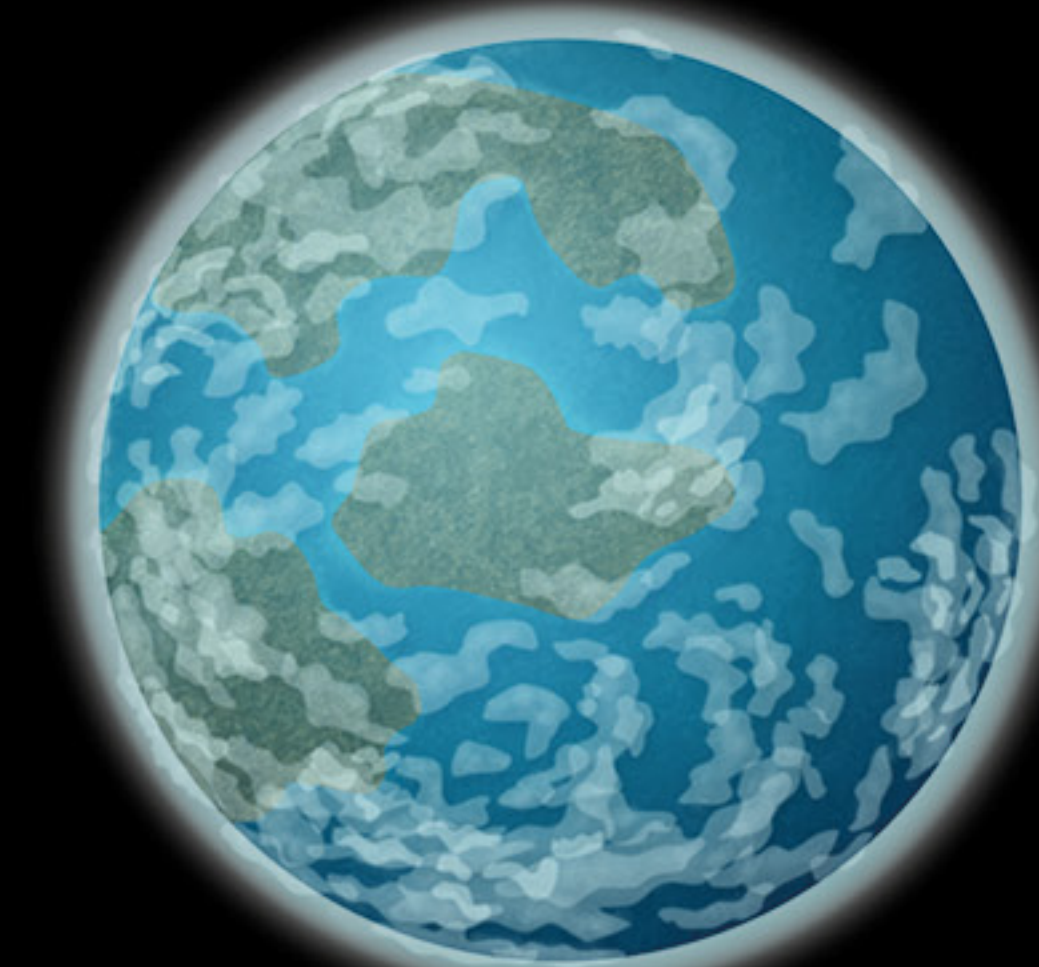
▲ **6. Earth and her sisters are born**
Approximately 50 million years after the Sun began shining, the planets Mercury, Venus, and Mars formed, as well as our Earth and Moon.



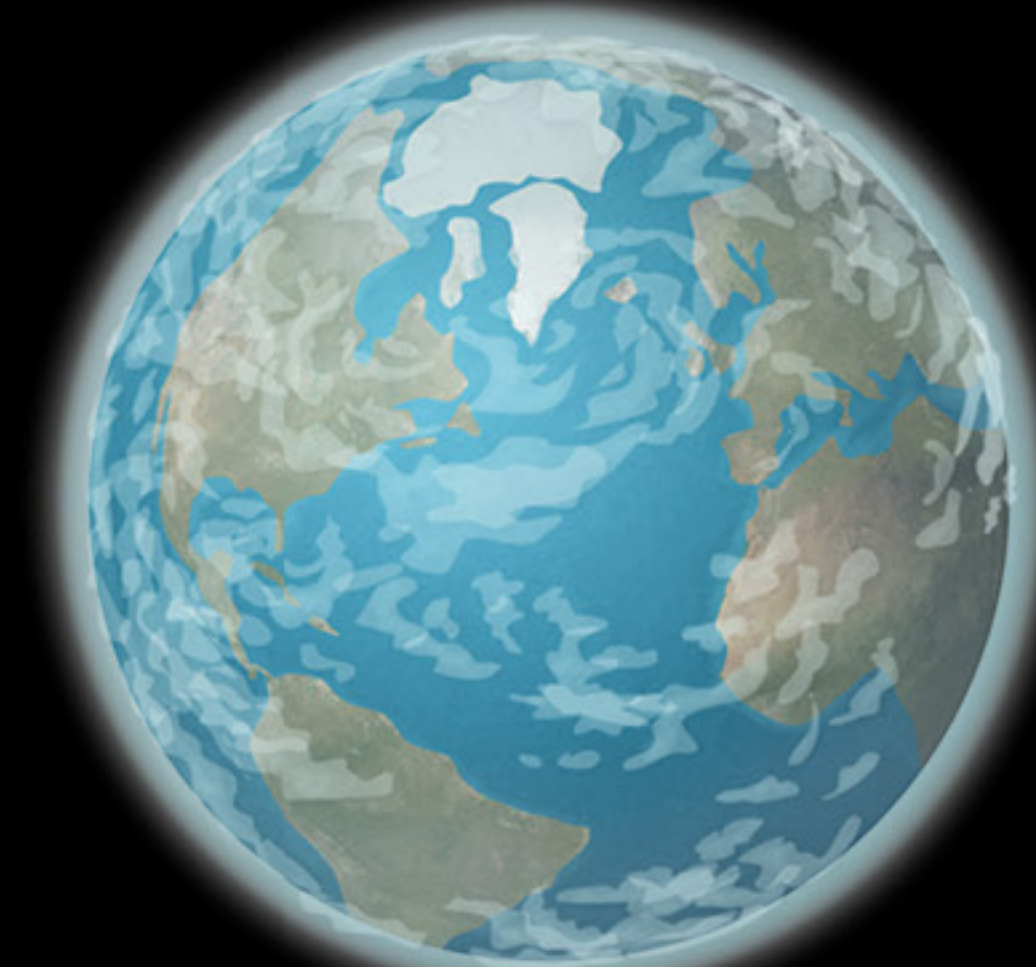
▼ **5. Sun becomes a star**
Our Sun first came on roughly 4.55 billion years ago.



▲ **7. Life on Earth**
Circa 3.8 billion years ago, the first primitive life appeared at the bottom of Earth's seas.

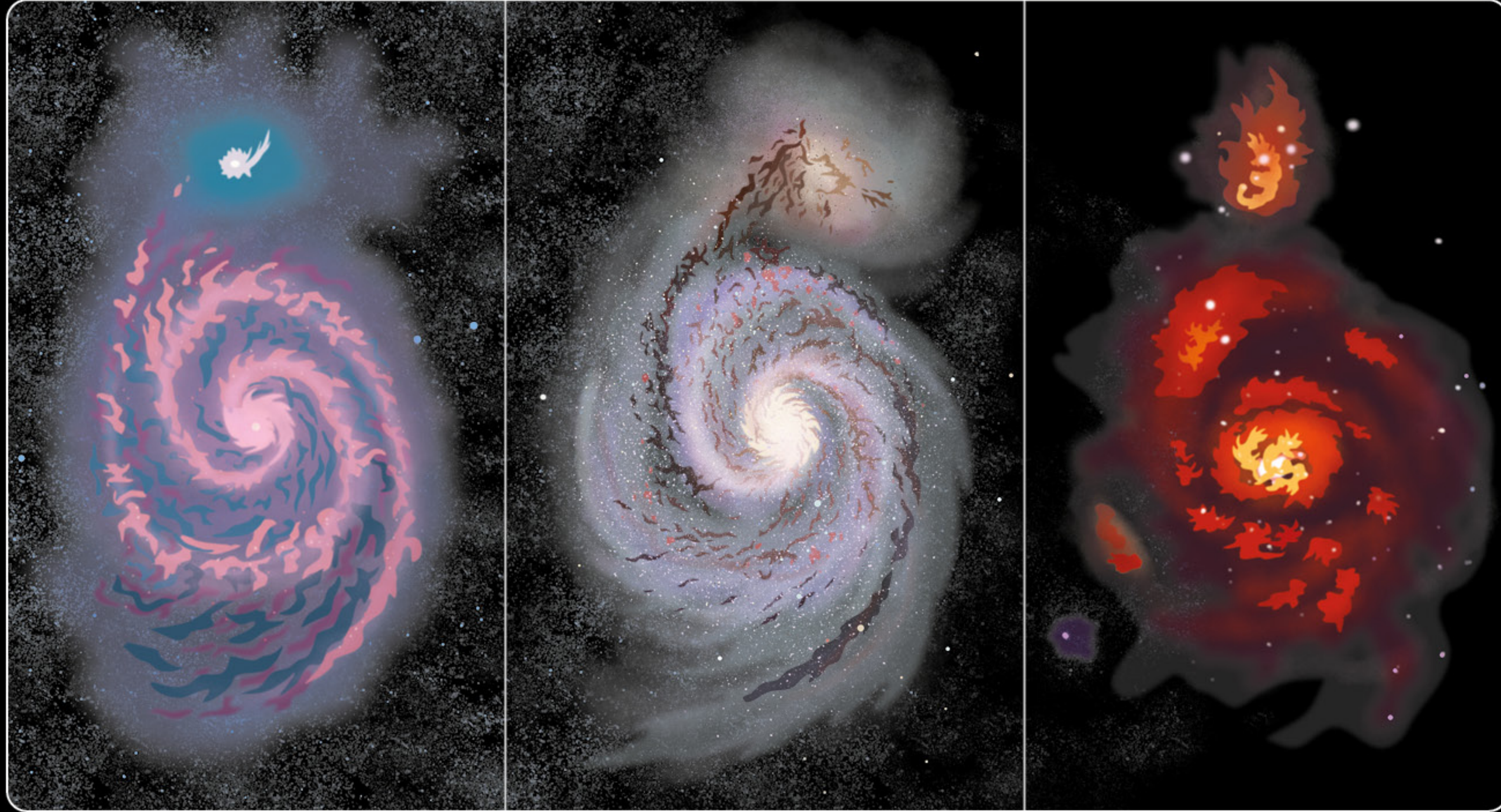


▲ **8. Breathable atmosphere**
Two-and-a-half billion years ago, photosynthetic organisms evolved on Earth and started pumping oxygen into the atmosphere, helping create the mixture of gases we breathe today.



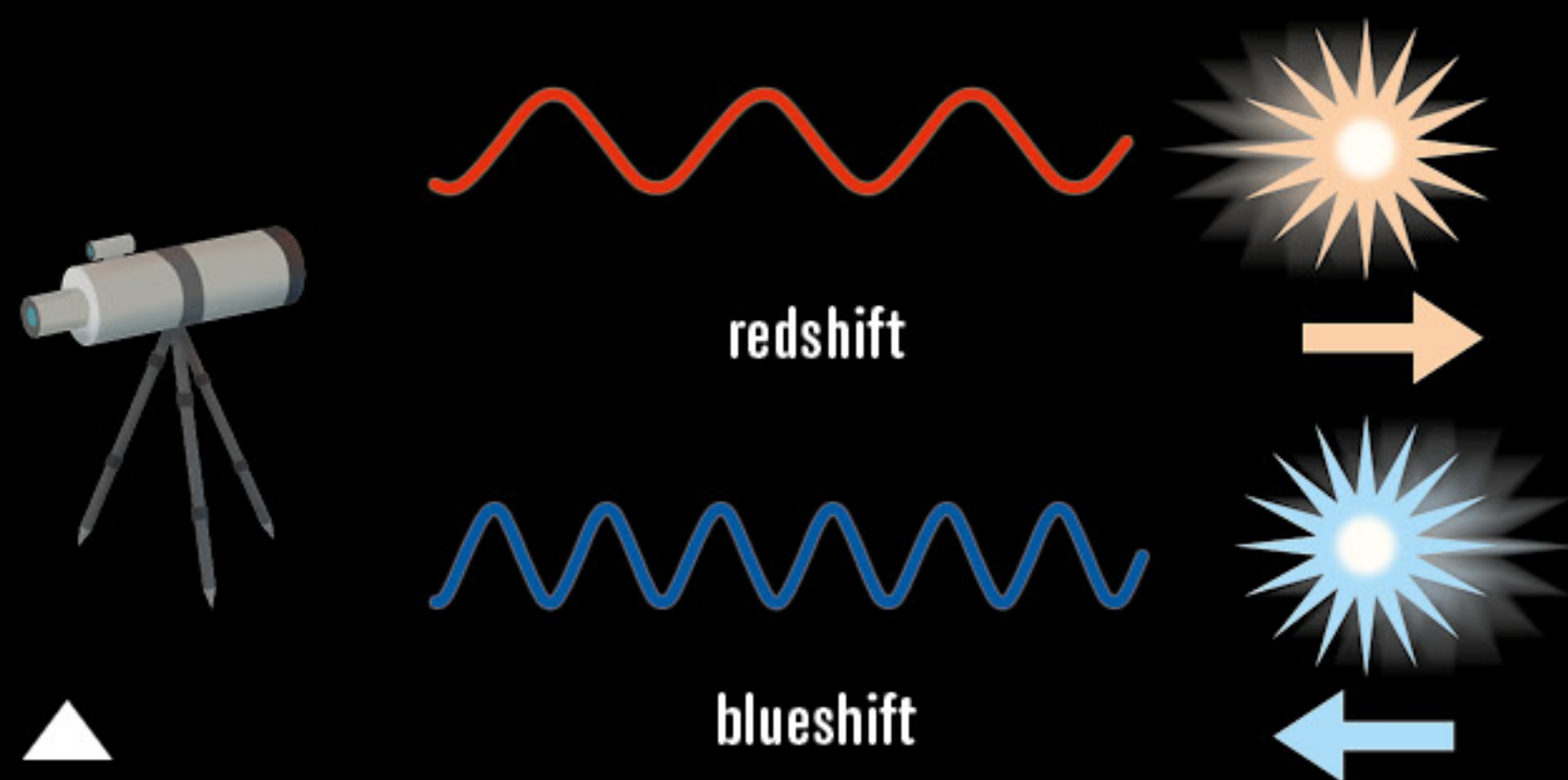
▲ **9. Present time**
Roughly half a billion years ago, multicellular organisms spread rapidly across Earth. Most of the first fossils of all known animal phyla ever found come from this period.

STARRY ISLANDS



Whirlpool galaxy

The view of the Whirlpool Galaxy M51, using various astronomy tools. Left: an ultraviolet image taken by the Spitzer Space Telescope. Middle: an image taken by the Hubble Space Telescope in the visible light. Right: an image taken by the Chandra X-Ray Observatory.



Redshift

Astronomers have discovered that the spectra of remote galaxies are leaning towards longer wavelengths. This is due to the expansion of the universe. The farther from our galaxy they are, the more they're moving away from us and the higher the redshift. Due to the so-called Doppler effect, the wavelength of an object moving away from the observer increases and spectral lines move into the red part of the spectrum. Conversely, blueshift occurs when an object moves towards the observer.

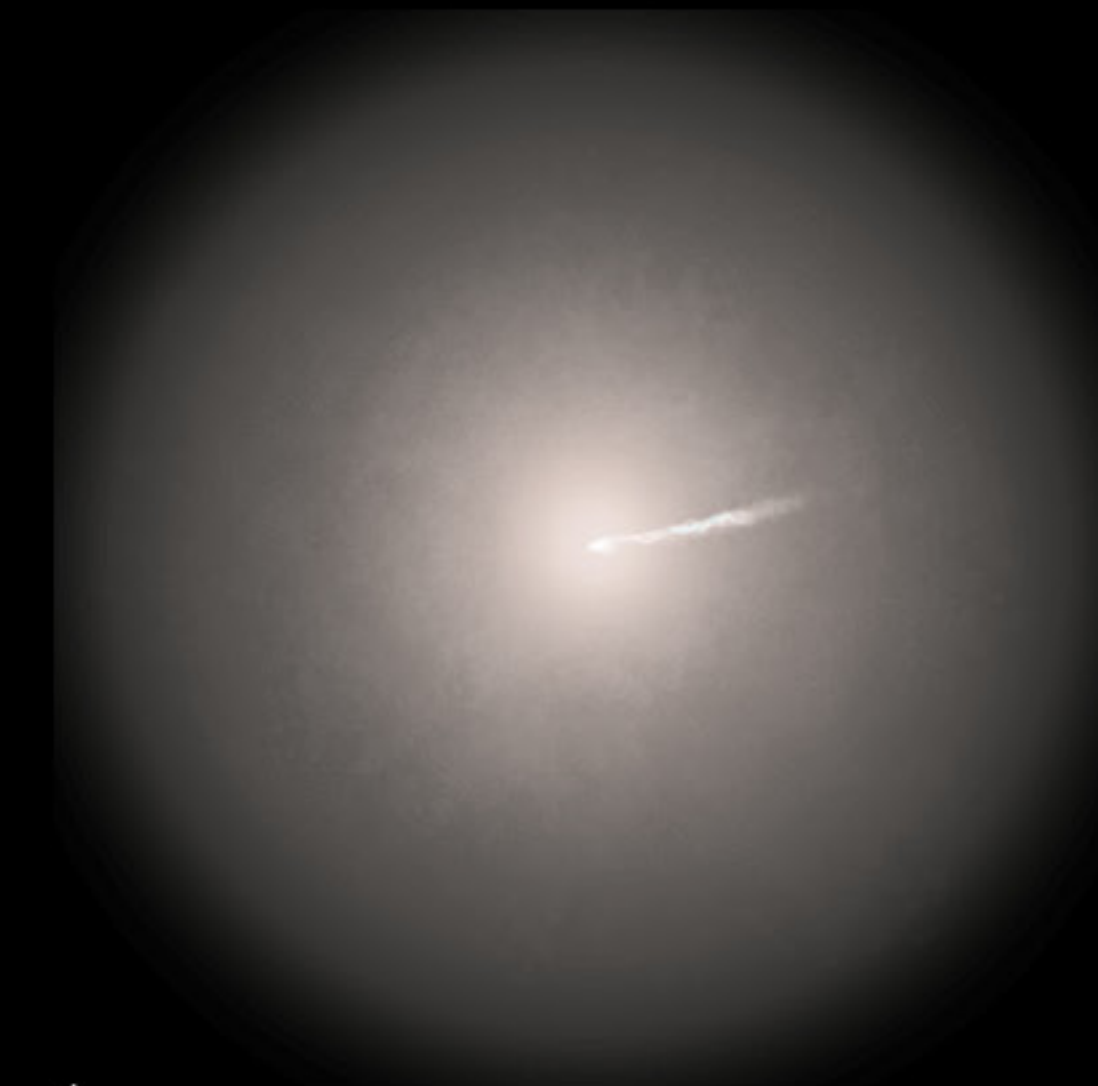
Black hole

This is an image of a supermassive black hole, located in the middle of the M87 galaxy. The black hole itself isn't visible; the dark spot in the middle is just its shadow. It's surrounded with a thin gas whose radiation has managed to reach Earth. That's why not even its centre is completely black.



Our galaxy

The word Milky Way refers to the galaxy we live in. It contains all stars visible by the naked eye, including our Sun which orbits the Galactic Centre at the distance of roughly 26 thousand light years. When seen from the side, the Galaxy appear relatively thin—its thickness amounts only to ca 1 thousand light years. On the other hand, it's approximately 200 thousand light years wide. It contains roughly 500 billion stars.



Elliptical galaxies

Elliptical galaxies are one of the largest starry islands in the universe, though they're not as impressive as their spiral siblings—that's because they have no arms. The image shows the huge elliptical galaxy M87 in the Virgo constellation, located 54 million light years away from us.

Galaxy cluster

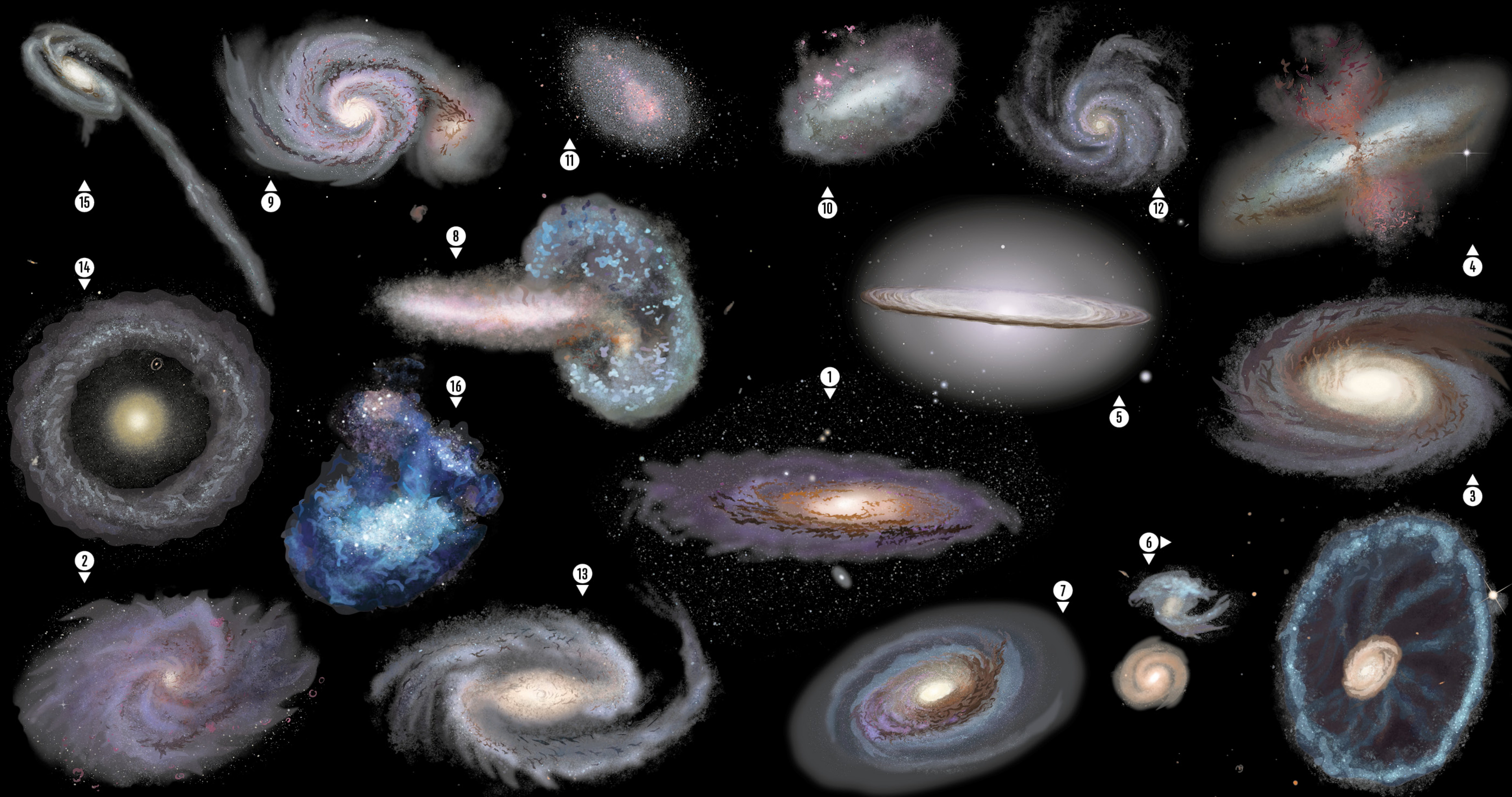
Galaxies don't like being alone. Most of them are bound by gravity to other galaxies, forming so-called clusters. Small galaxy clusters contain several tens of starry islands at most; large ones take up the space of tens of millions light years on average, accommodating up to thousands of starry islands!



In 1609, when Galileo Galilei aimed his telescope at the hazy belt known as the Milky Way, he was left in awe. The vague gleam which up until then had been considered to be nothing more than a foggy seam in the night's sky broke into thousands of stars. Thus, Galileo found out we were living in the middle of a huge starry island—a galaxy. Over time, astronomers discovered new clouds which, however, didn't turn out to be star systems. Many of them were dust clouds in our galaxy but there were also some which weren't nebulae at all. These included the Andromeda Nebula; it wasn't until 1923 when the U.S. astronomer Edwin Hubble learned it was a very distant galaxy, similar to ours.

Edwin Hubble





- 1. Galaxy M31** – Visible to the naked eye, the Andromeda Galaxy is located approximately 2.5 million light years away from us.
- 2. Galaxy M33** – It's located roughly 3 million light years away from us, one of the most remote objects visible to the naked eye.
- 3. Galaxy M81** – The light of this galaxy takes 12 million years to reach us.
- 4. Galaxy M82** – This special irregular galaxy can be found near Galaxy M81.
- 5. Sombrero** – Galaxy M104 looks sort of like a hat. There's a conspicuous dust ring surrounding it.

- 6. Cartwheel Galaxy** – This galaxy formed when two galaxies collided, their arms broke down and created spokes connecting the "felloes".
- 7. Black Eye** – Galaxy M64, with a dust belt near its centre, looks like a heavy-lidded eye.
- 8. Galaxy Arp 148** – The galaxy is a result of a collision of two large starry islands which are located roughly 500 million light years away from us.
- 9. Galaxy M51** – The Whirlpool Galaxy, which interacts with another galaxy, is one of the most beautiful formations you can observe with a telescope.

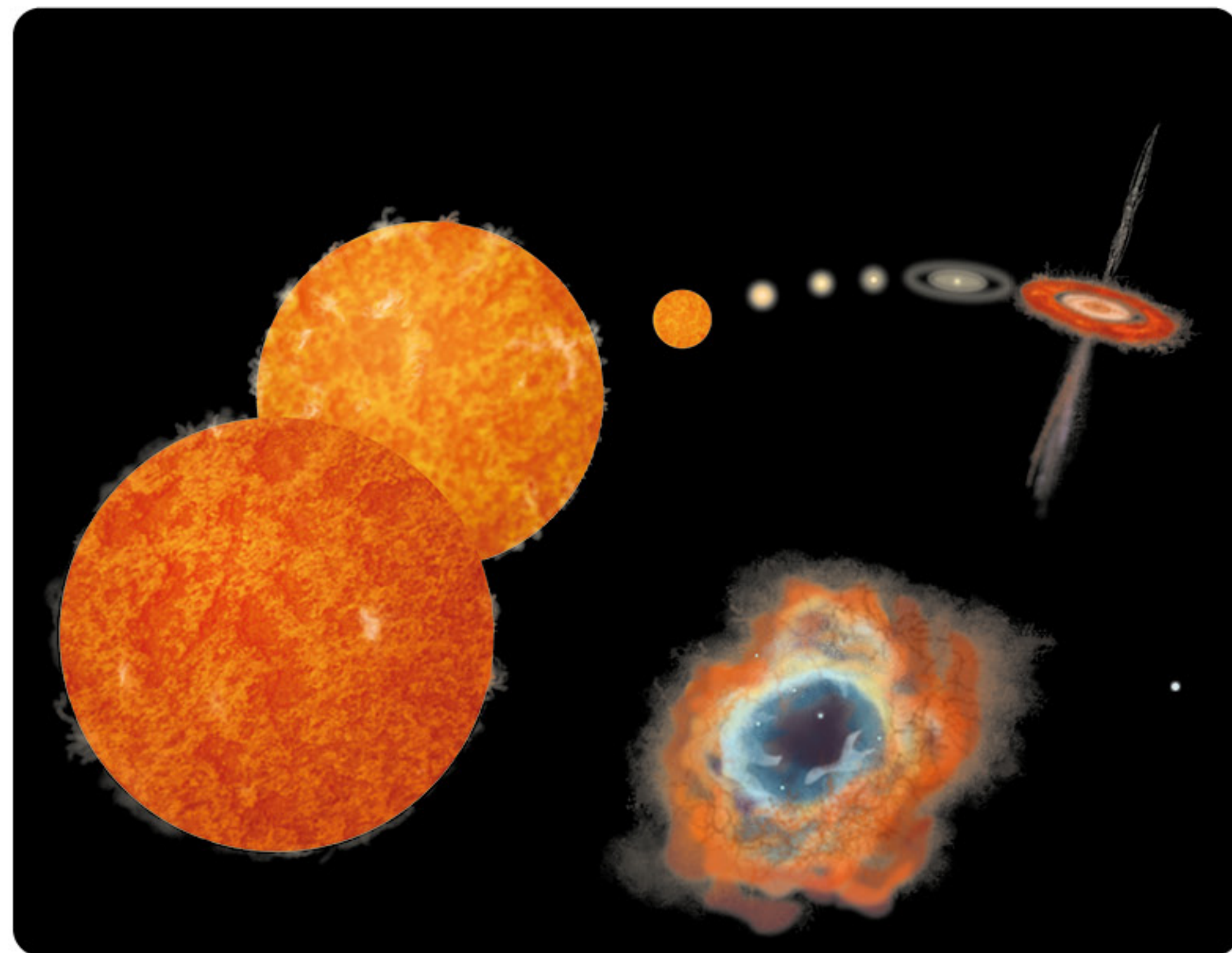
- 10. Large Magellanic Cloud** – A close neighbour of our own galaxy, it can only be seen from the southern hemisphere.
- 11. Small Magellanic Cloud** – It's located roughly 200,000 light years from Earth, that is approximately 30,000 light years further than the Large Magellanic Cloud.
- 12. Pinwheel** – The M101 is a face-on galaxy, meaning we can admire its arms to our heart's content.
- 13. Galaxy with a bar** – The NGC 1300 galaxy has a noticeable bar in the middle.

- 14. Hoag's object** – A ring galaxy, it likely formed after a collision of two different galaxies.
- 15. Tadpole Galaxy** – A galaxy whose trail is 280,000 light years long and full of young stars.
- 16. Distant galaxy** – An artist's rendition of one of the most distant galaxies, known as CR7. Its light takes 12.9 billion years to reach us!

REALM OF STARS

Life of stars ►

Astronomers observe a huge amount of stars in various stages of their life cycle. Monitoring the fate of other stars allows scientists to describe a star's past and future journey which depends mostly on mass—the more mass do it has at the beginning, the sooner and more horrible its end. Our Sun is currently in its prime. In a few billion years, it will puff up to become a red giant and once it turns old it will change into a cooling white dwarf, surrounded with an emission gas envelope.



▲ UY Scuti

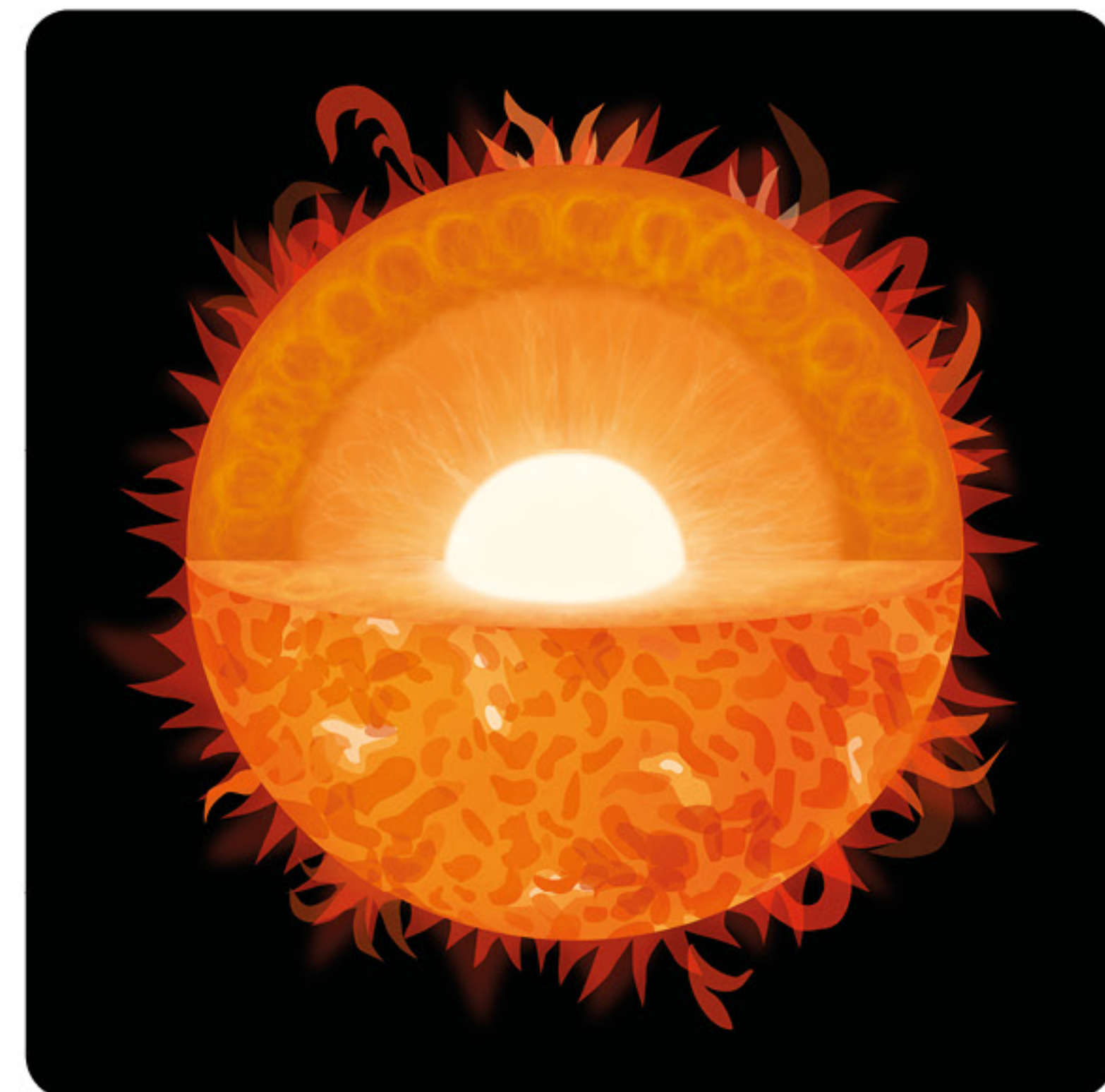
▲ Sun

Big boy star

The star called UY Scuti is a red hypergiant in the Scutum constellation. One of the biggest known stars, it's located roughly 9,500 light years away from us. Our Sun would look like a tiny dot when placed next to it; it's almost a thousand times smaller than this big boy!

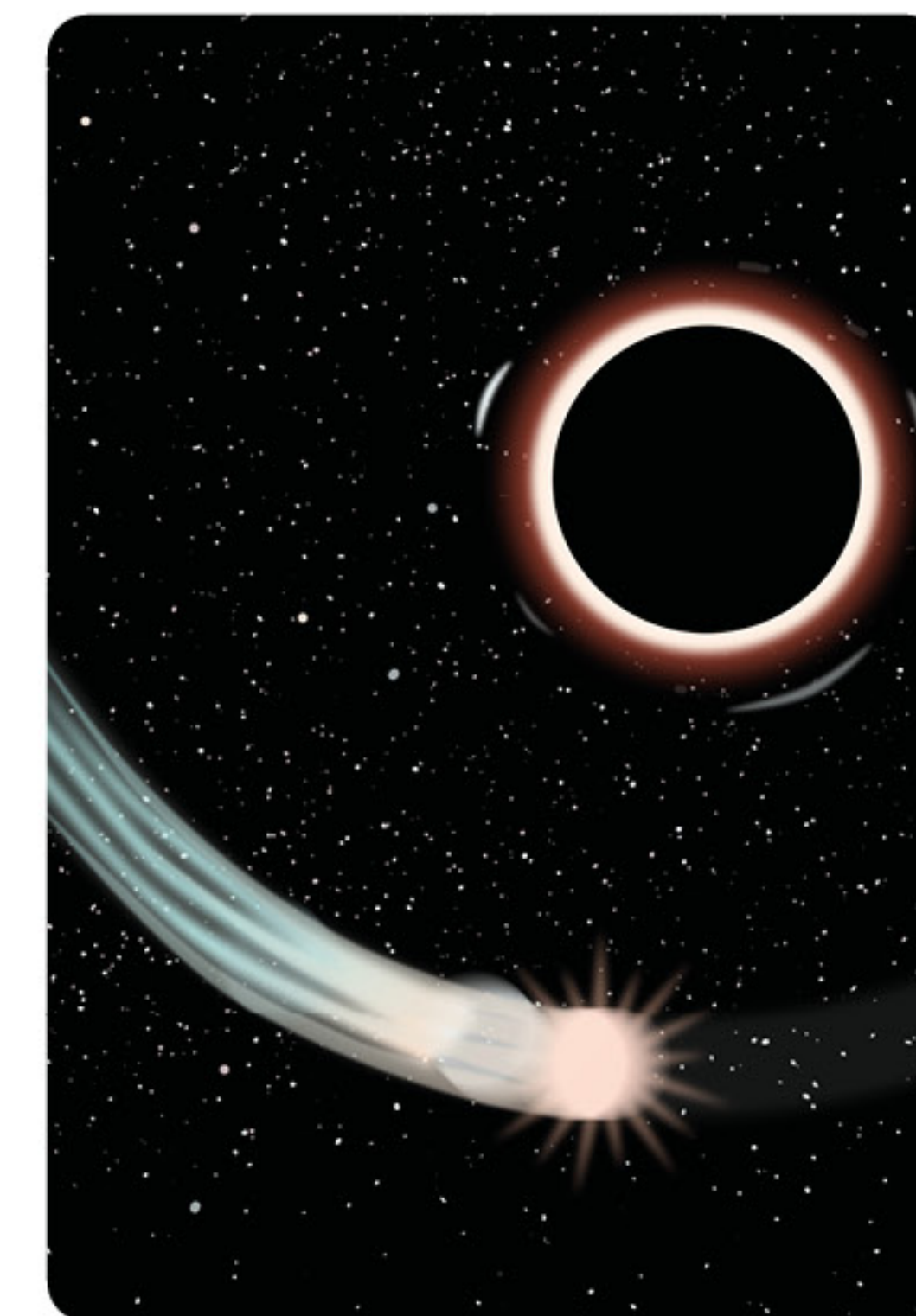
Inside the Sun

Thermonuclear reactions occur inside the Sun at huge temperatures and pressures, making our star shine. At the moment, the Sun burns hydrogen, converting it to helium. Once the Sun consumes almost all of the hydrogen, it will begin turning the helium to carbon, becoming a red giant. But that won't happen for 6 billion years.



Black holes ►

The most massive stars in the universe can look forward to a very cruel end. Once they're no longer able to resist the pressure of their own outer layers, they collapse and the so-called event horizon forms. The star essentially collapses into itself, creating a black hole from which nothing can escape, not even light itself.

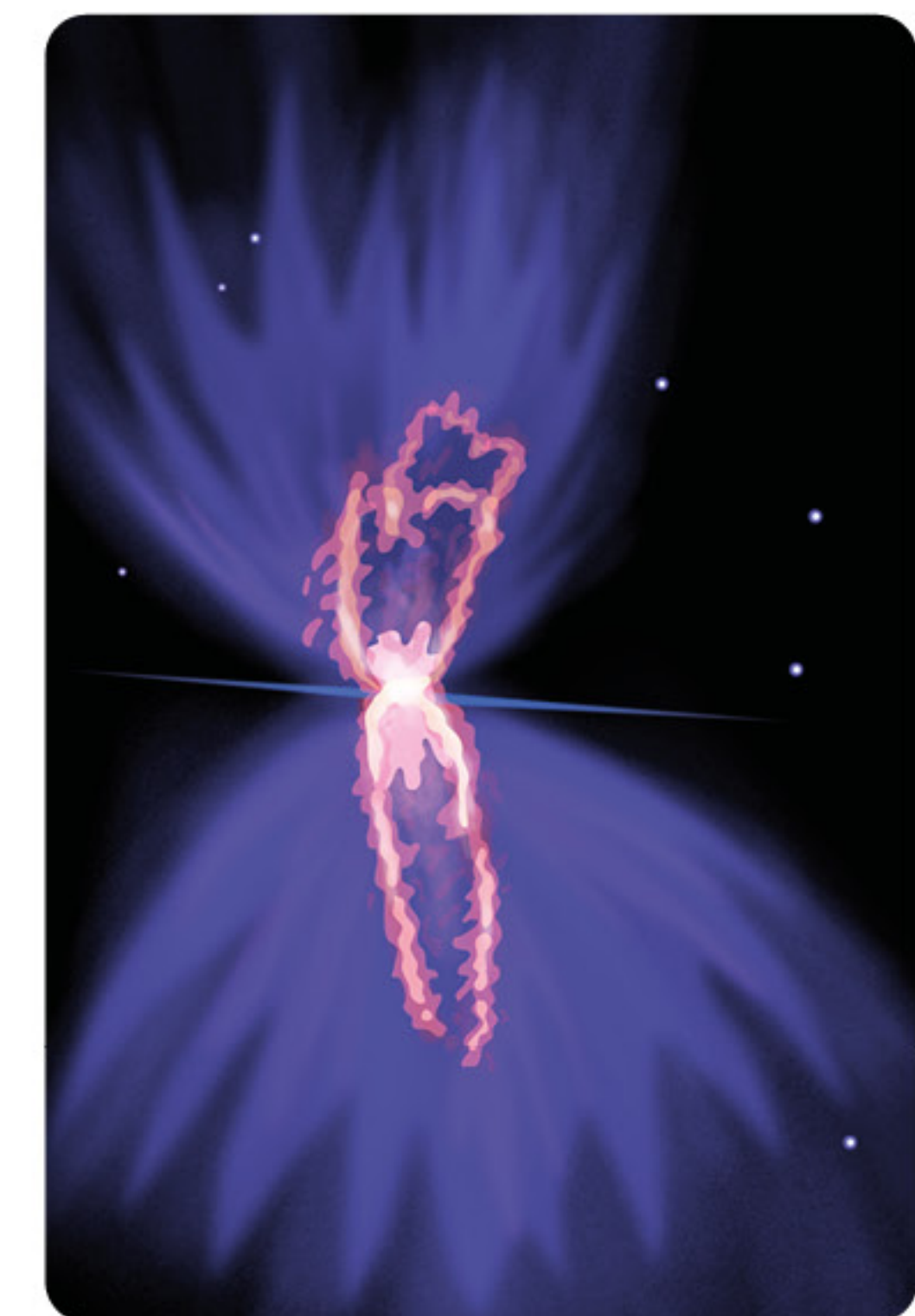


The fastest star

There's a supermassive black hole at the centre of our galaxy, whose gravity affects the behaviour of nearby stars mercilessly. One of the stars, named S2, orbits the black hole at the speed of 8,000 kilometres a second! If you were able to develop such a speed, you'd orbit Earth in just five seconds!

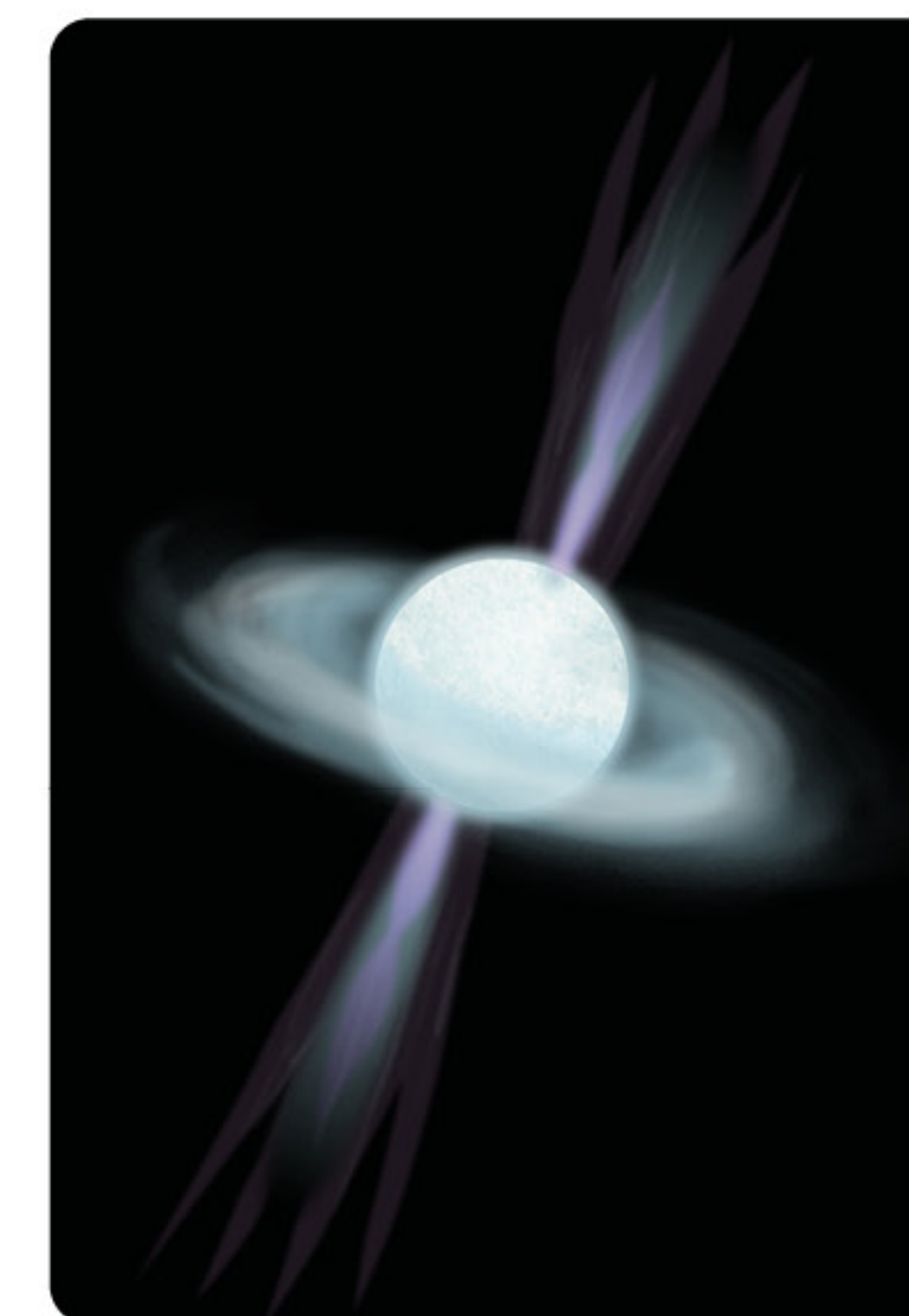
The coldest nebula

Stars are very hot but sometimes they can also create cold. That's the case of the Boomerang Nebula. In its centre, there's a star that releases gases at a rapid speed. Those cool the surrounding nebula to the incredible temperature of -271°C —just two degree above the absolute zero!



Neutron star

When a star explodes in the form of a supernova, it leaves behind its core which contains a huge amount of compressed matter. Imagine a sugar cube that has more mass than several fully loaded cargo ships! Neutron stars are also famous for their fast rotation. The fastest one rotate around their axis at the speed of up to 700 times a second!





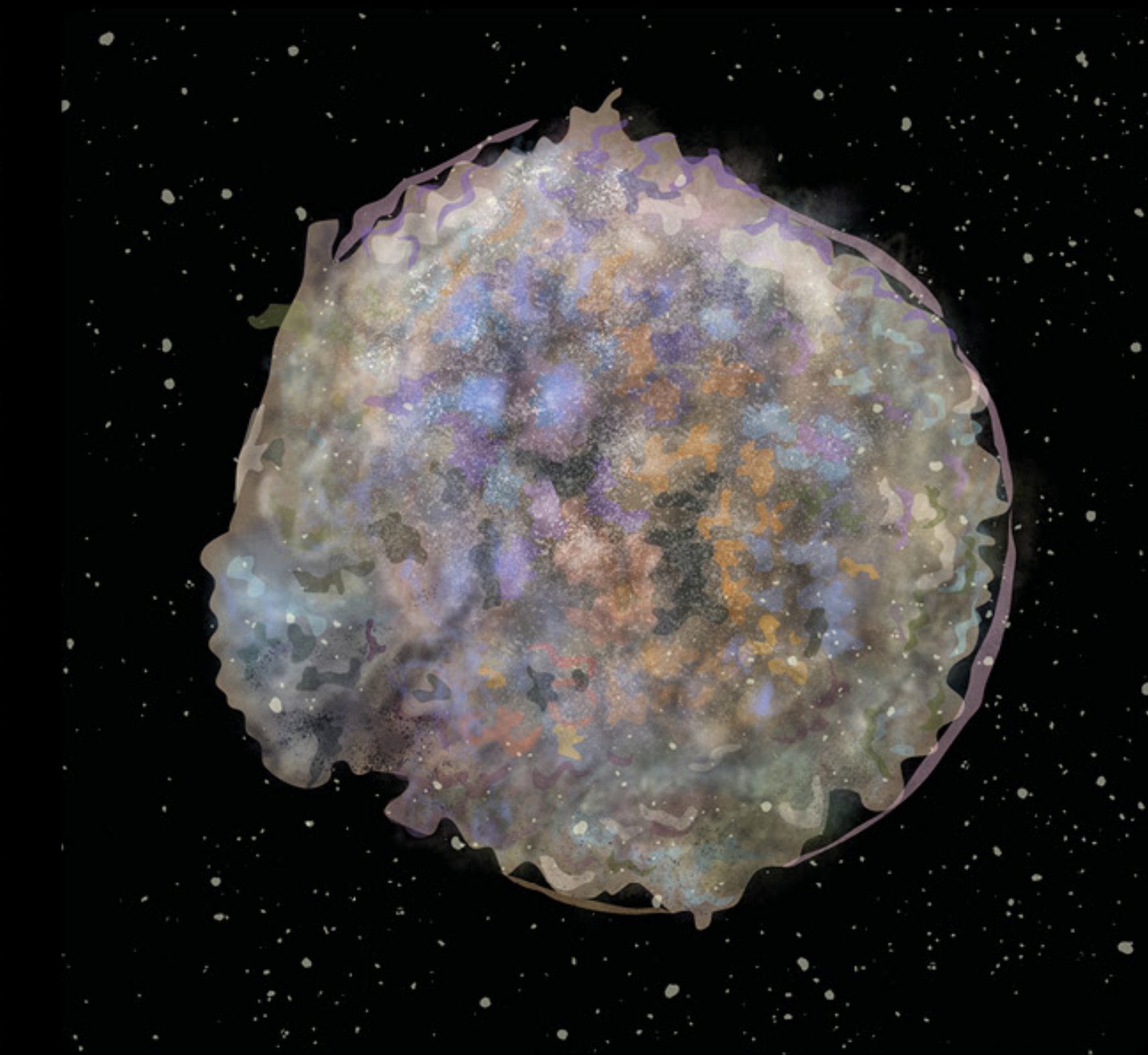
▲ **Helix Nebula**
A star's emission gas envelope, the so-called planetary nebula.



▲ **Horsehead Nebula**
A cloud of dust and gas in the Orion constellation.



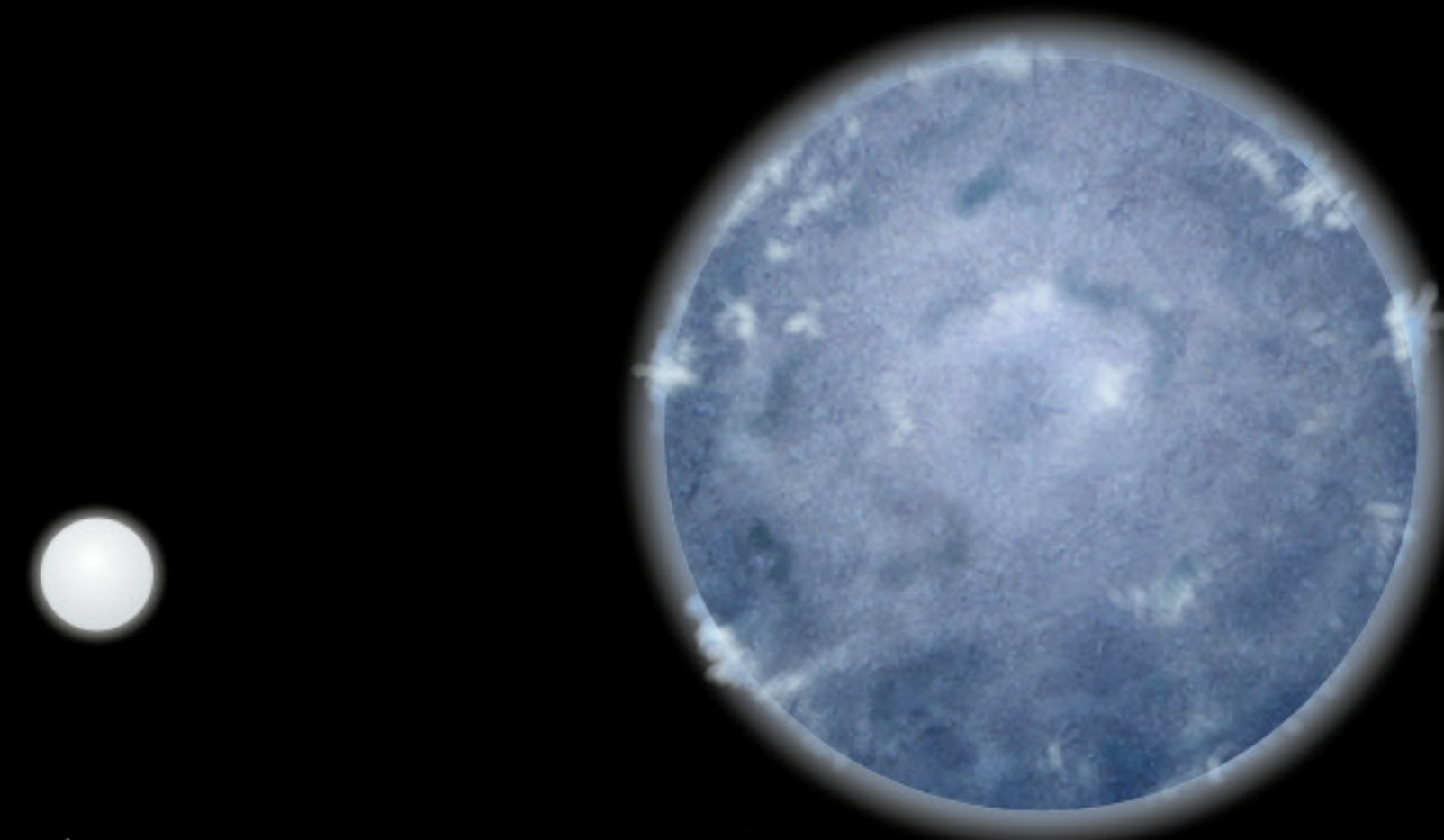
▲ **Omega Nebula**
It's likely that new stars are also forming in this nebula in the Sagittarius constellation.



▲ **Tycho's supernova**
Remnants of an explosion observed in 1572 by the astronomer Tycho Brahe.

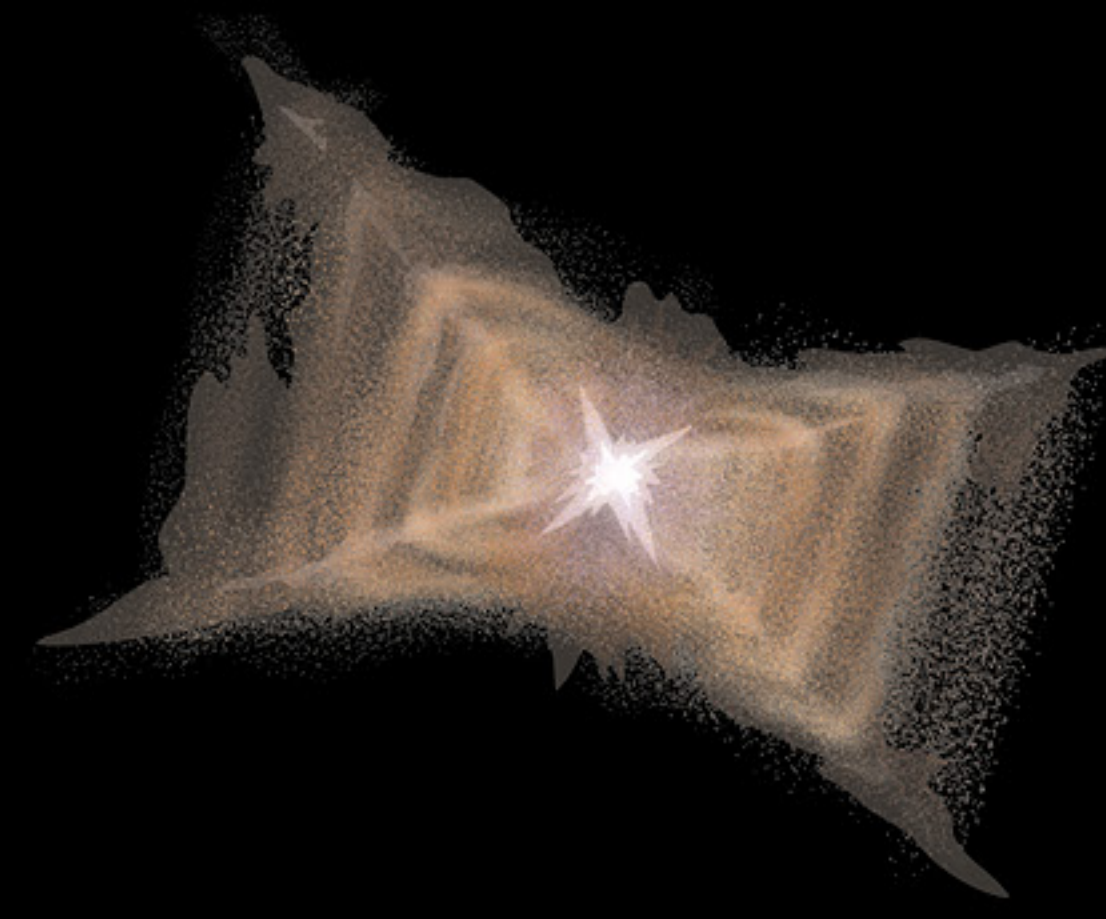


▲ **Pillars of Creation**
A known nebula in the Eagle constellation where new stars are forming.

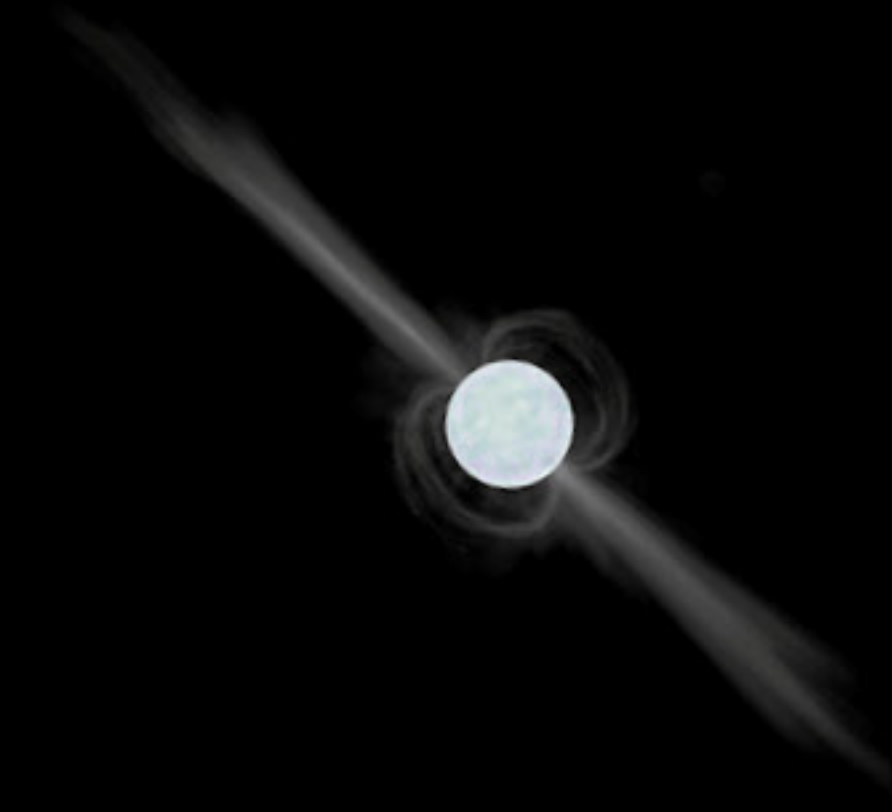


▲ **White dwarf**
One of the final stages of a star's life cycle. The Sun will go through it, too.

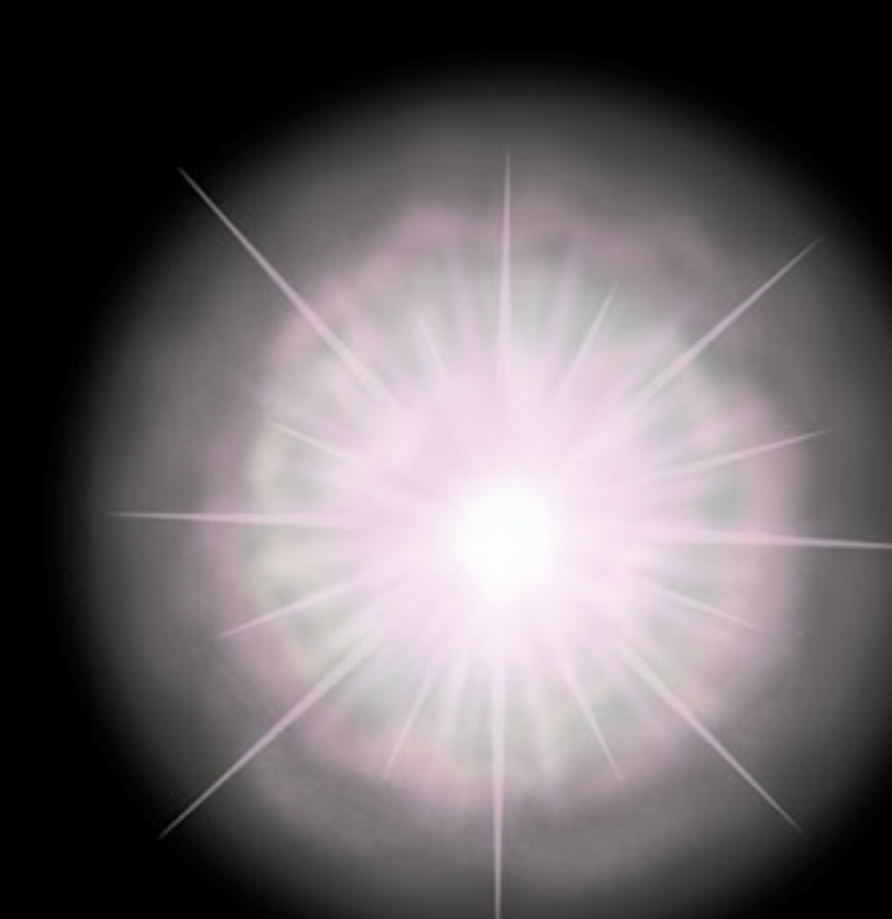
▲ **Blue giant**
This type of stars can have up to 150 times more mass than the Sun.



▲ **Red Rectangle Nebula**
An unusual planetary nebula.



▲ **Heart of the Crab Nebula**
This neutron star has only about 20 km in diameter but its mass is 5 times the Sun's!



▲ **Supernova explosion**
The Crab nebula formed during the explosion of a supernova in 1054.



▲ **Crab Nebula**
Remnants of a supernova explosion in the Taurus constellation.



CONSTELLATIONS



Northern sky

If you stand on the icy North Pole, you're only able to see the northern half of the sky. But the further south you go, the more of the southern part will reveal itself to you.



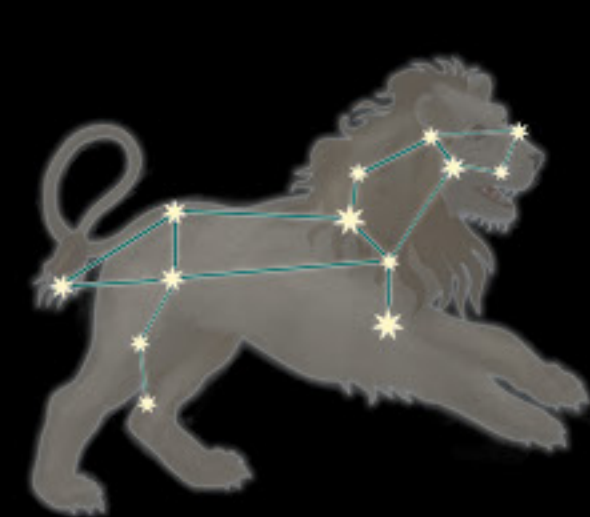
Southern sky

At the equator, you can observe both the northern and southern sky throughout the year. In the Antarctica, only the southern part is visible.



Claudius Ptolemy

People have been giving names to distinct clusters of stars since time immemorial. Thus, the heavens started to feature the names of gods or mythical heroes, as well as completely ordinary things. What gained the most prominence over time were the names of the constellations described by the Greek astronomer Claudius Ptolemy in 148 AD. It wasn't until 1930 when the International Astronomical Union tidied things up and introduced the 88 constellations we know today.



Leo – This constellation really does look like a resting lion, with the bright Regulus for heart.



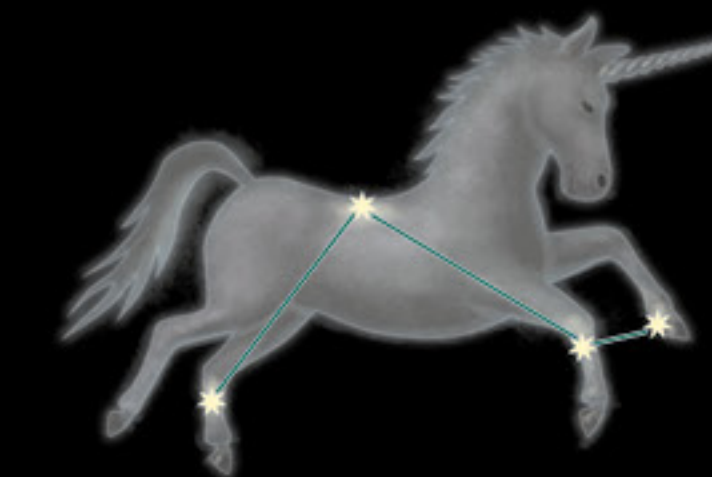
Boötes – A northern constellation which includes the distinct star known as Arcturus. The Boötes is considered to be the guardian of the Ursa Major and Ursa Minor constellations.



Cancer – An inconspicuous constellation with the open Beehive Cluster which in good conditions is visible to the naked eye.



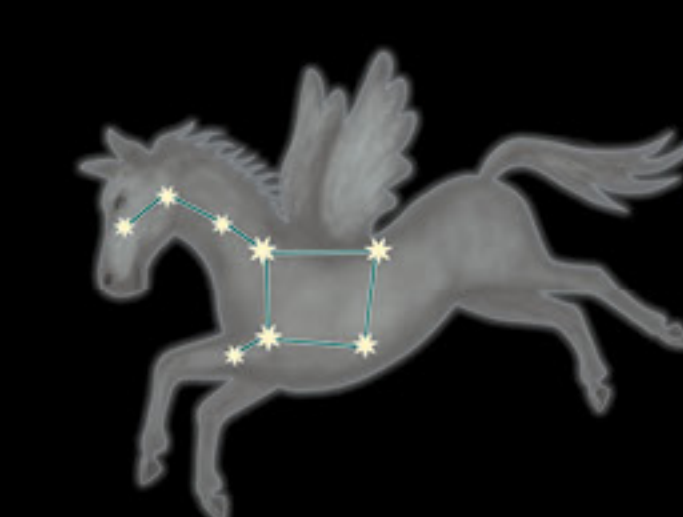
Lepus – Or Hare. It can be found near the Orion, a figure who hunts hares.



Monoceros – An inconspicuous constellation close to the Orion.



Cetus – The fourth biggest constellation in the sky. It stands for a sea monster sent by the god Poseidon.



Pegasus – A constellation named after a mythical winged horse, the son of Poseidon and Medusa.



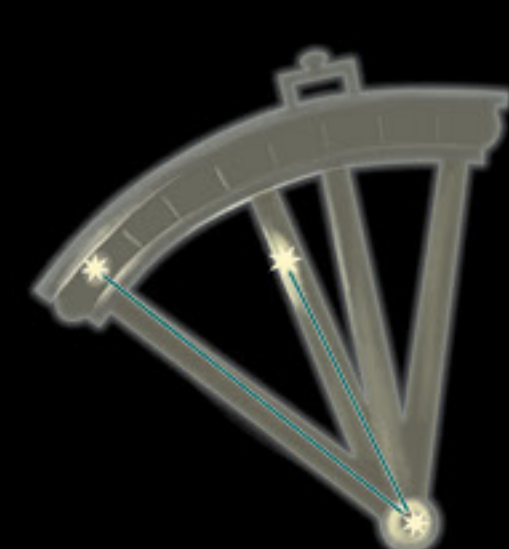
Capricornus – One of the less distinct zodiac constellations, named after the Greek god of pastures and forests.



Perseus – A distinct constellation in the northern sky. The Perseids, a meteoric shower, rain from its direction in the summer. The mythical Perseus cut off the head of the terrible Medusa who had snakes for hair.



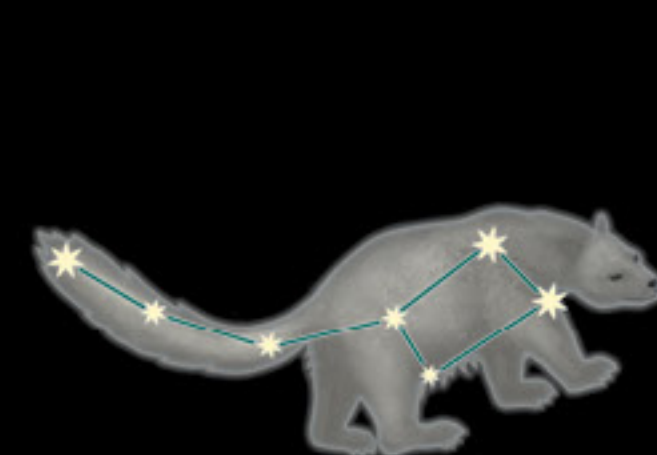
Sagittarius – A zodiac constellation which includes the brightest and most beautiful part of the Milky Way.



Sextans – A small constellation, named after the sextant—a tool for measuring angles in the sky.



Draco – A large constellation which never goes down in the northern hemisphere.



Ursa Minor – Also known as the Little Dipper. It includes the North Star which allows you to easily tell where the north is.



Ursa Major – The seven brightest stars of this large constellation make up the well-known formation called the Big Dipper.



Cygnus – A beautiful northern constellation which bears the Latin name for swan. According to legend, the god Zeus would turn into a swan whenever he wanted to walk among humans.



Delphinus – An adorable constellation which looks like a dolphin. According to a Greek legend, a dolphin saved the life of the poet Arion who was thrown by sailors into the sea.



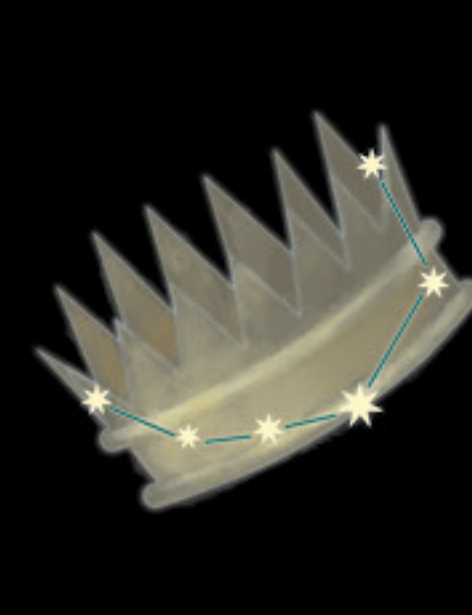
Crux – A distinct southern constellation which includes a bright part of the Milky Way. It's the smallest of the 88 constellations in the sky.



Tucana – A modern constellation, it was introduced by Dutch seafarers in the 17th century. It depicts a South American bird with a big colourful beak.



Cassiopeia – An easily recognisable W-shaped constellation in the northern sky.



Corona Borealis – A small constellation which looks like a crown with an inset jewel—its brightest star, Gemma.



Taurus – The Latin name meaning Bull refers to a very distinct constellation with the reddish star Aldebaran which stands for the bull's eye.



Orion – One of the most beautiful and majestic constellations of all. You can recognise it by the three bright stars which make up its belt.



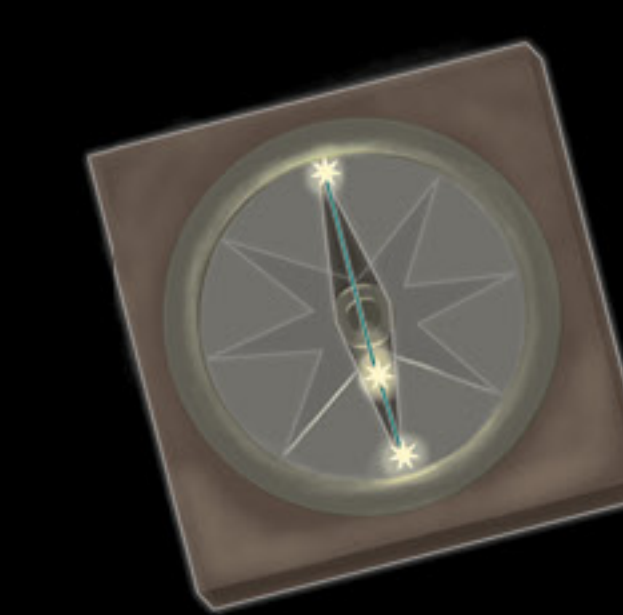
Columba – An inconspicuous constellation which stands for the biblical dove holding an olive leaf in its beak.



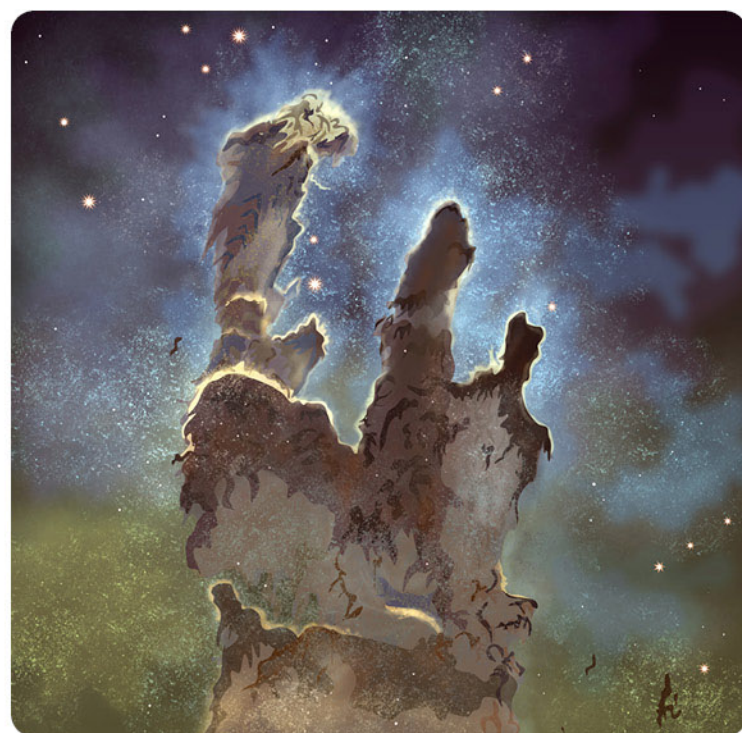
Phoenix – A southern constellation which shows the mythical Phoenix, a bird.



Volans – An inconspicuous constellation, named after flying fish whose fins enable them to glide across the surface of water.

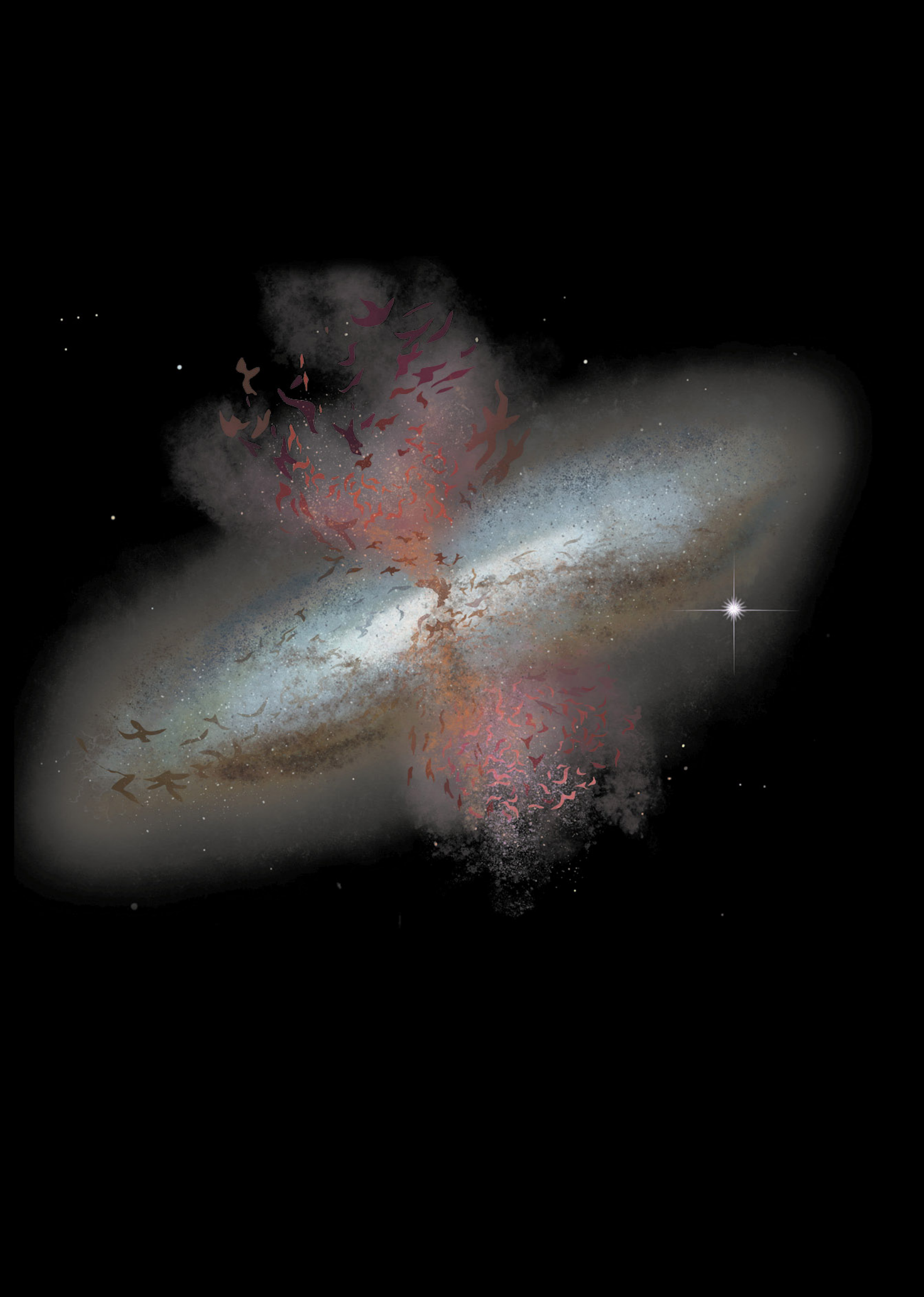


Pyxis – A small constellation which was only named by French astronomers in 1754.



Spacemanía

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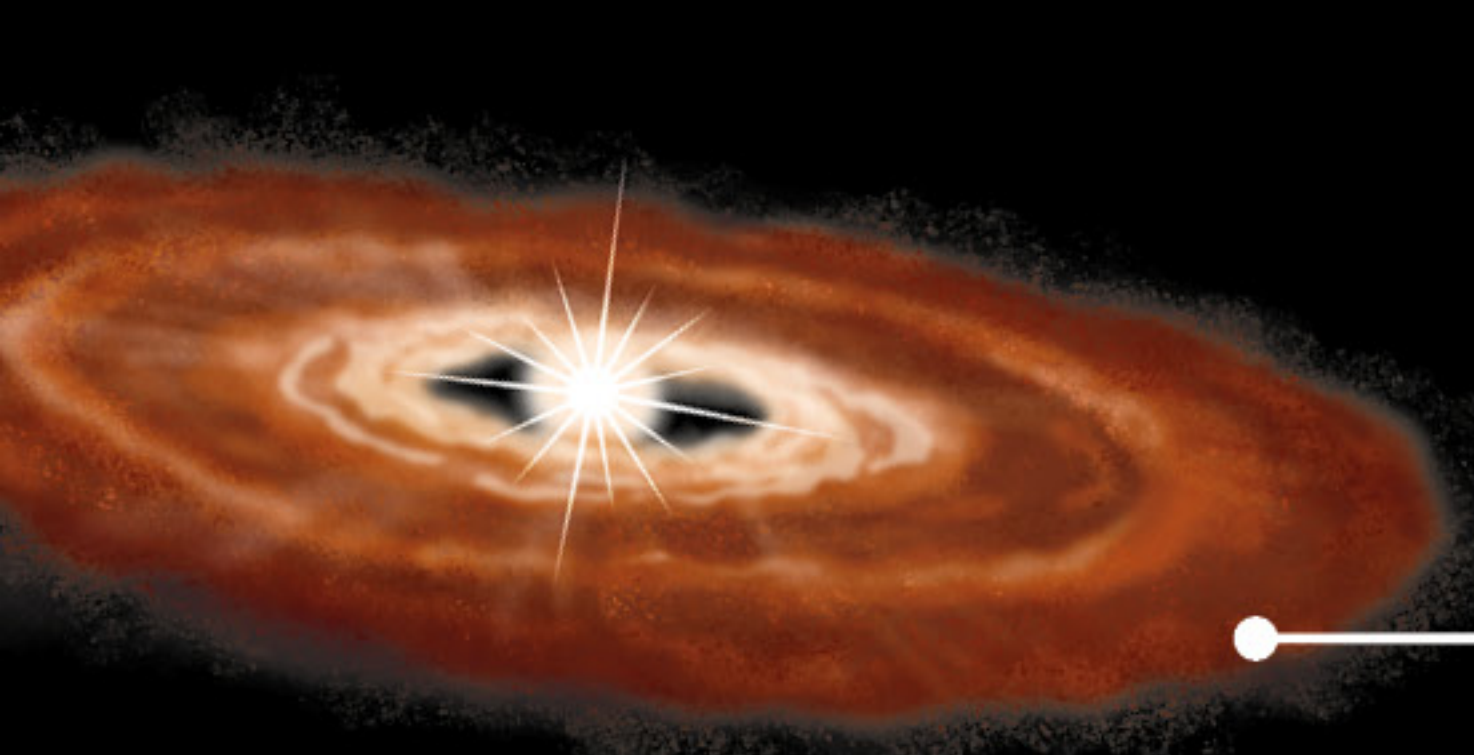
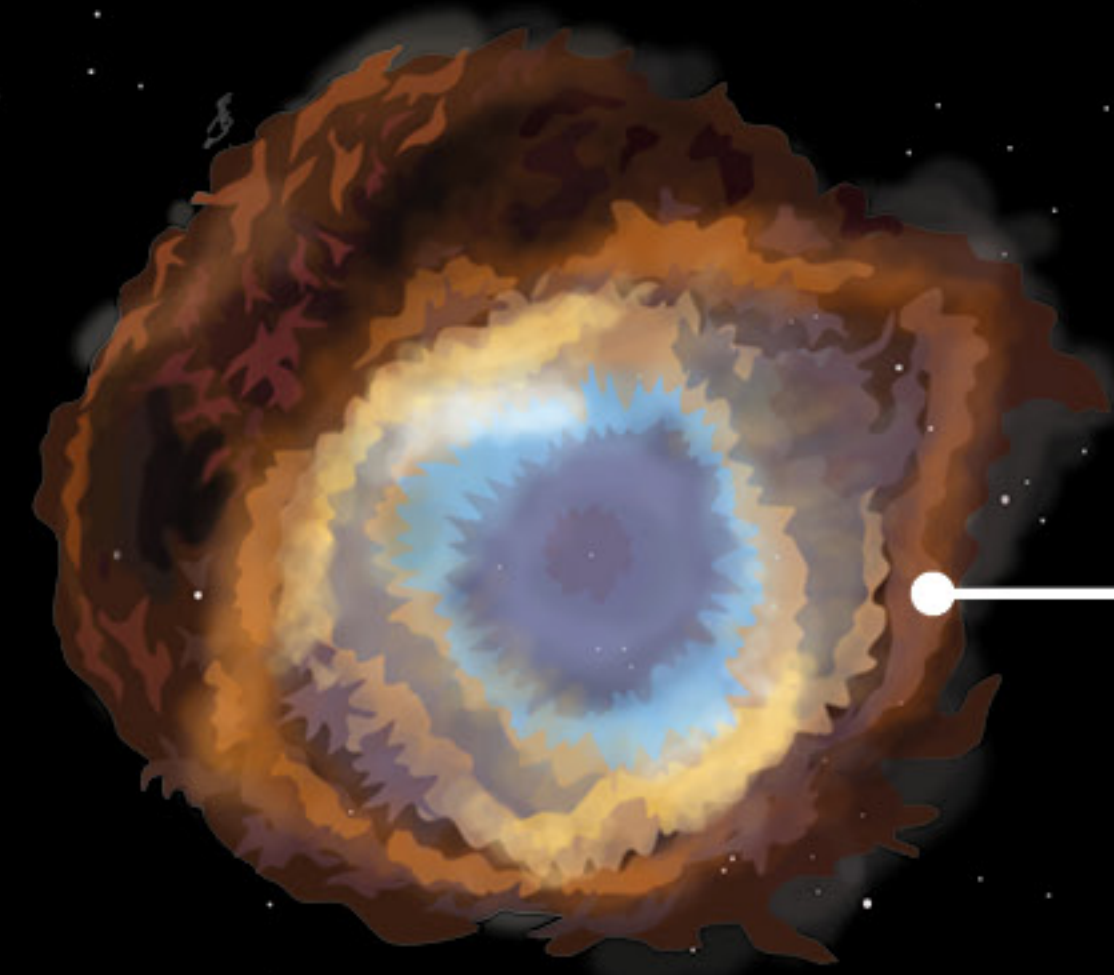
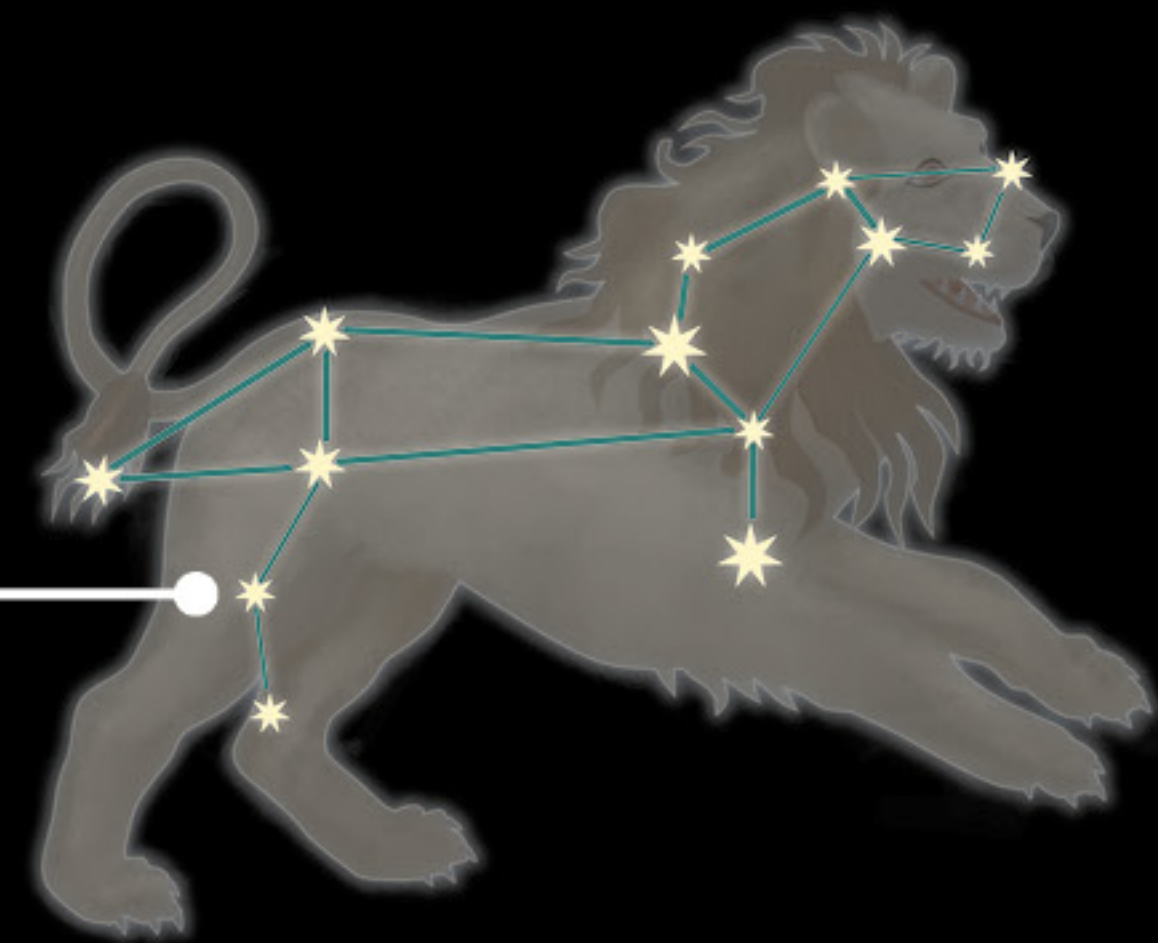


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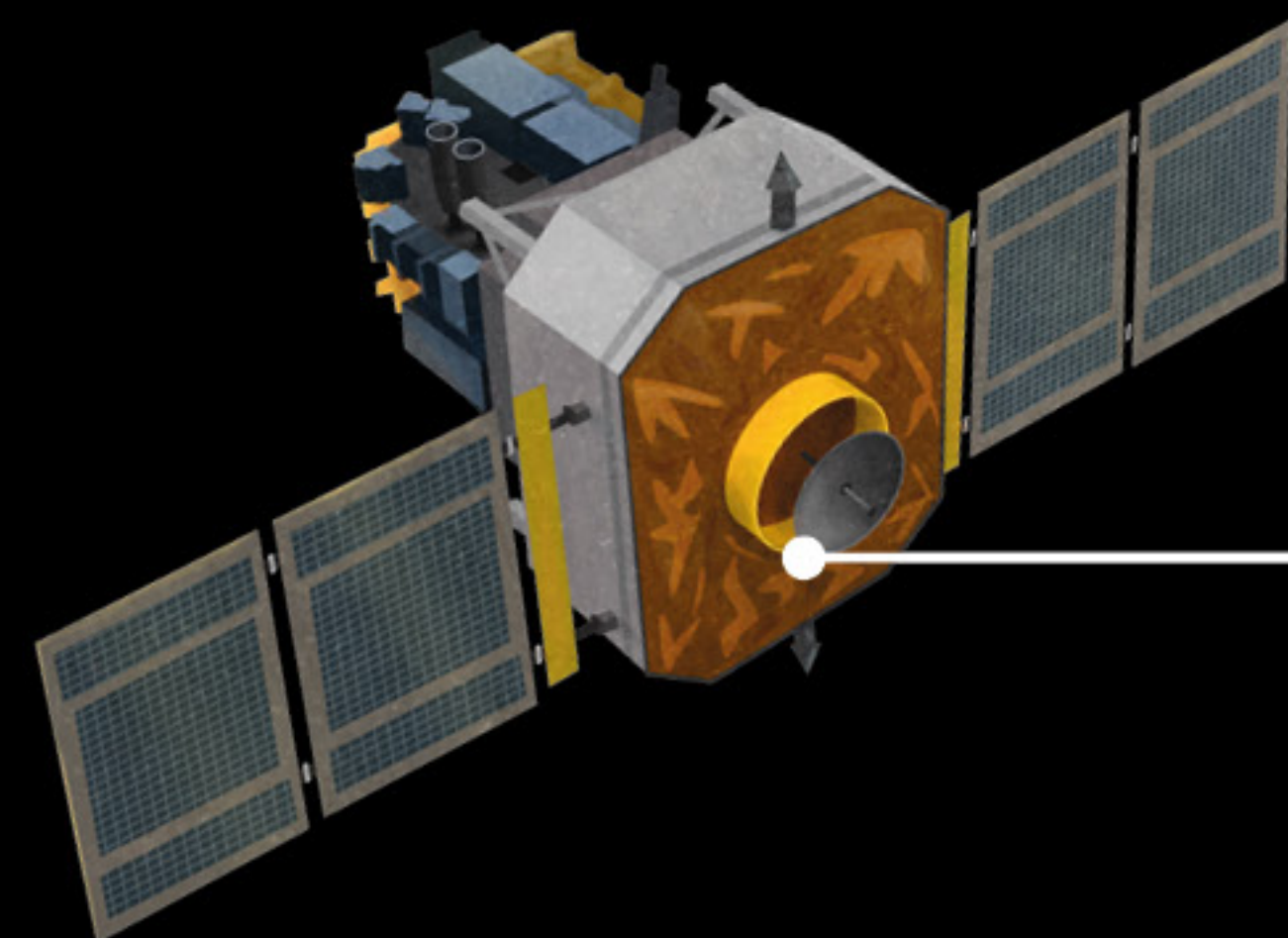
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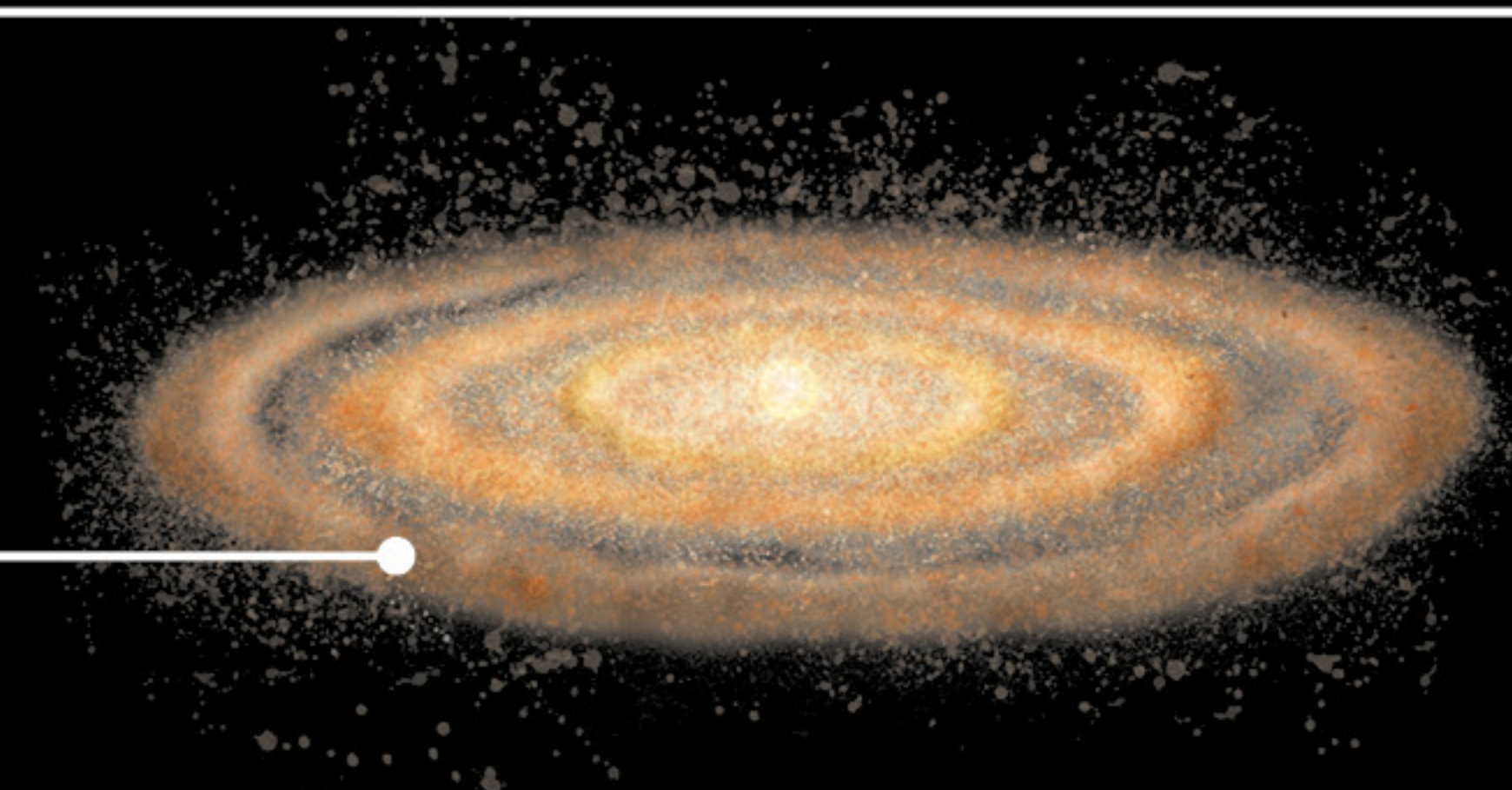
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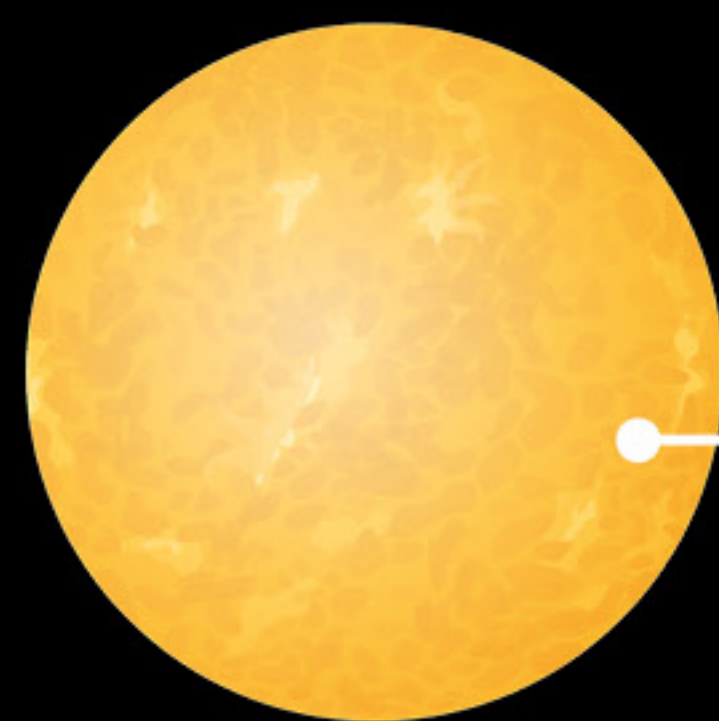
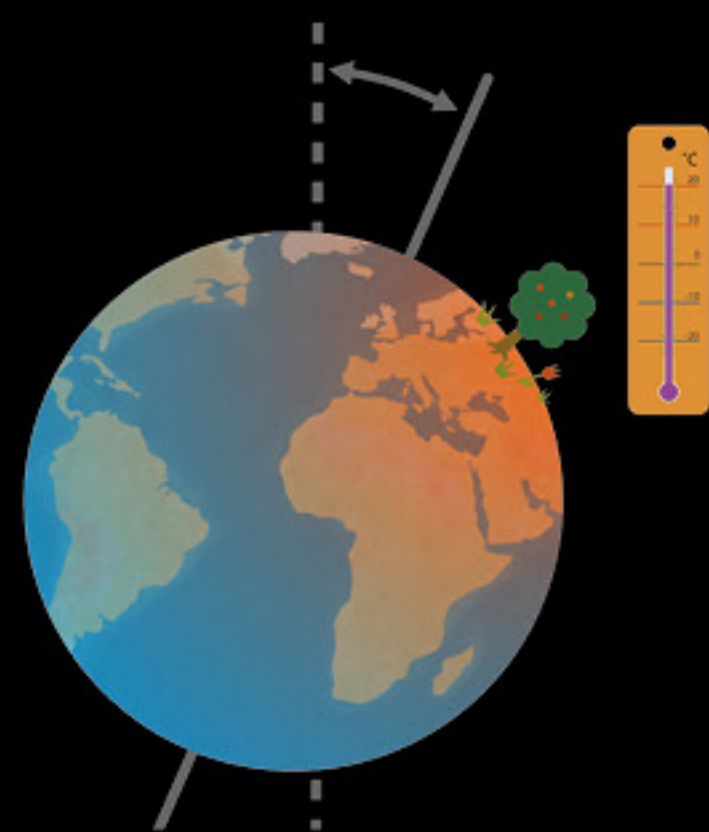
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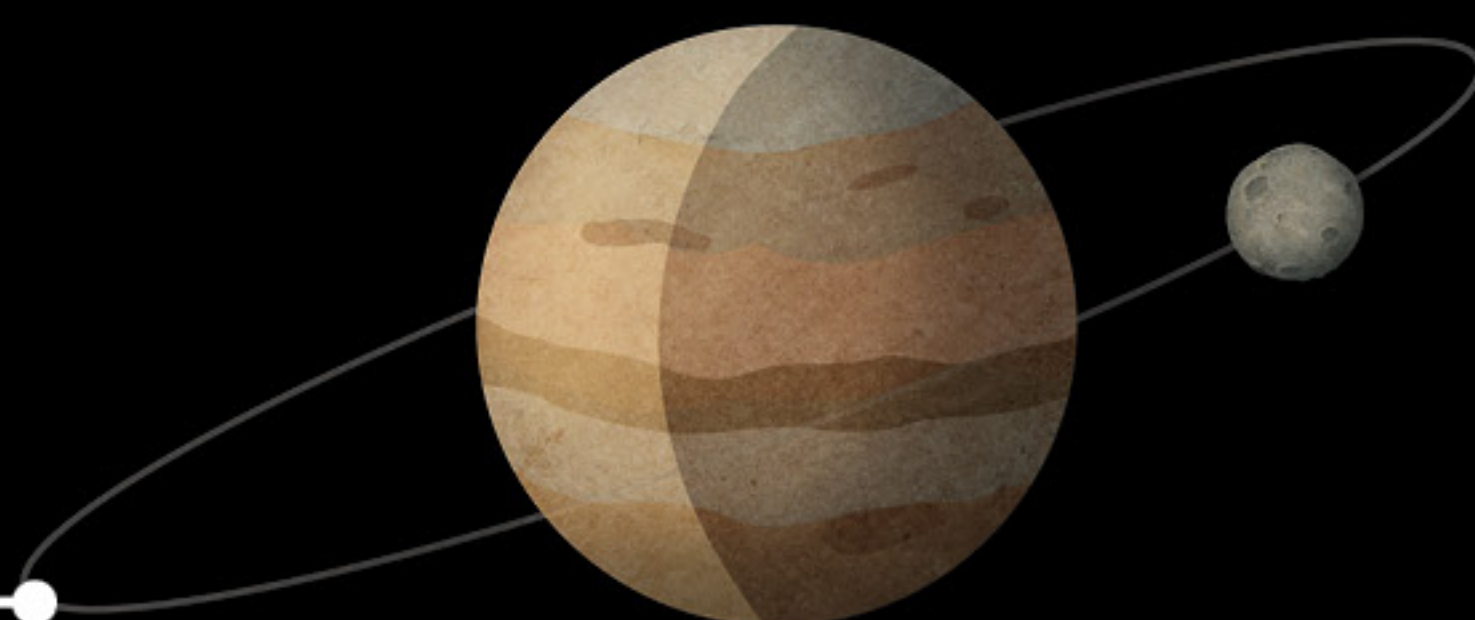


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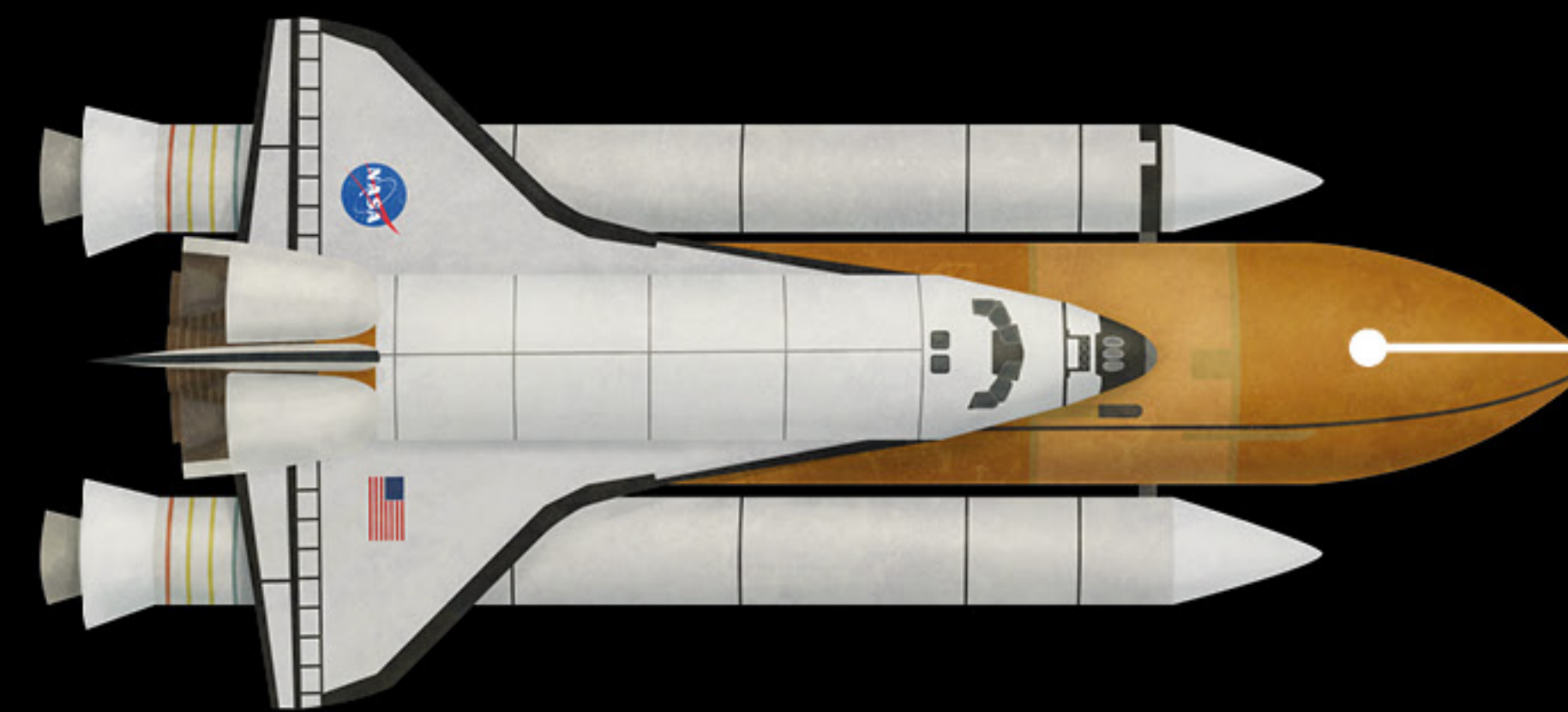
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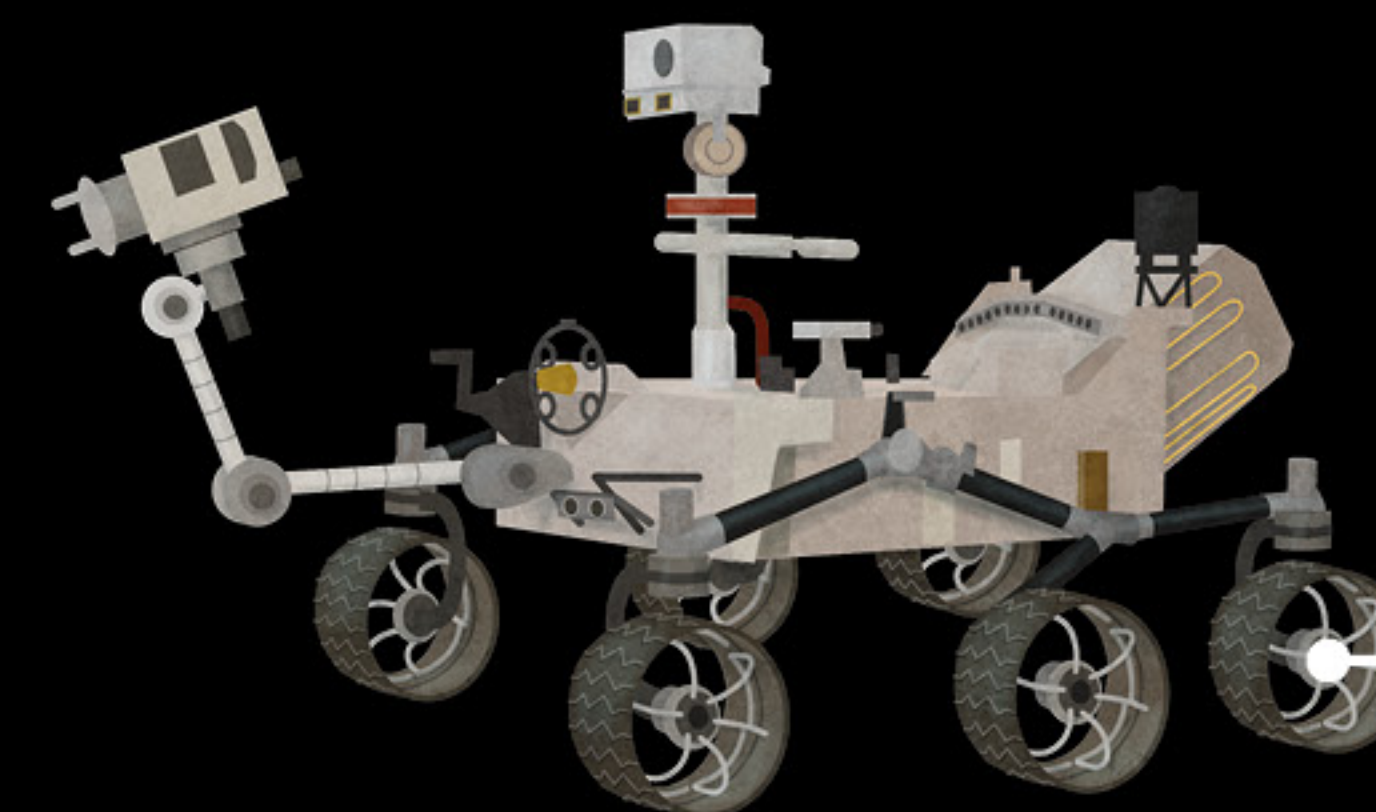
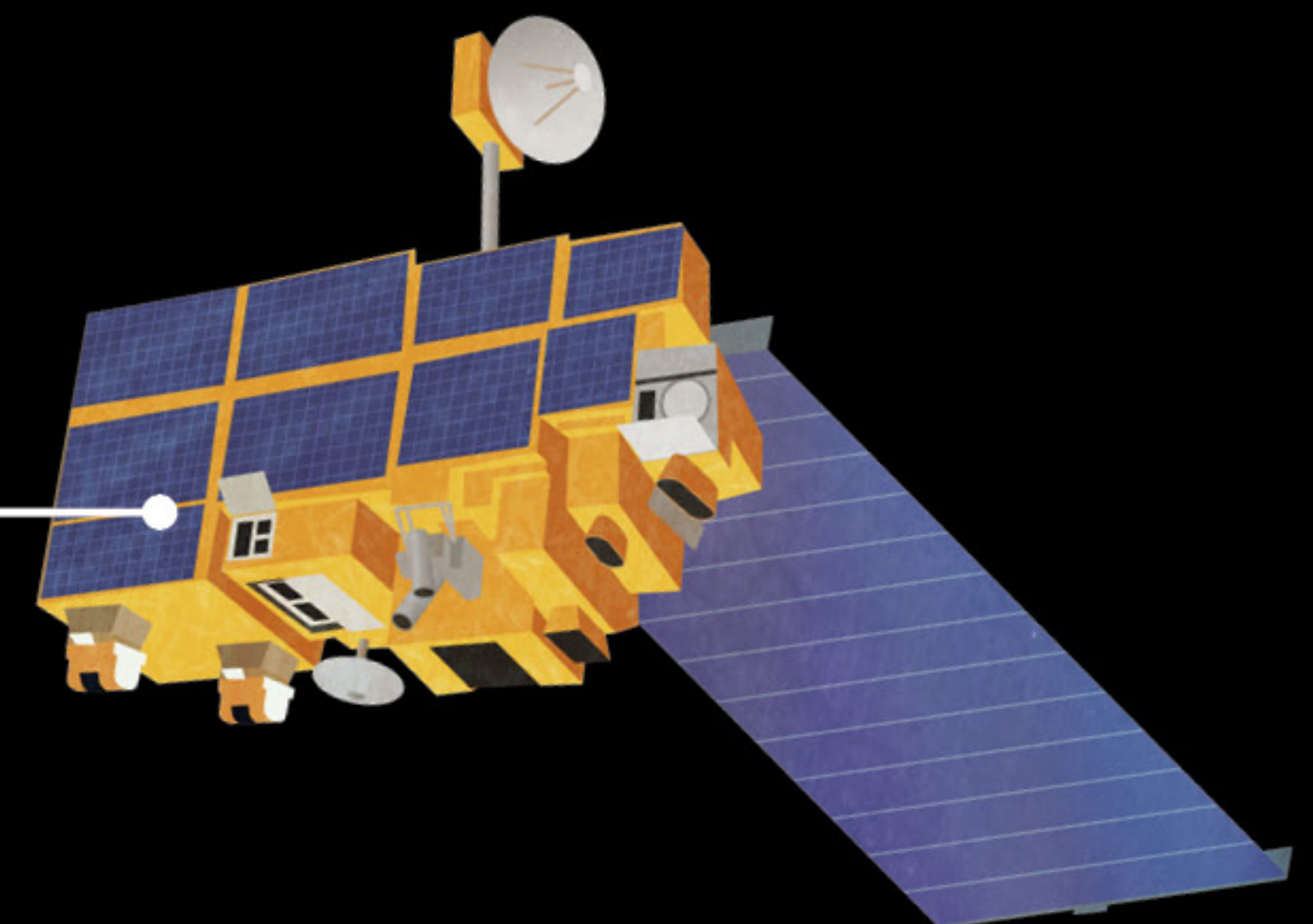


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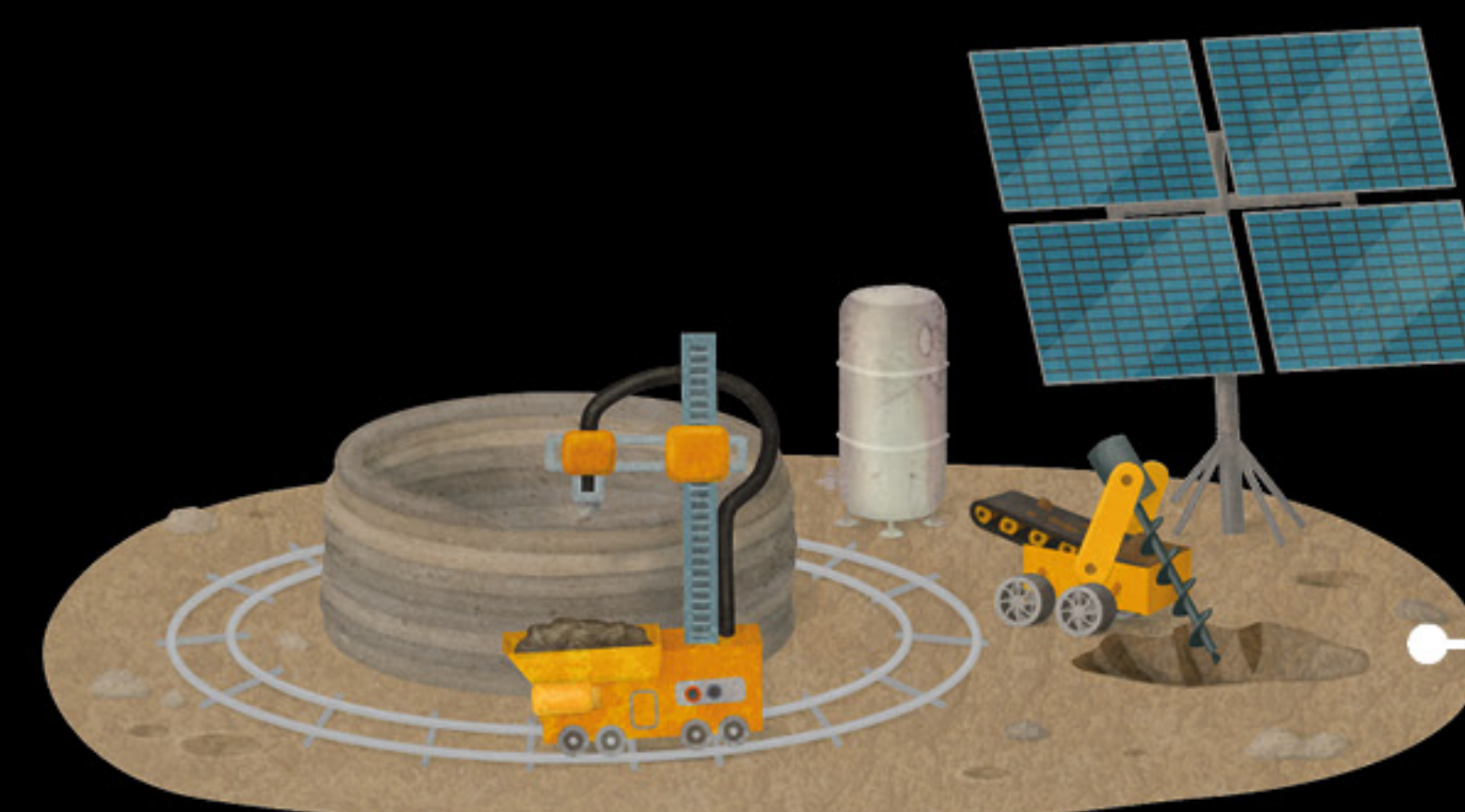
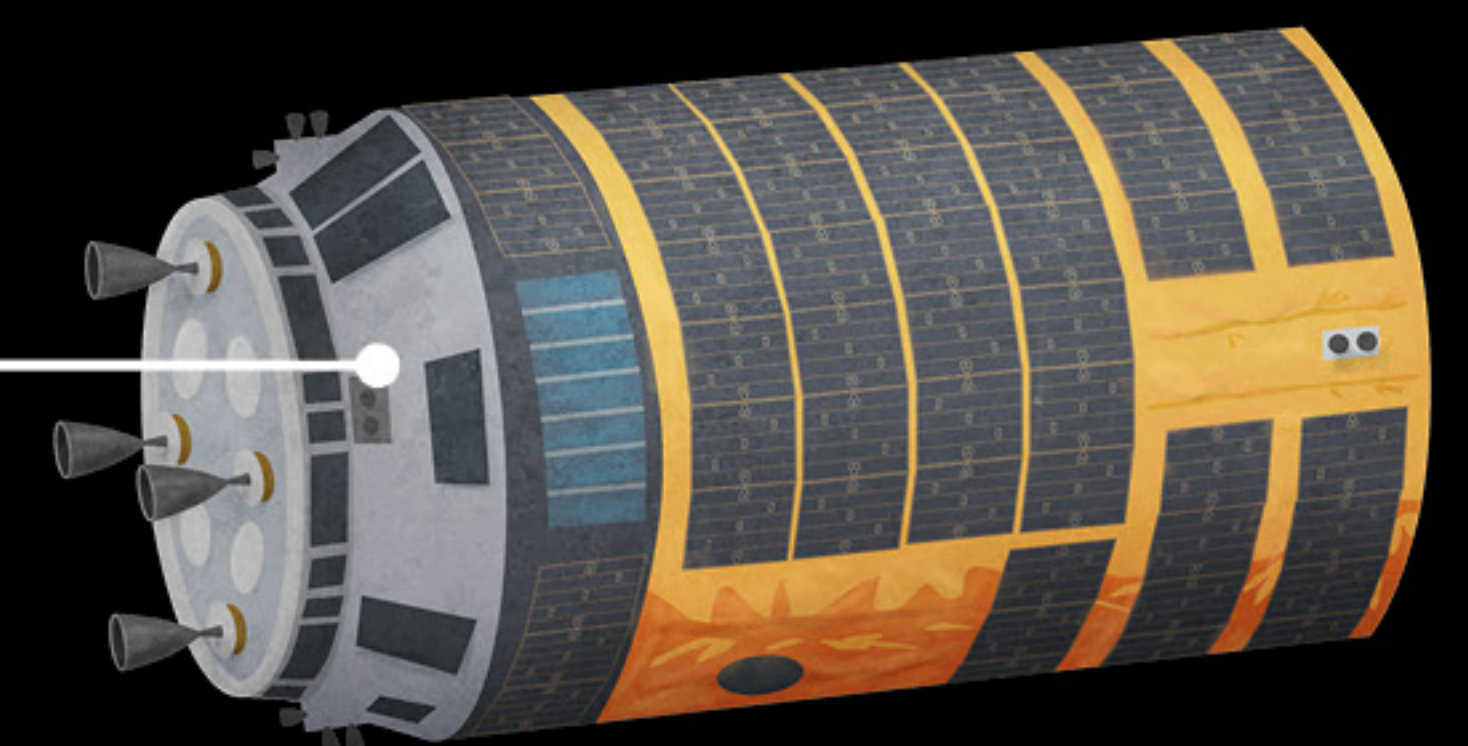
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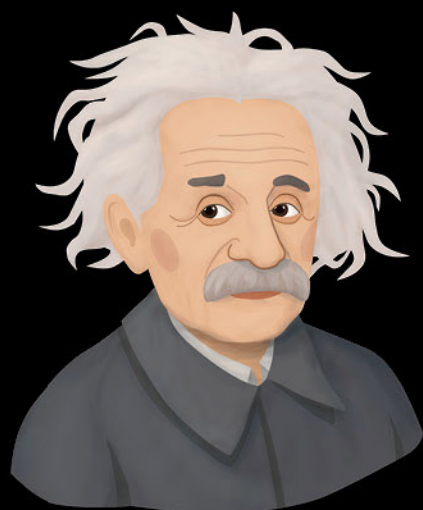
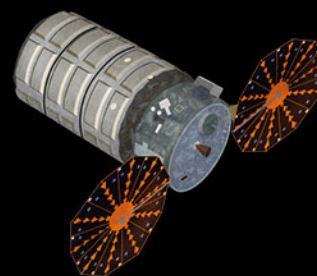


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Written by Pavel Gabzdyl
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