Encounters in the Milky Way
Descriptive Transcript

A starry night sky. A swath of diffuse light lies behind wispy black clouds.

On a clear night, a band of light stretches across the sky: the combined glow of billions of stars, partially obscured by great clouds of gas and dust. The majestic Milky Way.

The night side of Earth comes into view. The cities of North America are brilliant with electric lights. Day breaks as the Sun rises over the curvature of Earth.

From Earth, it looks like we are at the center, and all these stars revolve around us. But as astronomers learned to decipher celestial movement, we found our place in the cosmos.

Earth is bathed in sunlight, revealing blue oceans and white, swirling clouds.

The rising and setting of the Sun is caused by Earth's own rotation.

The planet begins to recede. As it rotates on its axis, day turns to night.

And just as the Moon goes around Earth…

The Moon passes by.

…Earth orbits the Sun. As do all the planets of the Solar System.

Colorful, concentric trails appear as Earth and the other planets circle the Sun.

We've discovered that our Sun, too, is in motion—traveling through the Milky Way Galaxy at 500,000 miles an hour—and taking us along for the ride.

The Sun begins to speed away, trailing a red line. The orbital paths of the planets twist around the Sun's trail in a colorful corkscrew.

I’m Pedro Pascal. Join me on a journey through our tight-knit stellar neighborhood into the bustling metropolis of the Milky Way. We’ll witness some of the chance encounters that have shaped the destiny of our Sun—and maybe even the course of life in the cosmos.

The speeding corkscrew turns back into concentric orbital paths.

Our first stop is beyond the orbit of the Moon…

Zooming in, we pass the Earth and Moon.

…a million miles from Earth, where the Gaia Space Telescope is hard at work mapping the Milky Way.

A spacecraft, roughly the shape of a top hat, looms into view. A rectangular volume of light approaches from across space.

Starlight from a patch of sky reaches Gaia.

The rectangular volume enters the spacecraft. Narrow beams of light bounce from surface to surface.

Mirrors inside the telescope focus the light onto detectors, which record the exact position of individual stars.

Passing through the spacecraft and back outside, we see there are two rectangular volumes of light reaching Gaia from different parts of the sky. As Gaia turns, these beams sweep around, gradually revealing many more stars and a much brighter sky.

By moving through space to observe from multiple angles, Gaia has built a three-dimensional atlas containing nearly two billion stars. That's 15,000-times more than were ever mapped before, and about a million times more stars than we see with the naked eye.

The sweeping action picks up pace.

Gaia has also measured the precise direction and speed of stars because, like our Sun, all those stars are in motion. They're just so far away, we can't perceive their progress in human time.

Lines connect several stars.

See the Big Dipper? Watch as we increase the rate of time to thousands of years per second.

The shape is distorted, as the stars that comprise the Big Dipper move in different directions.

By feeding Gaia's data into computer models, scientists can simulate the past, present and future of our entire 200-billion-star galaxy.

Countless stars are moving in every direction. Some brighter, some dimmer. Some faster, some slower.

With all this movement, paths cross, and stuff flies. Some wayward objects recently passed through our own backyard.

Fade to black. Scene opens with an edge-on view of the Solar System. A large boulder-like object passes by and disappears as it travels toward the Sun.

Our Solar System is swarming with rocky asteroids and icy comets that orbit the Sun, along with the planets.

Thousands of particles orbit the Sun, depicting the Asteroid Belt. Longer trails are the paths of comets making larger orbits of the Sun.

In 2017, astronomers were surprised to observe a 400-meter-long asteroid-like object zooming through our Solar System…

A green trail sweeps around the Sun.

…and a year later, an unusually fast comet.

A long orange trail passes by the Sun.

Their speed and angle of entry meant they had to be interstellar objects, coming to us from other star systems. These types of far-flung objects are hard to spot, but scientists think they're probably common. Which means debris from our own Solar System may be headed for other stars.

Pulling away from the Solar System.

Could the ingredients of life be carried from one star system to another, aboard a comet or asteroid? Scientists are studying the possibilities.

The Sun and orbiting planets lie in the distance, and a spacecraft looms into view. It has a large satellite dish and several long antennae.

Rocks aren't the only things leaving our Solar System.

The spacecraft passes by. A golden disk is secured to its exterior.

Voyager 2 is one of five spacecraft that have been sent out to study the outer planets. It's now past the eight known planets and the Kuiper Belt—a region of comets and asteroids that is also home to the dwarf planet, Pluto. But to escape our solar system entirely, it still has a long way to go. That's because our Solar System is a lot bigger than we once thought.

A cloud of white particles envelops the scene, with the Sun and planets in the distant center.

This is our Oort Cloud, a vast expanse of ice material left over from the birth of our Sun, four and a half billion years ago.

The extent of the cloud is revealed as we continue to pull away.

Our Oort Cloud extends one-and-a-half light years in every direction, meaning light from our Sun takes a

year and a half to reach the edge of the Solar System.

Five green lines emanate from the center: the paths of spacecraft moving away from the Solar System.

Our spacecraft travel a lot slower than light. It'll take them tens of thousands of years to exit the Oort Cloud. But once they do, they have a good chance of entering other star systems, since other stars also have Oort clouds.

The Sun's Oort Cloud is tinted yellow. It's surrounded by white spheres.

These shapes represent the extent of each star's Oort cloud.

Moving around, we see dozens of spheres of varying sizes.

The more massive the star, the larger its Oort cloud. All these stars are within our solar neighborhood and are visible in our night sky. There's Sirius.

A sphere is highlighted.

Vega. Altair.

Two others are highlighted.

But Gaia mapped hundreds of others in our neighborhood that are too dim for us to see with the naked eye. They may have Oort clouds too.

Hundreds of smaller spheres fade up. We fly around and through the particle-filled spheres.

With Oort Clouds in the picture, our neighbors just got a lot closer!

With everyone in motion, the neighborhood is always changing, and encounters are common.

The spheres move in different directions.

Watch this star here, Gliese 710.

An orange sphere is highlighted.

It's on track to pass through our Oort Cloud in just over a million years!

The orange sphere passes through the yellow sphere.

During its flyby, our systems will swap icy comets. Some will be flung out on their own paths—perhaps one day seeding other star systems with the chemical building blocks of life.

Yellow and orange comet trails shoot in all directions.

The trails fade off.

With our Sun still at center, let's pull out further.

Rings mark distances as we pull away. 1 light-year. 10 light-years.

Our Sun is middle-aged and travelling on its own. But it's surrounded by groups of young stars, shown here in different colors. They're just emerging from their stellar nurseries.

100 light-years. Colorful groups of dots denote star clusters.

It's likely our Sun once traveled in a pack, but as it aged, it struck out on its own. Astronomers are using the Gaia atlas to identify which stars might be our long-lost siblings.

Colorful groups of dots form a border around a clearer area.

Some star clusters hint at a large structure, a thousand light years across. It's a clearing within dense clouds of gas and dust.

A diaphanous shape fills the clearing.

We call this our "local bubble." Our Solar System is currently inside the clearing—which is why

stargazers on Earth have such a magnificent view of the Milky Way.

The blueish bubble is irregular, with many creases in its surface. It's surrounded by reddish dust clouds.

Scientists think our local bubble was formed by shockwaves from a series of supernova explosions starting 10 to 15 million years ago.

Fade to black. A bright flash forms a bubble. Subsequent flashes expand it.

Our Solar System passed through the boundary of the bubble about five million years ago— around the time our early human ancestors were starting to walk upright.

The Sun, shown as a pulsating dot, enters the bubble.

For a brief period, our entire Solar System was exposed to high levels of radiation, traces of which are recorded in ocean sediments on Earth.

Pulling further out, we see the swirling arms of the galaxy. Within churning, reddish dust are many clearings, rimmed with flashing stars.

On our travels, we can expect to pass through bubbles again and again, because the galaxy is peppered with massive stars that go out in a blaze, creating gigantic dust-clearing shockwaves.

The spiral disk rotates, and we pass through to the other side. A yellow trail shows the Sun's path around the galactic center.

Though each star's path is unique, we're all on a journey around the Milky Way Galaxy. For us—for our Sun and Solar System—one orbit takes 230 million years to complete. So far, we've made about 20 orbits. We're 20 galactic years old!

Pulling further out, a long stream of reddish dust and bright particles connects the swirling disk to a bright object.

Encounters also take place on a galactic scale. See that cascade of stars? That's evidence of an ongoing merger between the Milky Way and a smaller galaxy, known as the Sagittarius Dwarf Galaxy.

Fade to black. Scene opens with two spinning galaxies.

With computer modelling, scientists can go back in time to simulate multiple passes of the Dwarf Galaxy.

The smaller galaxy circles the larger one.

Each pass fuels supernova explosions, driving the formation of bubbles, like the one we're passing through now.

As the smaller galaxy passes through the larger one, it's pulled apart, trailing a stream of stars, gas and dust.

On its first pass 5 to 6 billion years ago, the Sagittarius Dwarf Galaxy sent a wave of energy through the larger Milky Way, pushing gas and dust together and triggering an era of star formation. That was the era in which our Sun was born!

With each intersection, the smaller galaxy is ripped apart.

We are a product of cosmic encounters. And what's happening in the Milky Way Galaxy is happening throughout our galactic neighborhood, and across the universe.

More galaxies become visible as we pull away from our own.

To see farther, we need to go closer to home.

Cross-fade to our Solar System.

We pass the Moon and the Earth.

A shiny, pinkish, diamond-shaped spacecraft comes into view.

This is the James Webb Space telescope. Like Gaia, it operates in a region beyond the Moon, a million miles from Earth—a mere five light-seconds away.

The spacecraft aims at a target in the sky.

Webb was launched in 2021 carrying the largest mirror ever constructed for a space telescope.

A cone of light from the distant target travels toward the telescope.

Webb's giant mirror collects infrared light and can study faint, distant galaxies in extraordinary detail.

Enlarged images of galaxies begin to appear on the screen.

Some of these galaxies are millions of light years away, yet they contain features we recognize: packs of young stars that travel together, star-forming bubbles, clouds of gas and dust, signs of galactic mergers.

It's no wonder we're so similar—we share a common ancestry that goes all the way back to the Big Bang, 13.8 billion years ago.

The images of distant galaxies fade off.

We pull away from the spacecraft.

As we approach Earth, the Sun is rising over the horizon.

Perhaps someone out there is looking our way, mapping our galaxy, tracking our star, or tracing comets back to our solar system.

Planet Earth is bathed in sunlight.

We may not meet in human time. But for those who can read the atlas, our story will be told in motion for eons to come.

Panning from Earth to the night sky, the stars begin to move again, darting in all different directions. Credits roll.