# Encounters in the Milky Way

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.

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.

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

And just as the Moon goes around Earth, Earth orbits the Sun—as do all the planets of the Solar System.

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.

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.

Our first stop is beyond the orbit of the Moon, a million miles from Earth… where the Gaia Space Telescope is hard at work mapping the Milky Way.

Starlight from a patch of sky reaches Gaia.

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

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.

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.

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

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

With all this movement, paths cross, and stuff flies.

Some wayward objects recently passed through our own backyard.

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

In 2017, astronomers were surprised to observe a 400-meter-long asteroid-like object zooming through our Solar System, and a year later, an unusually fast comet. 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.

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

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

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.

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

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.

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.

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

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.

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.

Watch this star here, Gliese 710.

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

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.

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

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.

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.

Some star clusters hint at a large structure, a thousand light years across. It's a clearing within

dense clouds of gas and dust. 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.

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

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.

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.

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.

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!

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.

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

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

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!

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.

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

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.

Webb was launched in 2021 carrying the largest mirror ever constructed for a space telescope. Webb's giant mirror collects infrared light and can study faint, distant galaxies in extraordinary detail.

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.

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

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.