STAR TRACKS

Where are we?

The picture on the right shows the Milky Way as seen from Earth, taken with an infrared camera.

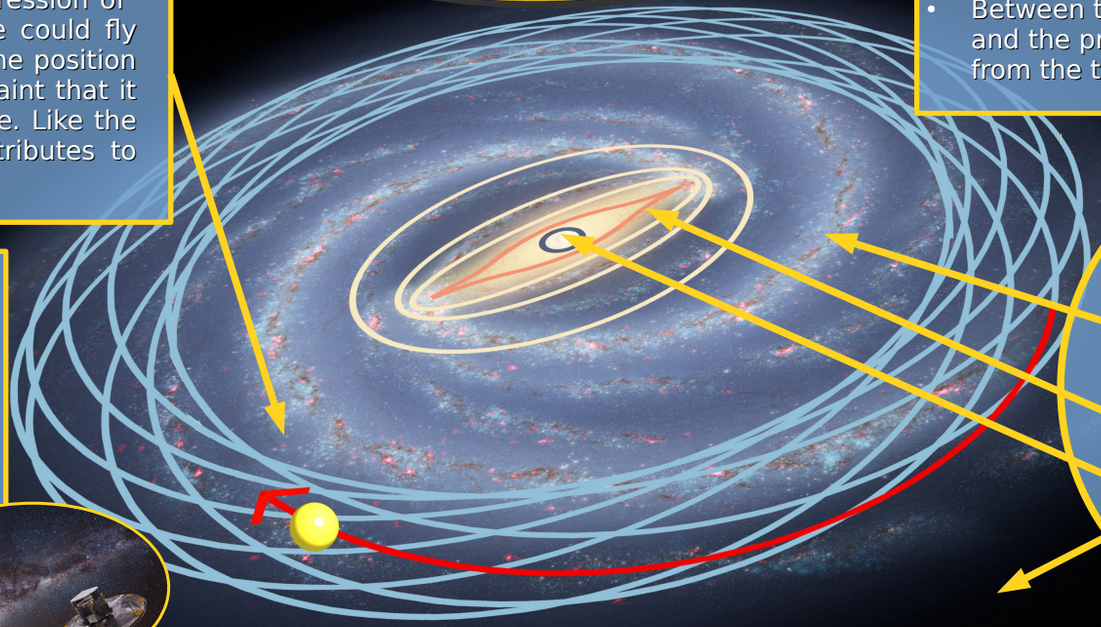
From this image we know that the Milky Way is a disc galaxy. We live inside it! We're about 27,000 light years from the centre.

The central picture is an artist's impression of how the Milky Way might look if we could fly over it. The big yellow circle marks the position of the Sun. In reality, the Sun is so faint that it could not be picked out in the picture. Like the billions of other stars, the Sun contributes to the diffuse light.

Credit: 2MASS

Stars Move!

- The stars in our Galaxy are moving at about **half a million miles per hour** (200 km/s) – that's over 200 times faster than the fastest fighter jet.
- Still, the Sun takes **200 million years** to loop around the Galaxy.
- Between the extinction of the dinosaurs and the present, the Sun has only moved from the tail to the tip of the red arrow!



Credit: thegboat.net

How do you make a Milky Way?

Beautiful spiral arms: where stars are born

Bar: drives gas to the centre.

Black Hole: fed by gas

Dark Halo: surrounds Galaxy

Gaia

- Gaia will measure the distances to **1,000,000,000 stars** in the next few years.
- This is 10,000 times more stars than seen by its predecessor, Hipparcos.
- This will tell us how our Galaxy works and what it *really* looks like.

Our Research

Our research group at the University of Oxford seeks to discover how the Milky Way works as a machine and how it was assembled. The Milky Way is not special. In fact, there are at least billions of galaxies in the Universe very similar to our own. However, we are in the fortunate position of being able to observe our Galaxy in exquisite detail.

Gaia will provide us with extraordinarily accurate information on the position and motion of stars, as well as their ages and chemical compositions.

As the timescale on which the Galaxy evolves is so long, Gaia will only see a single snapshot of the motions of the stars. From this snapshot, we want to understand both the present *and* past structure of our Galaxy.

We understand our Galaxy by modelling the orbits of stars. Orbits are conceptually simpler when they are reduced to a single point in a three dimensional abstract space called the action space. Important information is revealed by the location of an orbit in action space. We think of the Galaxy as a smooth distribution of orbits in action space.

Galactic Structure: orbits are determined by the Galaxy's gravitational field and the positions and velocities stars have when they are born. From Gaia's measurements we can probe the gravitational field and thus determine the distribution of the "dark matter" (see back) that generates most of that field and get insight on the overall morphology of the Milky Way.

Galactic Archaeology: how can we learn about the history of the Galaxy? For instance, we would like to know where and when the Sun was born. An individual star experiences many different Galactic environments throughout its life. Spiral arms can cause stars to move from one orbit to another as they age, so by studying the correlation between age and orbit type we can learn how strong spiral arms were in the past.

Galactic Centre: we live in the suburbs of the Galaxy, where the stars are mostly confined to a thin disc. Towards the centre of our Galaxy, the stars form a rotating bar that draws gas inwards. Right in the centre lives a supermassive black hole, approximately 4,000,000 times the mass of our Sun. We develop models to understand this mysterious region of our Galaxy.

A great mystery...

Our Galaxy is not only made of stars. We now believe that most of its mass is in a mysterious component that, simply because we cannot see it, we call dark matter.

How do we know dark matter is there if we can't see it?

It affects things that we ***can*** see, like the stars. If we believe that our current theory of gravity is correct, then the measured motion and position of stars tell us that something else, something that we cannot see, is there.

What is dark matter made of?

We don't know yet. There are a few possible candidates. Many candidates, such as rocks and dark stars, have been ruled out, and we are now turning to more exotic explanations such as undiscovered particles. One of the main interests of our research group is to shine light on this mysterious component that permeates our home.

Credit: Fermilab

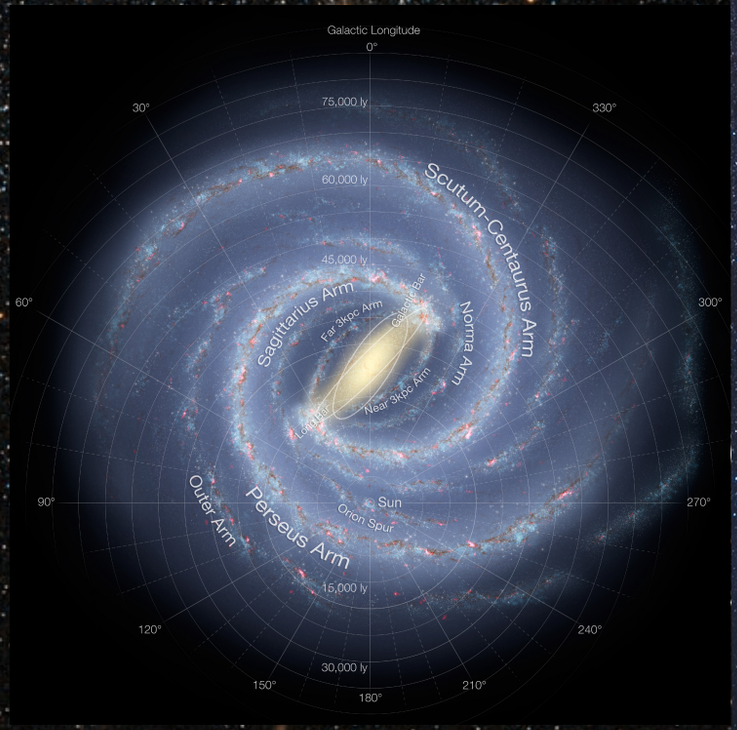
For more information

http://www2.physics.ox.ac.uk/research/galactic-dynamics

http://sci.esa.int/gaia/

Ask us a question!

Credit: NASA



Produced by the Galactic Dynamics group, Rudolf Peierls Centre for Theoretical Physics, University of Oxford: Prof. James Binney, Dr John Magorrian, Dr Paul McMillan, Dr Tilmann Piffl, Dr Stuart Sale, Dr Ralph Schönrich, Jason Sanders, Mattia Sormani.

Royal Society Summer Exhibition 2014

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Galactic Dynamics, University of Oxford