Our Parent Galaxy

Milky Way is what our galaxy appears as in the night sky.
Our galaxy is a **spiral** galaxy. The Andromeda Galaxy, our closest spiral neighbor, probably resembles the Milky Way fairly closely.
Our Parent Galaxy

Here are two other spiral galaxies, one viewed from the top and the other from the side:

“Face on”  “Edge on”
Our Parent Galaxy

Here is a better twin to the MW, NGC 6744. Barred, medium-sized bulge, flocculent spiral.
Galactic Structure

The various parts of our galaxy:
Galactic Structure

This **infrared** view of our galaxy shows much more detail of the galactic center than the visible-light view does, as infrared is not absorbed as much by gas and dust.
Measuring the Milky Way

We can measure distances to (bright) parts of the MW with many techniques: spec parallax, Cepheid and RR Lyrae variables, cluster sizes, expanding photospheres, moving cluster method, stat parallax, novae, etc, etc.

Finding Cepheids out to 25 Mpc was the original “Key” project for the Hubble Space Telescope.
Measuring the Milky Way

Modern mapping of the M.W. Has relied on a variety of observations, especially 20 cm radio observations of the HI gas.
Many RR Lyrae stars are found in globular clusters. Harlow Shapley used these to estimate the size of the M.W. He correctly determined that we were far from the center. But he overestimated the size.
Measuring the Milky Way

One of the first attempts to measure the Milky Way was done by W. Herschel (1738-1822) using visible stars.

Problems:
1. patchy dust blocked view! (extinction)
2. all stars do not have the same luminosity!!
Measuring the Milky Way

A model based on star brightnesses, types, & motions was done by Jacobus Kapteyn (1850-1922).

Still lacked corrections for extinction.
Sun 2000 LY from center.
Star counts can be imagined out to a limiting distance, \( d \) (as above). These are integrated star counts represented by \( N \).

However, it is easier to measure magnitudes than distances, so usually star counts are done down to a limiting magnitude (integrated star count, \( N \)), or in magnitude bins (differential star count, \( A \)).

Note that the distance corresponding to a limiting magnitude, \( m \), will be greater for more luminous stars (with lower \( M \)).
If we want to use stars to probe the geometry of the MW, we need to know about their demography.

Near stars: faint.

Brightest: luminous.
Studies of volume-limited samples reveal the rarity of luminous stars.
Stellar orbits in the disk move in a common plane (co-planar) and in the same direction. The orbits in the halo and bulge are much more random (isotropic).
The spiral arms cannot rotate exactly as the stars do; they would “wind up”. (The “winding problem”.)

The speed of the stars is almost constant with radius, so inner stars make it around in less time than outer stars. The period is ~240 Myrs. MW formed ~50 rotations ago.
Galactic Spiral Arms

Rather, they appear to be density waves, with stars moving in and out of them such as cars move in and out of a traffic jam:
The orbital speed of an object depends only on the amount of mass between it and the galactic center:
Beyond the limits of the visible galaxy, the velocity should **diminish** with distance, as the dashed curve shows.

It doesn’t; more than **twice** the mass of the galaxy would have to be outside the visible part to reproduce the observed curve.
The Mass of the Milky Way Galaxy

The MW has a dark matter halo.

Candidates:
MACHOS:
Brown dwarfs
Red dwarfs
Stellar black holes
Neutron stars

WIMPS:
Axions, neutrinos, unknown