The “Milky Way”...

...Our Home Galaxy!
(The “Hubble Deep Field”)

The Hubble Deep Field is a series of images taken by the Hubble Space Telescope, showing a small patch of the universe containing a large number of galaxies.
The “Messier Catalog”: 
Among the many tasks of William Herschel... 

...Mapping the Whole Galaxy!
The Curtis-Shapley Debate

- what is the size of our galaxy?
- what is the nature of spiral nebula?
Shapley: Our Galaxy is the entire universe. Spiral nebulae are clouds of gas. The sun is not near the center of the Galaxy/Universe, but is in the center of a cluster of stars 50,000 light years from the center. The galaxy is 300,000 light years across.

Curtis: Spiral nebulae are galaxies like our own. The sun is near the center of our Galaxy. The galaxy is less than 30,000 light years across.
Science Sparring Society

Fight 2: Shapley Vs. Curtis

- solar system ($10^{-4}$ ly)
- nearby stars ($10^2$ ly)
- Milky Way ($10^7$ ly)
- nearby galaxies ($10^{10}$ ly)
- galaxy clusters

- Cepheids

- Hubble's law: $d = \frac{V}{H_0}$

- Radar ranging
- Parallax
- Relative apparent brightness
- Surface temperature (K)
- Main-sequence fitting
- Luminosity
- Period
- Tully–Fisher relation
- White dwarf supernovae
- Tully–Fisher relation
- Distant standards
Sombrero Galaxy • M104

NASA and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope ACS • STScI-PRC03-28
(a) Artist’s view of Milky Way from afar

(b) Real image of Milky Way from inside
Spiral galaxy.

Artwork of a spiral galaxy seen face on.

The spiral arms (blue) contain hot, young stars.

The yellow central core contains a dense population of older stars.
<table>
<thead>
<tr>
<th>Galactic Disk</th>
<th>Galactic Halo</th>
<th>Galactic Bulge</th>
</tr>
</thead>
<tbody>
<tr>
<td>highly flattened</td>
<td>roughly spherical—mildly flattened</td>
<td>somewhat flattened and elongated in the plane of the disk (“football shaped”)</td>
</tr>
<tr>
<td>contains both young and old stars</td>
<td>contains old stars only</td>
<td>contains both young and old stars; more old stars at greater distances from the center</td>
</tr>
<tr>
<td>contains gas and dust</td>
<td>contains no gas and dust</td>
<td>contains gas and dust, especially in the inner regions</td>
</tr>
<tr>
<td>site of ongoing star formation</td>
<td>no star formation during the last 10 billion years</td>
<td>ongoing star formation in the inner regions</td>
</tr>
<tr>
<td>gas and stars move in circular orbits in the Galactic plane</td>
<td>stars have random orbits in three dimensions</td>
<td>stars have largely random orbits, but with some net rotation about the Galactic center</td>
</tr>
<tr>
<td>spiral arms</td>
<td>no obvious substructure</td>
<td>central regions probably elongated into a bar; ring of gas and dust near center</td>
</tr>
<tr>
<td>overall white coloration, with blue spiral arms</td>
<td>reddish in color</td>
<td>yellow-white</td>
</tr>
</tbody>
</table>
The diagram illustrates the formation of a galaxy. It starts with young stars (a) releasing gas and dust, which then forms a cloud (b) rotating around its center.

Gas and dust from the cloud fall to the plane (c), creating a flattened structure with ordered rotation (d). The halo (b) and disk (d) are distinguished, with the halo exhibiting disordered motion and the disk showing ordered rotation.
Expanding shock wave

New stars

Location of original stars

Gas

Young stars

Compressed gas

Supernova explodes

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