Galaxies

- Star systems like our Milky Way
- Contain a few thousand to tens of billions of stars,
- as well as varying amounts of gas and dust
- Large variety of shapes and sizes

The Family of Galaxies

Even seemingly empty regions of the sky contain thousands of very faint, very distant galaxies

Large variety of galaxy morphologies:
- Spirals
- Ellipticals
- Irregular

Galaxy Classification

<table>
<thead>
<tr>
<th>Elliptical Galaxies</th>
<th>Spiral Galaxies</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0, E1, E2, E3, E4, E5, E6, E7</td>
<td>Sa, Sb, Sc, Sd</td>
</tr>
<tr>
<td>E0 = Spherical</td>
<td>Large nucleus, tightly wound arms</td>
</tr>
<tr>
<td>E7 = Highly elliptical</td>
<td>Small nucleus; loosely wound arms</td>
</tr>
</tbody>
</table>

Gas and Dust in Galaxies

- Spirals are rich in gas and dust
- Ellipticals are almost devoid of gas and dust
- Galaxies with disk and bulge, but no dust are termed S0
**Barred Spirals**

Some spirals show a pronounced bar structure in the center. They are termed barred spirals:

Sequence: SBa, ..., SBc, analogous to regular spirals.

**Irregular Galaxies**

Often: result of galaxy collisions / mergers
Often: Very active star formation ("Starburst galaxies")
Some: Small ("Dwarf galaxies") satellites of larger galaxies (e.g., Magellanic Clouds)

*Edwin Hubble's Classification Scheme*

- Ellipticals
- Spirals
- Young stars
- Old stars

Large Magellanic Cloud

NGC 4038/4039 The Cocoon Galaxy
Galaxy Environments

Clusters
- Morphology variations
- Clusters ~55% E/S0s
- Field ~20% E/S0s
- Two observables
- Morphology
- Star formation

Galaxy Classification Lab
- Use data from the Sloan Digital Sky Survey to learn about the different types of galaxies and how to classify them.
- We will then classify galaxies in the Virgo cluster and see that clusters contain more elliptical galaxies than spiral galaxies.