Introduction to Astrophysics; The Milky Way Galaxy and the Interstellar Medium

Physics 152 Fall 2012

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Office Hours: M T W noon-1:30 p.m. or by appointment/e-mail Rm: 233 Physics

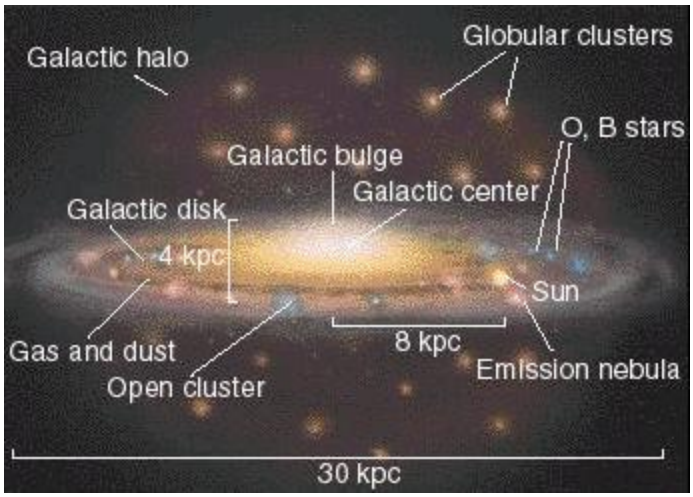
Text: An Introduction to Modern Astrophysics (2nd Ed.) Bradley W. Carroll & Dale A. Ostlie
ISBN 0-8053-0402-9

Grading: Class homework (~25%) , One midterm exam (~20%), final exam (~25%), class Wikki & group presentation (~30%)

Additional References:

"*The Milky Way as a Galaxy*" – G. Gilmore, P.C. van der Kruit, R. Buser, & I.R. King (University Science Books, 1990)
"*Galaxies: Structure & Evolution*" – R.J. Taylor (Cambridge, 1993)
"*The Physical Universe: An Introduction to Astronomy*" – F.H.Shu (University Science books, 1982)
"Galaxies and Galactic Structure" – Debra M. Elmegreen (Prentice Hall 1998)

(additional material handed out in class)



Course outline

Background material (See Chapter 3 - Sec. 1,2,4,6 ; Chapter 5 - Sec. 1 & 3; and Chapter 8 - Sec 1 & 2)

Review: Stellar magnitudes, colors, spectral types, distance modulus, distance determination

1. The Milky Way - The BIG Picture (Chapter 24.1)

(a) Shape and size – Historical context
  i. Star counts, Kapteyn model
  ii. Role of globular clusters – Shapley
  iii. Cepheid variable stars – Leavitt (See Chapter 14.1)
(b) Milky Way as a spiral galaxy- distance scale problem
  i. Shapley-Curtis debate
  ii. Cepheids used to set distance scale, distance to Andromeda galaxy

2. Contents - Stars, Gas & Molecules, Dust

Overall Structure Chapter 13.3, 24.2, 24.4

i. Thin Disk vs.Thick Disk
  Population I – Youngest objects - in thin disk
  A. Kinematics & Orbits
  B. Higher heavy element abundance

ii. Bulge
  Metal-rich old stars
  Bar Structure in center

iii. Galactic Center ~ 8 kpc. Away
  (a) Evidence for supermassive black hole
  (b) Substructure near center : outward rushing ring of molecular gas, dense stars clusters, supernovae
  (c) Synchrotron Radiation (Chapter 4, p. 101-102; Chapter 16, p.592-593; Chapter 28, p. 1088-1090)

iv. Halo
  Population II – Oldest stars & Globular Clusters
  A. Random orbits
  B. Lower heavy element abundance.

3. Interstellar Medium – Chapter 12.1

(a) Dust
  i. Dark nebulae, interstellar clouds
  ii. Extinction – optical depth (τ_λ); opacity (κ_λ) – see Chapter 9 p.240-244
  iii. Reddening
  iv. Reflection nebulae
  v. Composition – silicates, graphite, ices
  vi. Interstellar Chemistry
  vii. Infrared emission – where absorbed energy goes
(b) Gas (See Chapter 9 p. 244-248; also Harris' **Modern Physics** - Chapter 9.8 Lasers)
  i. Neutral, atomic hydrogen
    A. Interstellar absorption lines
    B. 21 cm. line, hyperfine splitting, line measures amount of H I
  ii. Molecular hydrogen
    A. Dense molecular clouds
    B. Radio Lines due to rotating molecules
  iii. Photo-ionized/excited gas – H II regions (see Ch 12.3: p. 431- 434)

A. Ionized by O & B stars
B. Planetary Nebulae (See Ch 13.2 p. 470-474)
C. Optical forbidden and fluorescent lines – measures of gas temperature and density

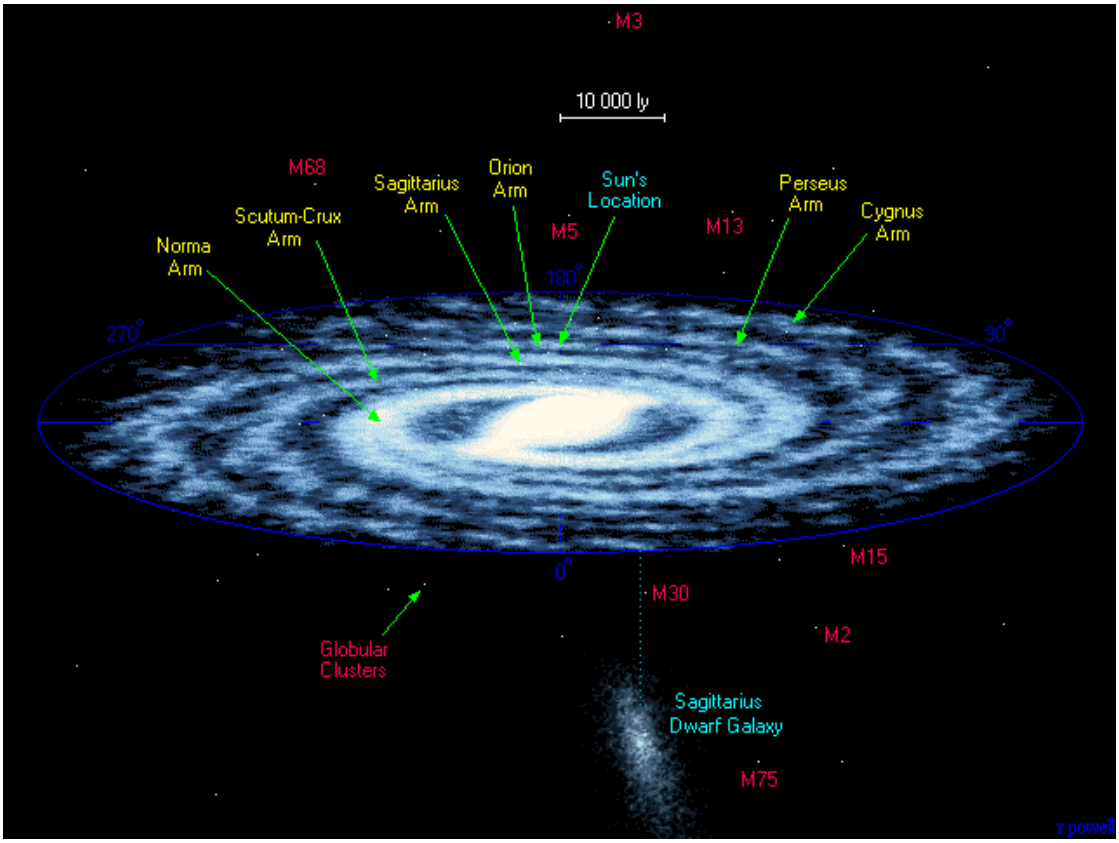
iv. Collisionally ionized/excited gas
v. Cosmic Rays (see Chapter 15.5)

4. Rotation Curve of the Milky Way/ Galactic Dynamics - Chapter 24.3, 25.3

(a) Oort analysis of relative motions
(b) Local solar neighborhood bright stars
(c) Distant clouds of hydrogen – 21 cm. observations
(d) Flat rotation curve of the Milky Way
i. Massive halo of dark matter
(e) Structure of spiral arms
i. Density wave theory

5. Formation of the Milky Way (if time permits) – Chapter 26.2

(a) Population structure ⇒Due to collapse
(b) Collapse of gas ⇒ rotating disk
(c) Collapse of stars ⇒ spheroid with random orbits
(d) Start with pure hydrogen and helium cloud
(e) Collapse, make stars, disperse heavy elements
(f) Real history more complex ⇒ several "collapses" due to mergers
i. Evidence for recent tidal disruptions of other nearby galaxies and mergers



The Milky Way Galaxy