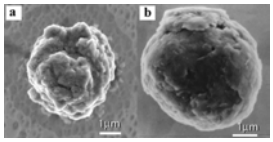
Dust [12.1]

- Tiny grains (≤ 1μm)

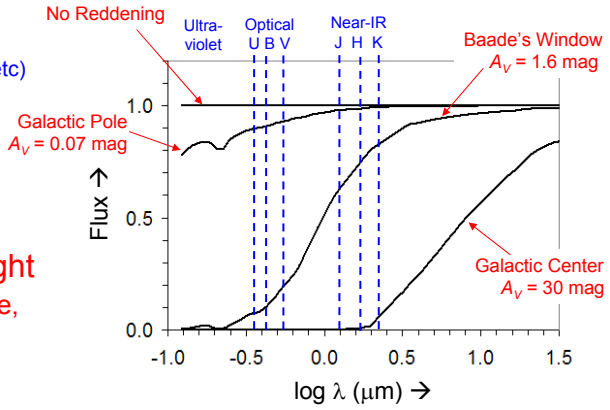


- Cores consisting of
  - Graphite
  - or Silicates

($Mg_xFe_{1-x}SiO_3$; $Mg_{2x}Fe_{2-2x}SiO_4$; etc)

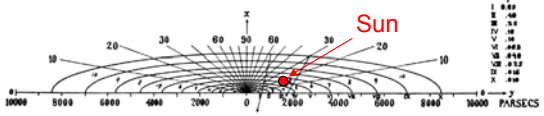
- Ices can condense on surface:
  - C,O combined with H

- **Absorb and scatter light**
  - Effect strongest in blue,
  - less in red,
  - zero in radio.

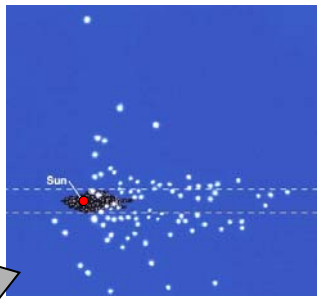


Mapping Our Galaxy

From star counts:



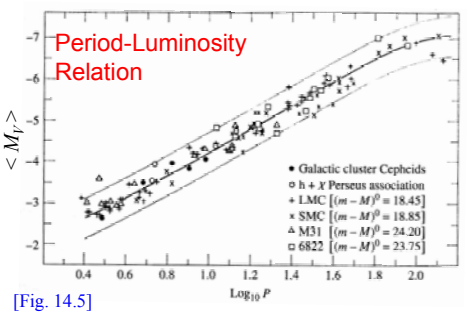
Kapteyn (1922). Surfaces of constant star density.



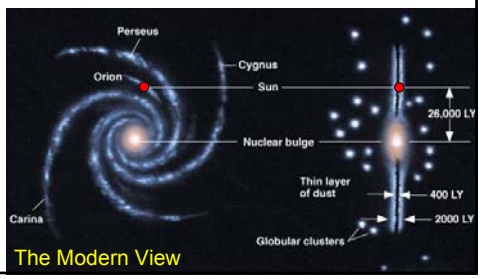
Shapley (1920) Globular Clusters
(distances using RR-Lyraes)

From distribution of Globular Clusters:

- Use pulsating variables to find clusters' distances.
- Clusters are out of MW disk ➔ little reddening.



[Fig. 14.5]



The Modern View

[Table 24.1]

Disks

	Neutral Gas	Thin Disk	Thick Disk
M (10^{10} $M_\odot$)	0.5[a]	6	0.2 to 0.4
L_B (10^{10} $L_\odot$)[b]	—	1.8	0.02
M/L_B ($M_\odot/L_\odot$)	—	3	—
Radius (kpc)	25	25	25
Form	e^{-z/h_z}	e^{-z/h_z}	e^{-z/h_z}
Scale height (kpc)	< 0.1	0.35	1
σ_w (km s^{-1})	5	16	35
[Fe/H]	> +0.1	−0.5 to +0.3	−2.2 to −0.5
Age (Gyr)	$\lesssim$ 10	8[c]	10[d]

Spheroids

	Central Bulge[e]	Stellar Halo	Dark-Matter Halo
M (10^{10} $M_\odot$)	1	0.3	190^{+360}_{-170}[f]
L_B (10^{10} $L_\odot$)[b]	0.3	0.1	0
M/L_B ($M_\odot/L_\odot$)	3	~ 1	—
Radius (kpc)	4	> 100	> 230
Form	boxy with bar	$r^{-3.5}$	$(r/a)^{-1}(1+r/a)^{-2}$
Scale height (kpc)	0.1 to 0.5[g]	3	170
σ_w (km s^{-1})	55 to 130[h]	95	—
[Fe/H]	−2 to 0.5	< −5.4 to −0.5	—
Age (Gyr)	< 0.2 to 10	11 to 13	~ 13.5

Usually see deVaucouleurs' $r^{1/4}$ surface brightness law:

$$\log_{10}\left[\frac{I(r)}{I_e}\right] = -3.3307\left[\left(\frac{r}{r_e}\right)^{1/4} - 1\right]$$

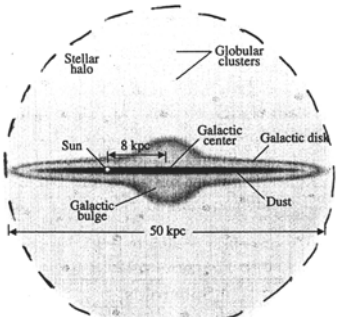
Milky Way's Morphology

Exponential disk

$$n(z,r) = n_o(e^{-z/z_{thin}} + 0.02e^{-z/z_{thick}})e^{-r/h_r}$$

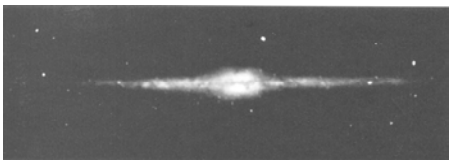
+ spheroids with various "forms"

$$n = n_0 \times form$$

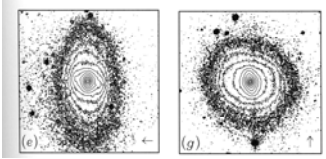


[Fe/H] =log(Fe/H) abundance ratio relative to Sun

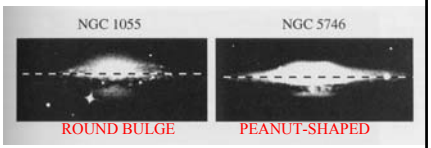
Milky Way Bulge



- Elongated… now thought to be a bar
  - From observations of Mira pulsating variables.
  - Minor/major ~0.6
- Roughly follows DeV profile ($r^{1/4}$ law)
- Baade's window
  - Moderate metallicity (-1 < [Fe/H] < +1)
    ~10^{10} $M_\odot$
- Expanding 3kpc arm
  - H I feature
  - v_r = -50 km/s
  - Elliptical orbit due to bar



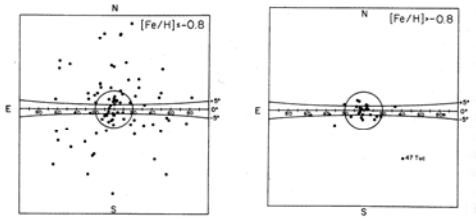
SB0 isophotes [BM] Fig 4.57



The Psychedelic Barred Spiral Movie

Milky Way Halo

- Globular clusters + field stars
- Field stars = high velocity stars
- ~150 globular clusters known, in 2 different systems:
  - Older (~13 Gyr)
    - Very metal-poor (-2.5 < [Fe/H] < -0.8)
    - Spherical distribution around galactic center
    - No net rotation



[Fig 24.12]

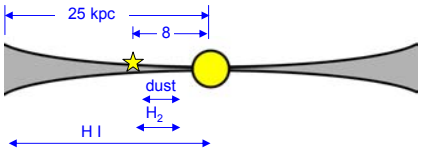
  - Younger
    - (~11Gy, ~ same as thick disk)
    - Moderate metallicity ([Fe/H]> -0.8)
    - Compare to thick disk –0.6 < [Fe/H] < -0.4
    - Flattened
    - Show net rotation => part of thick disk??

Warning! These are plots of directions in sky, NOT cross-sections of MW

[Table 24.1]

	Disks		
	Neutral Gas	Thin Disk	Thick Disk
M (10^{10} $M_\odot$)	0.5[a]	6	0.2 to 0.4
L_B (10^{10} $L_\odot$)[b]	—	1.8	0.02
M/L_B ($M_\odot/L_\odot$)	—	3	—
Radius (kpc)	25	25	25
Form	e^{-z/h_z}	e^{-z/h_z}	e^{-z/h_z}
Scale height (kpc)	< 0.1	0.35	1
σ_w (km s^{-1})	5	16	35
[Fe/H]	> +0.1	−0.5 to +0.3	−2.2 to −0.5
Age (Gyr)	$\lesssim$ 10	8[c]	10[d]

The Gas Disk



Radius (kpc)	Half-density Thickness (pc)
< 4	100
4 - 10	250
11	300
15	650
20	1000

- HI (= H^0) detected through 21 cm emission
  - Electron spin-flip transition in H ground state
  - Galaxy essentially transparent at 21 cm
- Diameter: ~ 50 kpc
- Thickness:
  - Increases outward
  - Sun is ~ 30 pc above midplane.
  - Disk is warped starting at R ~ 7 kpc
- Mass
  - H I: 4 x 10^9 $M_\odot$
  - H_2: 1 x 10^9 $M_\odot$
- Average density: 0.04 $M_\odot$ pc^{-3}