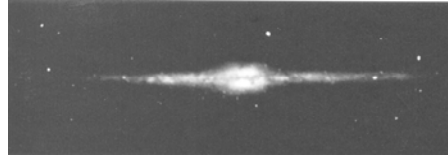
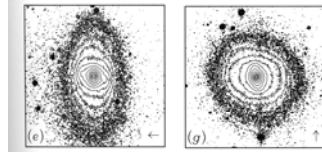


Milky Way Bulge

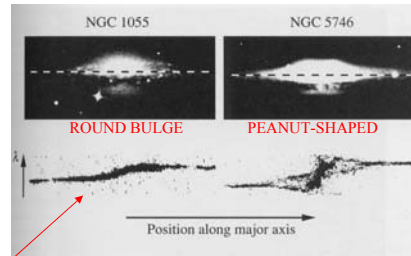


- Elongated... now thought to be a bar
 - From observations of Mira pulsating variables.
 - Minor/major ~ 0.6
- Roughly follows DeV profile ($r^{1/4}$ law)



SBO isophotes [BM] Fig 4.57

- Baade's window.
 - $-1 < [Fe/H] < +1$
 - $\sim 10^{10} M_{\odot}$
- Expanding 3kpc arm
 - HI feature
 - $V_r = -50$ km/s
 - Elliptical orbit due to bar



Kinematics of gas, in [NII]
[BM] Fig 4.60

Long-slit spectrum

Milky Way Halo

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

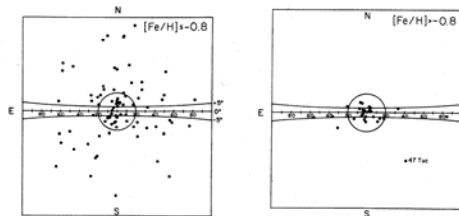
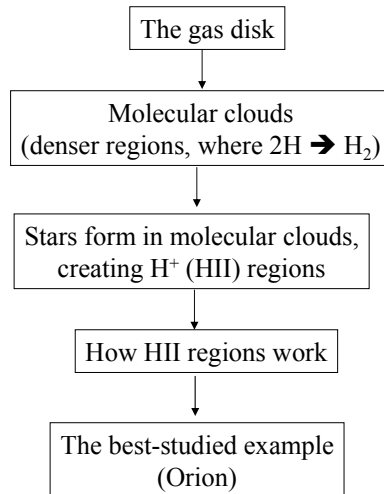


Fig 24.12

- Younger
 - (~ 11 Gy, \sim same as thick disk)
 - $[Fe/H] > -0.8$
 - Compare to thick disk $-0.6 < [Fe/H] < -0.4$
 - Flattened
 - Show net rotation \Rightarrow part of thick disk??

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

The Gas Component of the Milky Way



The Interstellar Medium (ISM)

- Very hot, low-density medium
 - $T \sim 10^6 \text{ K}$, $N \sim 10^{-3} \text{ cm}^{-3}$, 70% of volume.
 - Heated by SNe
- Cold, predominately neutral gas
 - $T \sim 100\text{K}$, $N \sim 20 \text{ cm}^{-3}$, 2-4% of volume
- Hot neutral gas
 - $T \sim 6 \times 10^3\text{K}$, $N \sim 0.3 \text{ cm}^{-3}$, 20% of volume
- Molecular clouds
 - $T \sim 20\text{K}$, $N > 10^3 \text{ cm}^{-3}$, <1% of volume
 - Contain appreciable fraction of gas mass
- HII regions
 - $T \sim 8 \times 10^3\text{K}$, $N > 0.5 \text{ cm}^{-3}$, 10% of volume

Roughly in pressure balance: $N_1 T_1 = N_2 T_2$

The Gas Disk

HI detected through 21 cm emission

- Galaxy is essentially transparent

Diameter: ~ 50 kpc

Thickness:

- Sun is ~ 30 pc above midplane.
- Disk is warped starting at $R \sim 7$ kpc
 - Reaches ~ 1 kpc at $R = 15$ kpc

Radius (kpc)	Constituent
3-7	Cool dust
3 - 8	H ₂
3-25	H

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

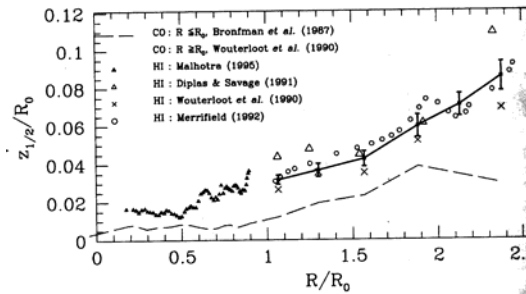
Mass

- HI: $4 \times 10^9 M_{\odot}$
- H₂: $1 \times 10^9 M_{\odot}$

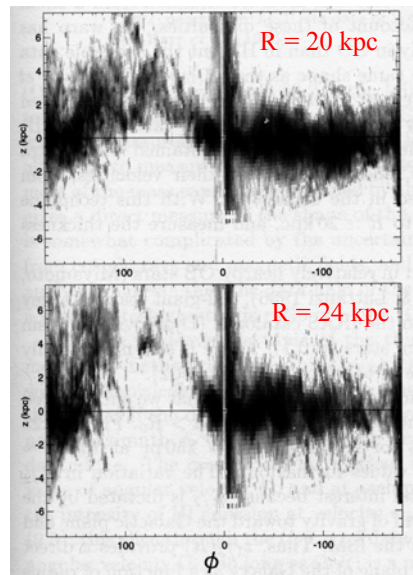
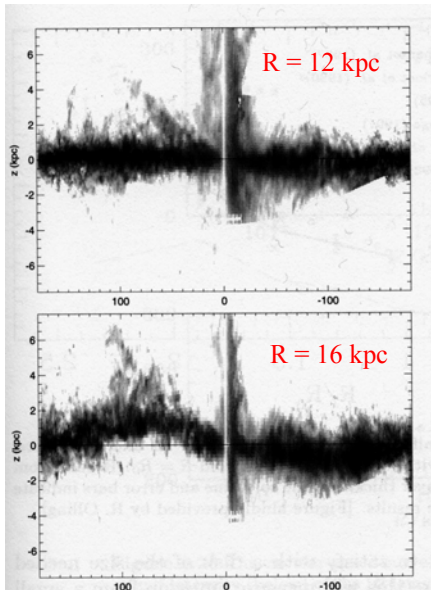
Average density: $0.04 M_{\odot} \text{pc}^{-3}$

Cold component delineates spiral arms.

But most of volume of gas disk is filled by hot component.

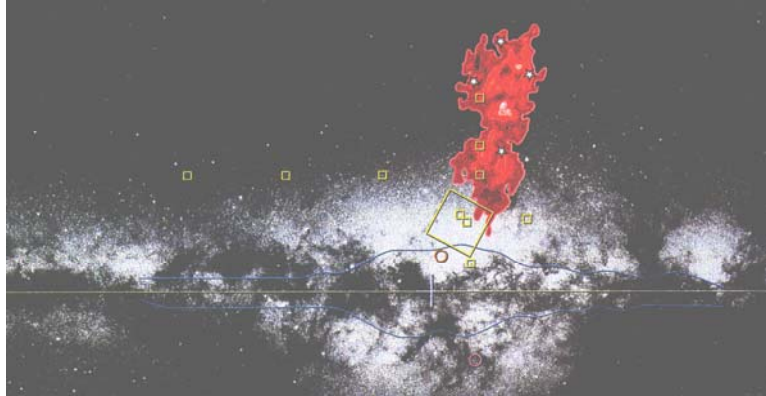


The Warp, from HI maps of MW Disk



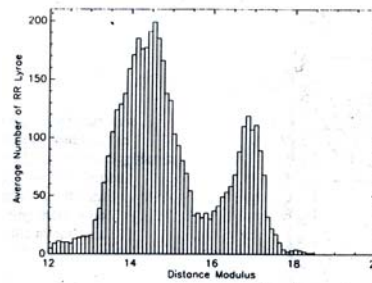
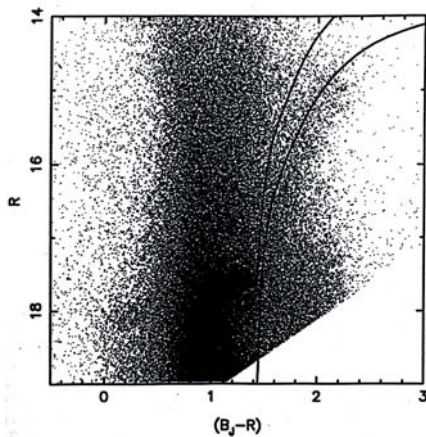
$R =$ distance from Galactic Center

Sagittarius Dwarf Galaxy



- Discovered in 1994 from *star counts* + **radial velocity study of K,M giants towards** Galactic Center.
- $\sim 5 \times 10^9 M_{\odot}$
- ~ 17 kpc beyond GC, and currently falling into disk

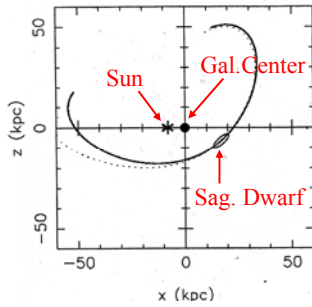
Sagittarius Dwarf Galaxy A needle in a haystack.



Number of RR Lyrae's vs.
distance after correction for
extinction.

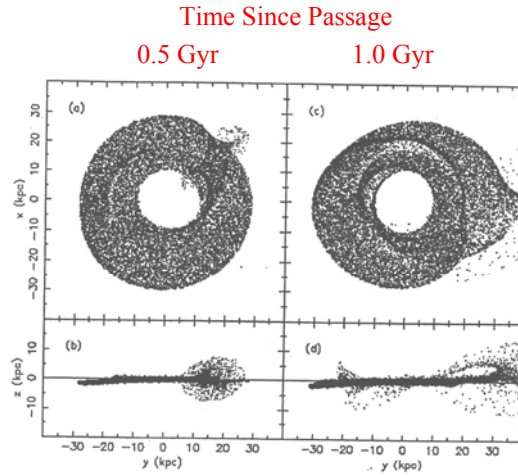
Color magnitude diagram in direction of Sag. Dwarf.
Most stars are giants in Galactic Center.

Numerical Simulation of Effect on Milky Way Disk



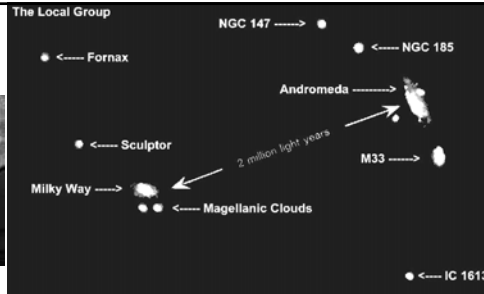
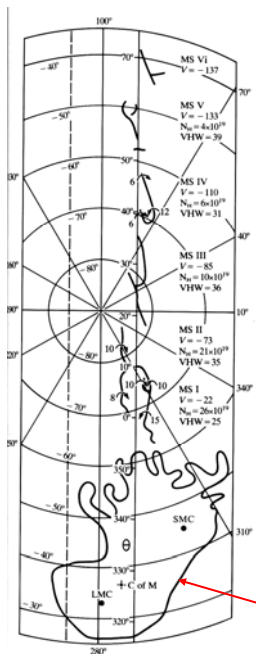
Orbit
Period ~ 1Gyr

Orbital period appears to be < relaxation time of MW disk.



Disk of MW

The Magellanic Stream



- LMC, SMC in common HI envelope.
 - In high-inclination orbit about Milky Way
 - Present distances
 - LMC: 50 kpc
 - SMC: 63 kpc
- Magellanic stream covers 110° on sky.
 - Series of 6 elongated HI clouds leading back to Magellanic Clouds
 - Pulled out of clouds by tidal interaction with MW.

$N_{\text{HI}} = 5 \times 10^{19}$ surface density contour