



DARA Basic Training

NAMIBIA-BOTSWANA 2019

UNIT 1: INTRODUCTION TO ASTROPHYSICS

Windhoek, 7 –18 January 2019

The Milky Way

- The Galactic Plane
- Spiral arms
- Galactic Halo

The Galactic Plane

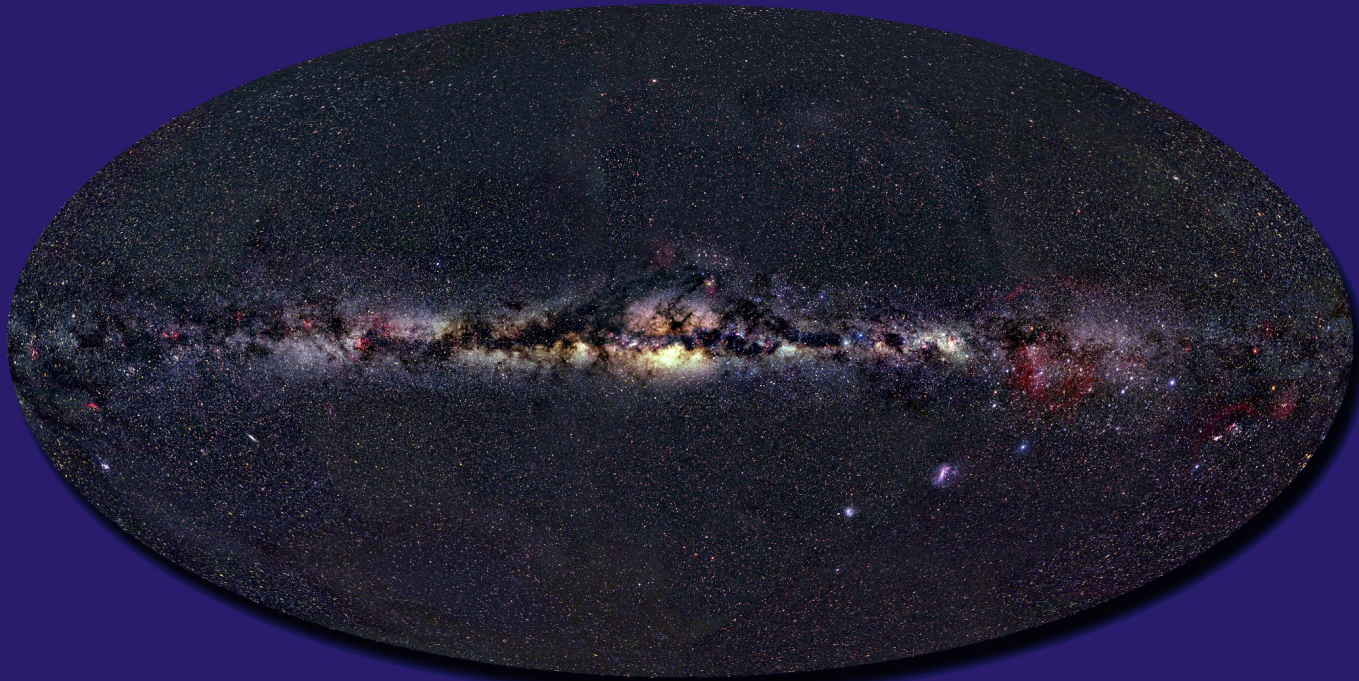
- In optical light the Milky Way delineates the plane of our Galaxy
- Dust lanes obscure much of the structure
- The true structure is only revealed in the near-IR where extinction is lower
- We are located about 8 kpc from the centre in a disc with a radius of about 20 kpc



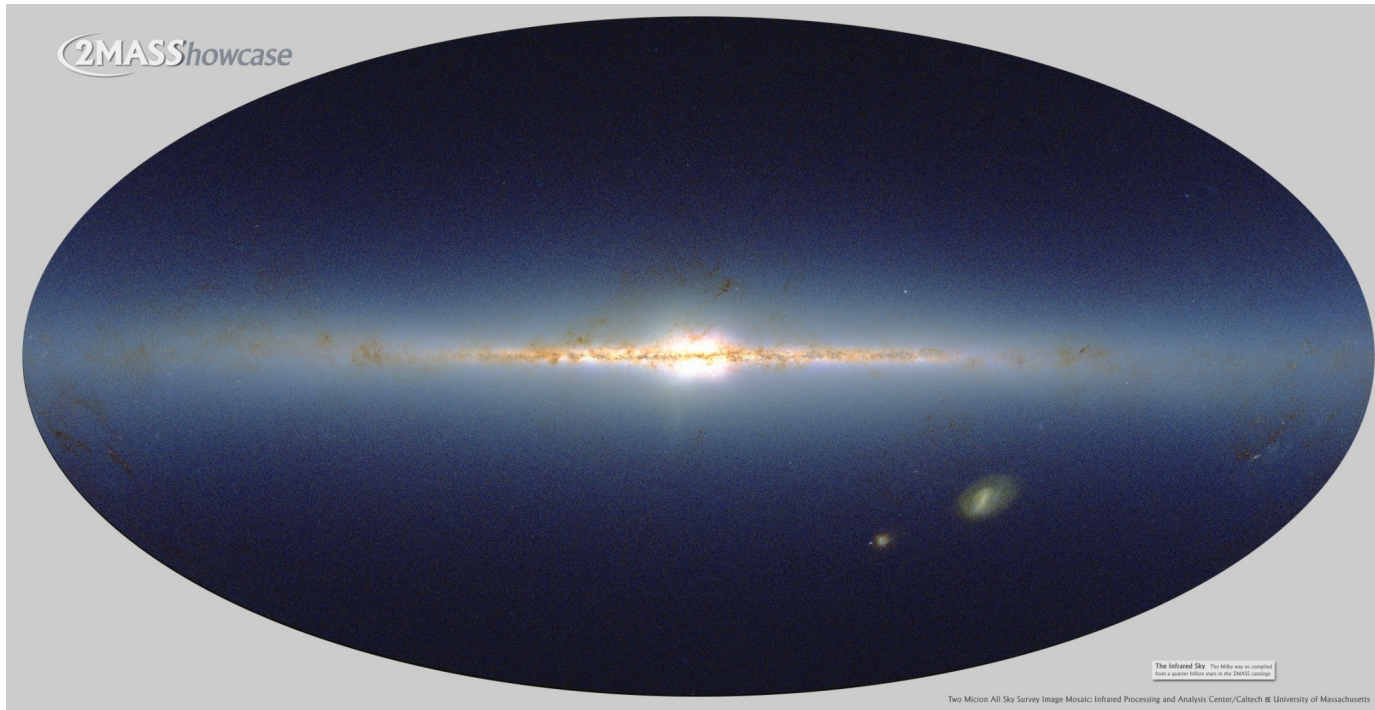
Copyright: Alan Dyer

Optical

A. Mellinger Photomosaic



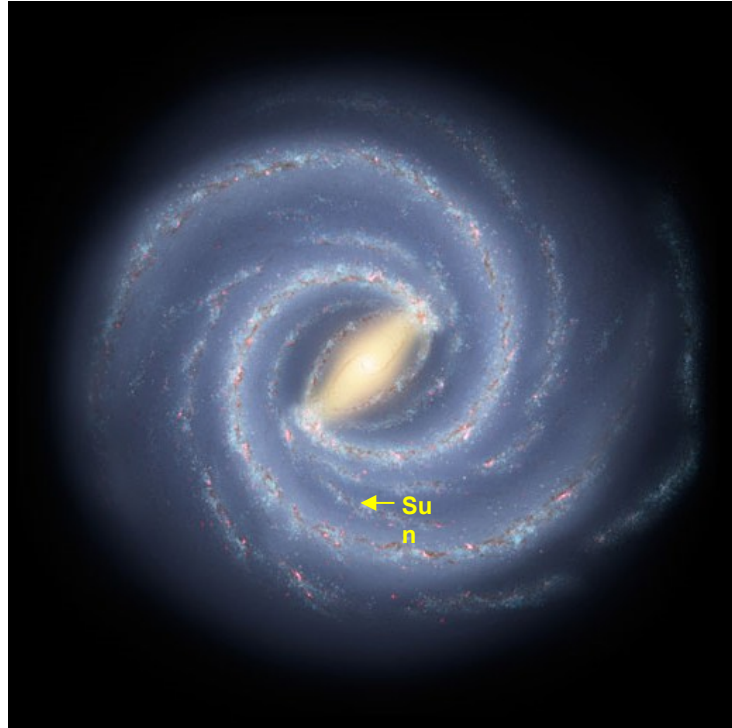
Near-infrared: 1-2 μm



Atlas Image obtained as part of the Two Micron All Sky Survey (2MASS), a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

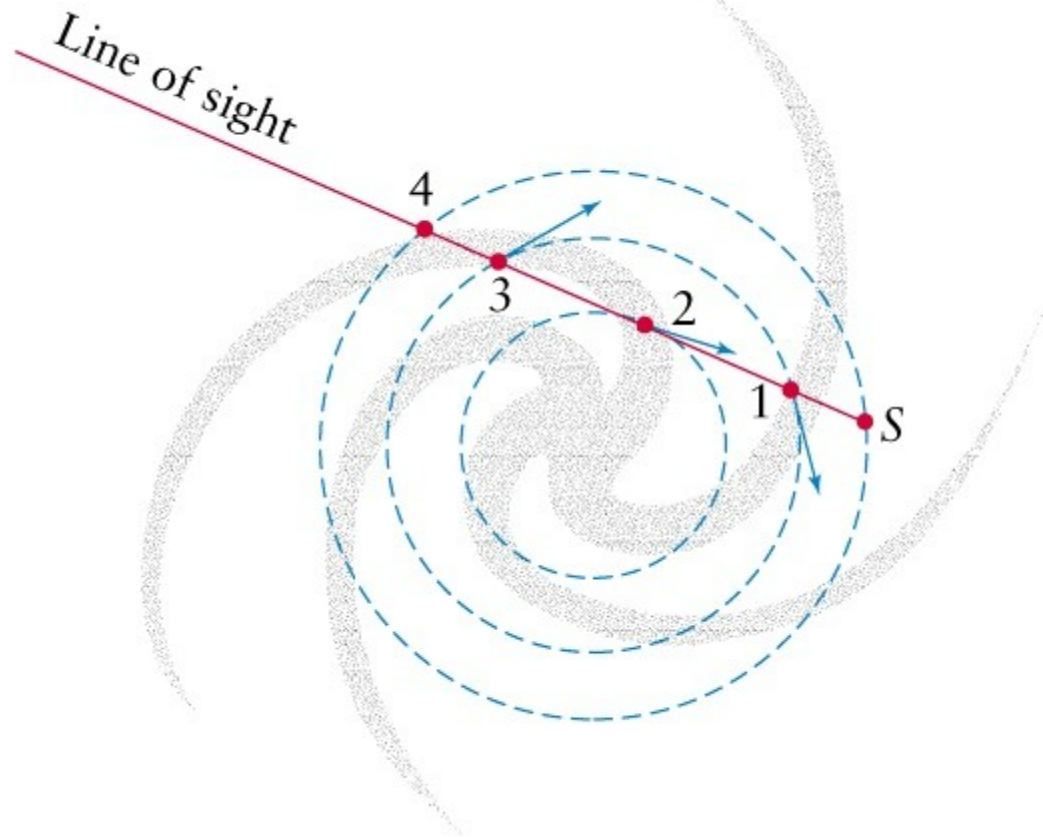
The Bulge and Bar

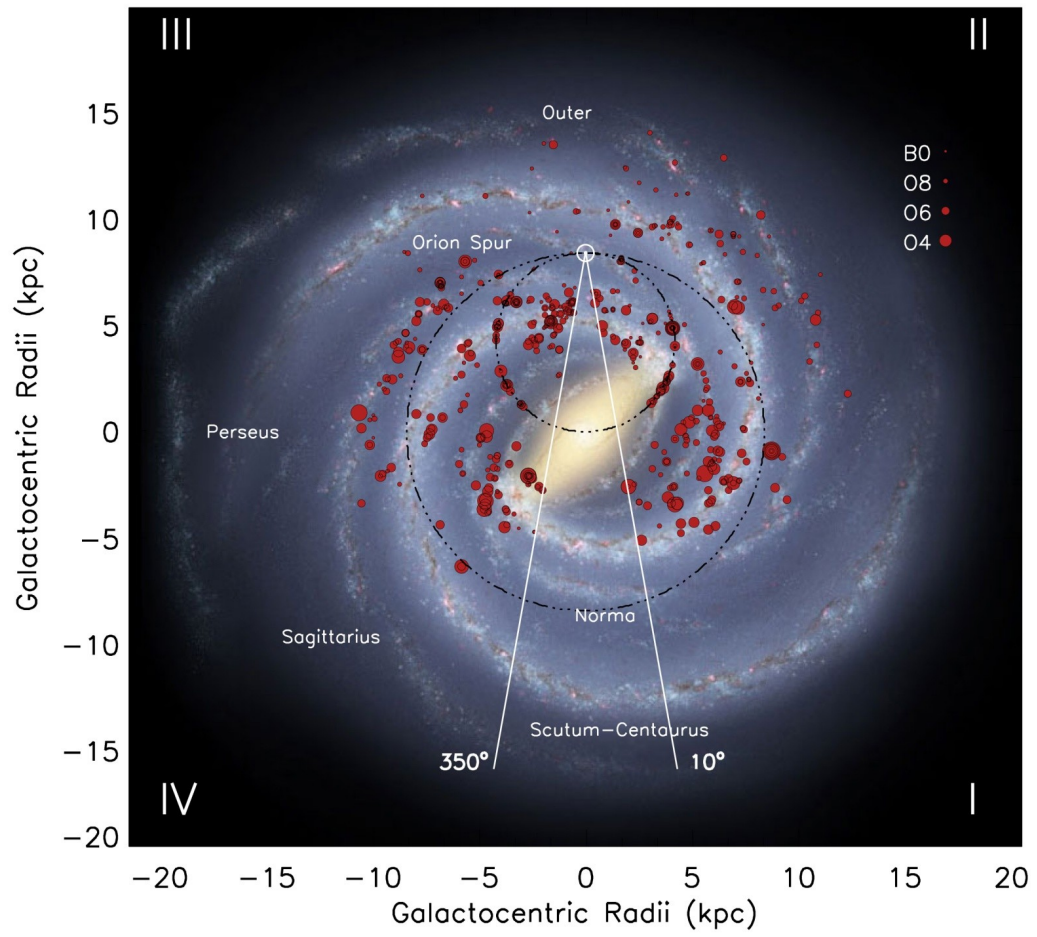
- Bulge is about 1 kpc in radius
- Bar is about 4 kpc in length



Spiral Arms

- The spiral arm structure is determined using tracers of massive star formation with known distances – usually via their Doppler shift and a rotation model
- H II regions and CO clouds are used
- Our galaxy has 4 star-forming gaseous arms and 2 stellar arms originating at each end of the bar





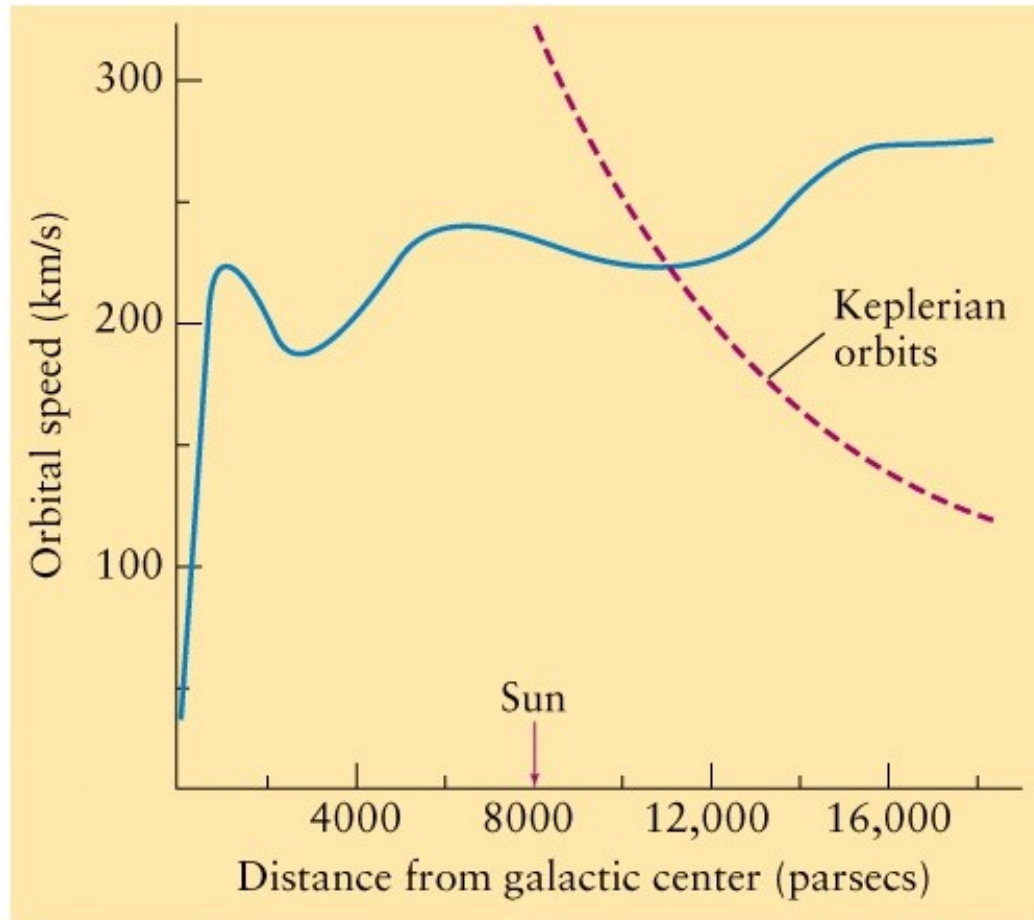
Distribution of massive star forming regions from the Red MSX Source Survey www.ast.leeds.ac.uk/RMS

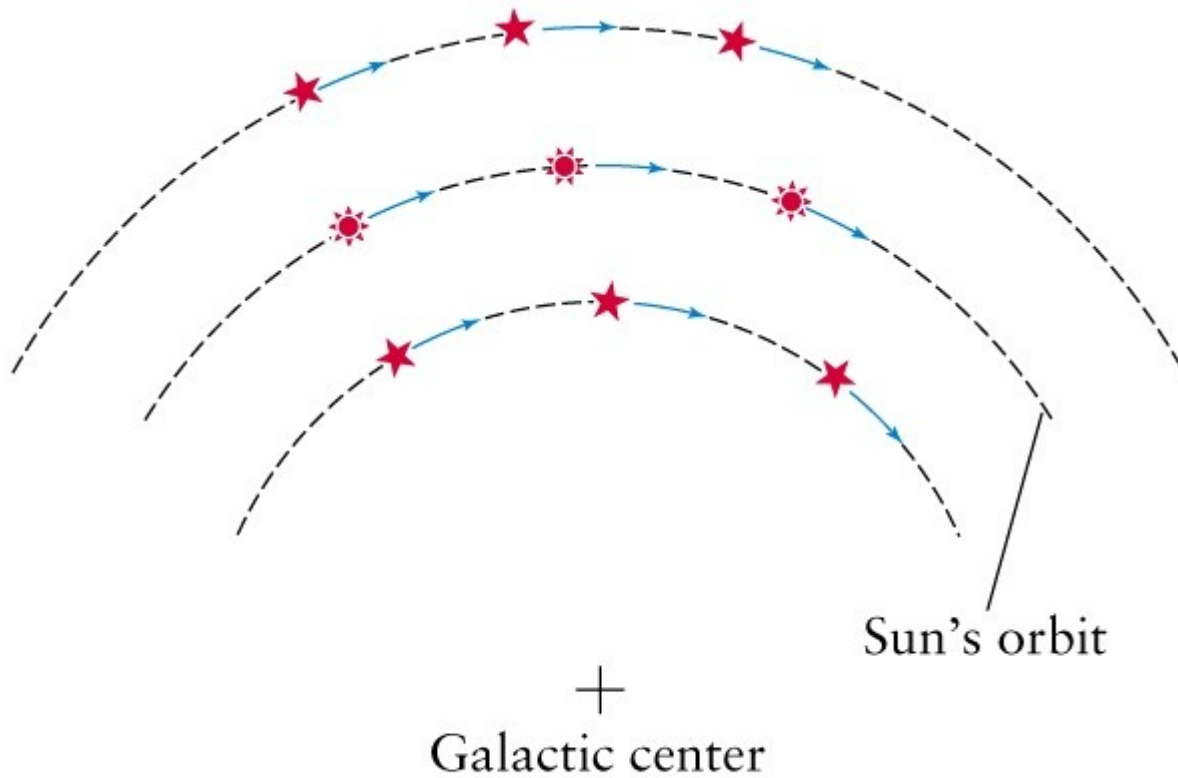
Rotation of the disc

- The observed rotational velocity of the Galactic disc is approximately constant with radius

$$v \approx \text{constant} \approx 220 \text{ km s}^{-1}$$

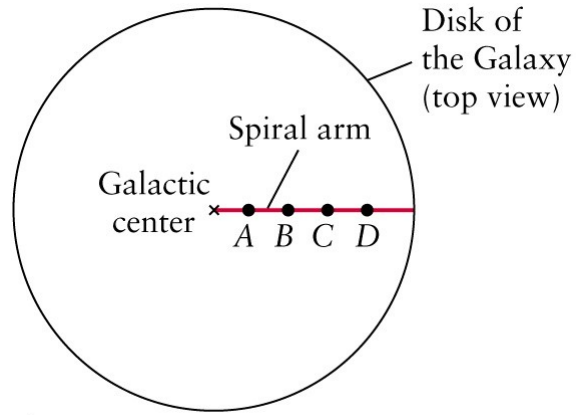
- This requires differential rotation: stars closer to the centre of the galaxy orbit in a shorter time (period $P \propto r$) and overtake us, whilst we overtake stars further out



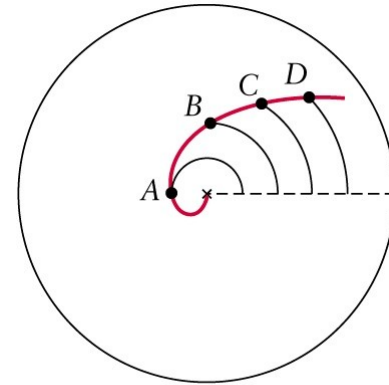


The Wind-up Problem

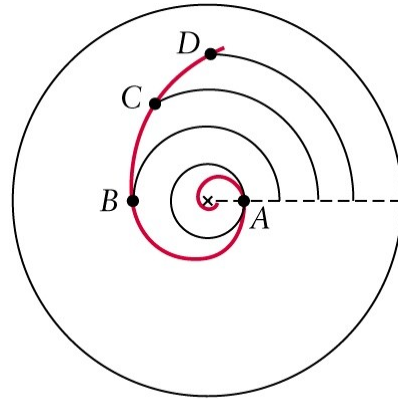
- If the spiral arms were a fixed pattern in the stars and gas the differential rotation would cause them to 'wind-up' in a few revolutions



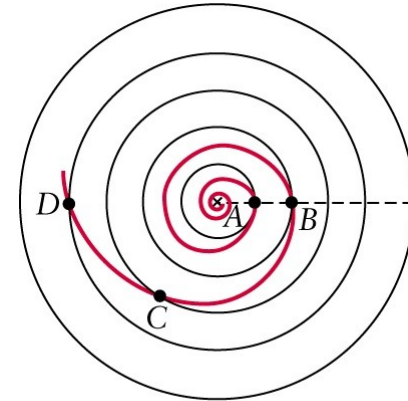
a



b After $\frac{1}{2}$ orbit of star A



c After one orbit of star A



d After two orbits of star A

Density Waves

- The current model for spiral arms is that they are a density wave pattern that rotates at a slower speed than the galaxy
- Stars and gas pass in and out of the arm
- As gas gets compressed in the arm molecular clouds form with subsequent star formation
- Spiral arms usually trail the rotation

- Dust lane where material enters spiral arm, then H II regions, then blue stars



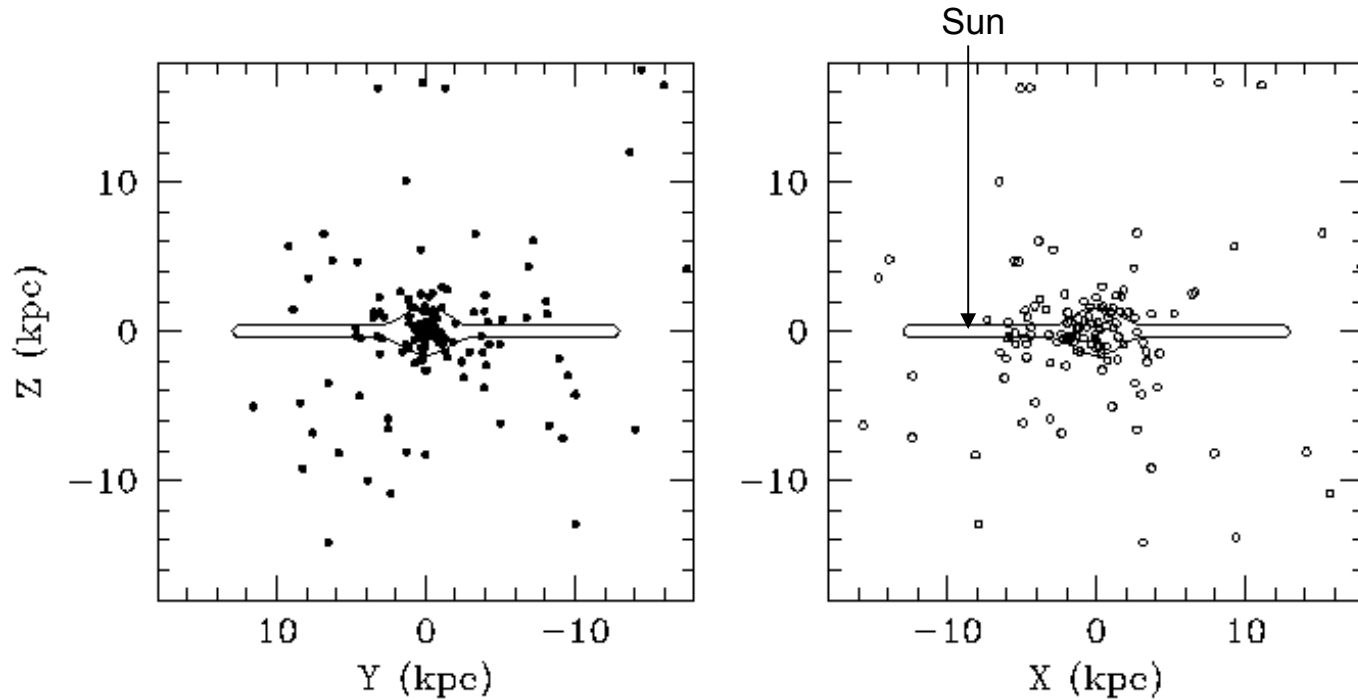
Credit: NASA and The Hubble Heritage Team (STScI/AURA)

The Galactic Halo

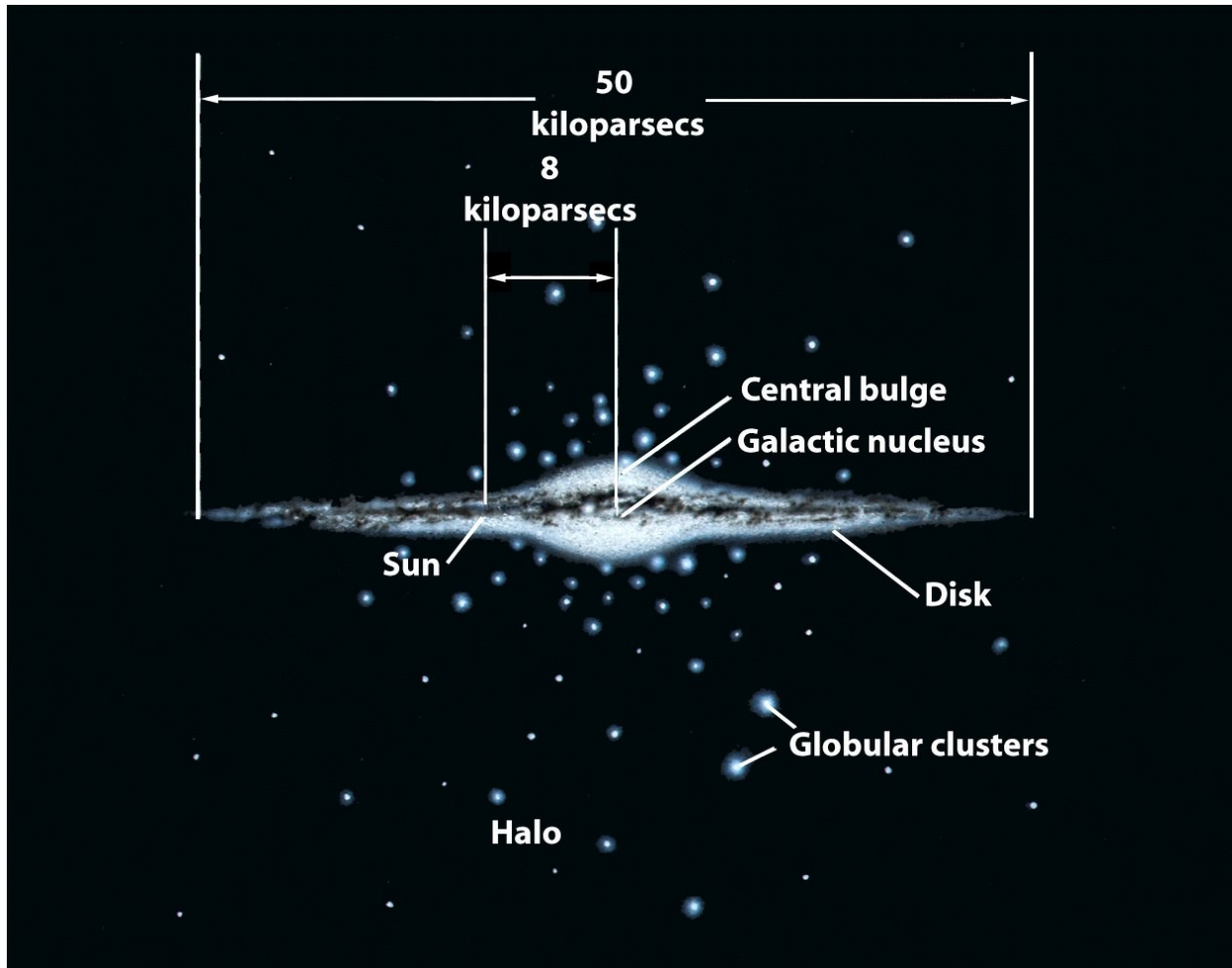
- The plane of our galaxy is surrounded by a more spherical halo of objects
- Consists of globular clusters and halo stars
- Total radius of the halo is ~ 100 kpc



Globular Cluster M80: NASA HST



Distribution of nearby globular clusters in the plane of the Galaxy



Formation of the Galaxy

- Spherical halo formed first out of metal-poor material
 - One initial burst of star formation and none since
- Disc formed later
 - Continuous star formation leading to metal-rich population
- Bulge also has some metal-rich stars as a result of mergers with small galaxies

Summary

- Our Galaxy is a SBb or c
- The disc is surrounded by a spherical galactic halo
- The galactic halo is made up of Population II objects and was formed at an earlier stage than the disc