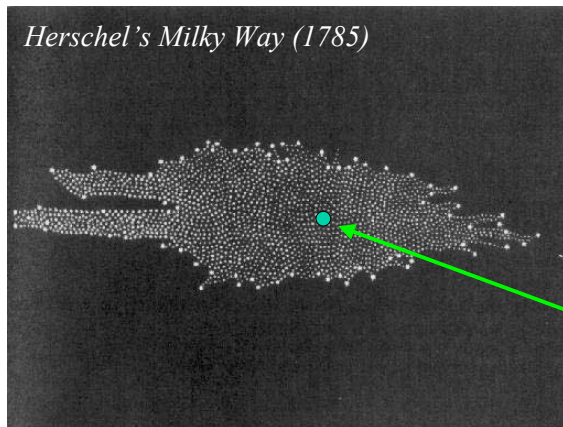# Milky Way

- Modification to the Newtonian universe
  - Distribution of stars is not spherical
- Thomas Wright (1711-1786)
  - "An Original Theory of the Universe" (1750)
  - Two models accounting for the Milky Way
  - Many-universe hypothesis
- Immanuel Kant (1724-1804)
  - Adapted one of Wright's idea: the Milky Way is disky
  - Many-universe: nebulae are other milky ways
- William Herschel (1738-1822)
  - Discovered Uranus
  - His observations of stars showed that the Milky Way was flat.
  - Famous diagram of the Milky Way (1785)

Herschel's Milky Way (1785)

Sun near the center

- Distances to the stars were measured assuming:
  - No absorption or attenuation in interstellar space
  - All stars are similar to the Sun
  - Stars are distributed uniformly in space
- None of the assumptions was correct

How was Herschel deceived?

- Estimated distances were inaccurate because of…
  - Interstellar absorption and attenuation
    - Distant stars look dimmer because:
      - they are farther away, *and*
      - their lights are attenuated by interstellar dust.
    - He did not know about the latter → overestimated distances toward the center of the Milky Way
  - Stars are different
    - Binary stars (two stars orbiting each other) are at the same distance, but they have different brightness
- Stars are not uniformly distributed
  - The most clouded region does not necessarily imply the most extended region
- After proper corrections, the Sun is not at the center of the Milky Way.

Many or One?

- Pierre Simon de Laplace (1749-1827)
  - Rotation balances gravity
  - The nebular theory of formation of the Solar System
  - One-universe hypothesis
    - only one Milky Way (or galaxy) in the universe, and nebulae are gas clouds forming other solar systems
  - His model remained standard until 1924
    - In 1924, Edwin Hubble showed that Andromeda was far beyond the outer reaches of stars in the Milky Way
- Now we know that what they called "nebulae" included both galaxies and gas clouds.

How was c measured?

- Galileo Galilei
  - Exchange of light between two people separated by one mile – failed to measure c: $c > 333.5$ km/s
- Ole Roemer in 1676
  - Eclipse of Io
  - $c = 214,000$ km/s
- James Bradley in 1725
  - Aberration of light from stars (41 arc-seconds)
  - $c = 301,000$ km/s
- Armand Fizeau in 1849
  - A noble experiment using a rotating cogwheel
  - $c = 315,000$ km/s
- Currently accepted value is $c = 299,792.458$ km/s (1972)
  - Now used for definition of the meter (1983)