

# ASTR 1040 Recitation: Cosmic Distance

Ryan Orvedahl

Department of Astrophysical and Planetary Sciences

April 7 & 9, 2014

- Night Observing: Wednesday April 9 (8:30 pm)
- Fiske Planetarium: Thursday April 10 (9:30 am)
- Heliostat Observing: Thursday April 10 (2:00 - 4:00 pm)

# Today's Schedule

- Past/Current Homework or Lecture Questions?
- Density Wave Theory
- Standard Candles
- Magnitudes
- Cosmic Distances

# Why Spiral Structure? – Density Waves

- Gas/Stars move in/out of dense regions
- Gas/stars are pulled toward high density
- Clumping gives rise to spiral structure
- Spiral structure has high star formation



# Density Waves in Action

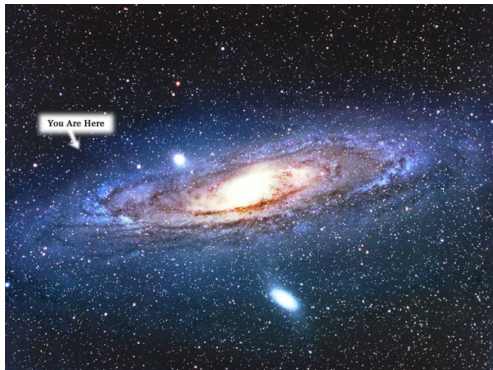
# Density Waves in Action



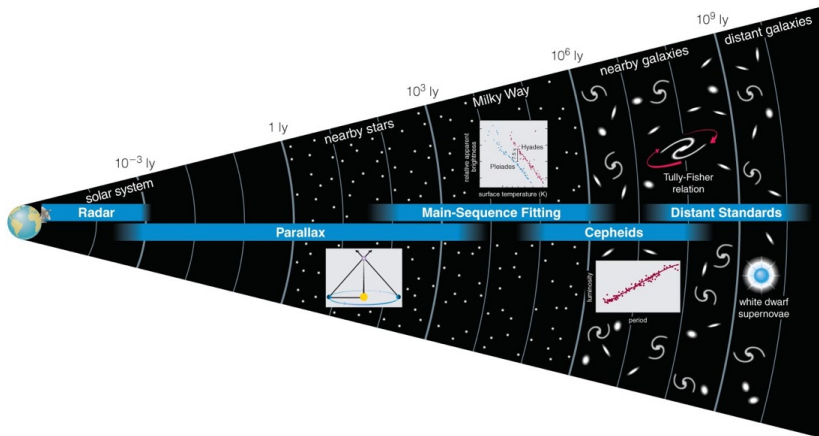
M51 – Whirlpool  
Galaxy

# Cosmic Distances

- The universe is big
- How do we know?
- We measured it



# Cosmic Distance Ladder



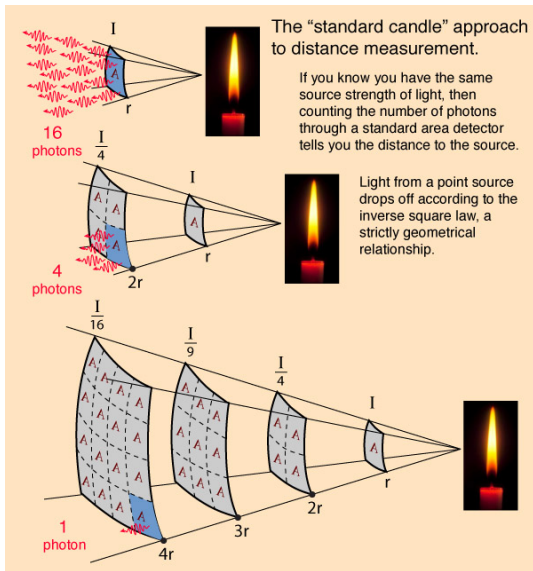
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# Standard Candles

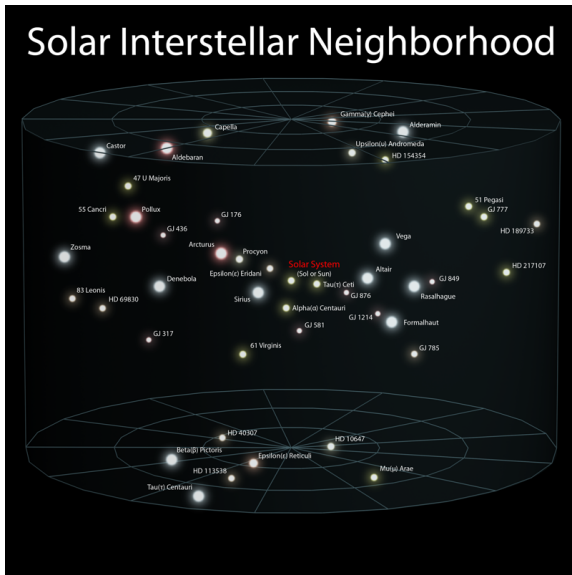


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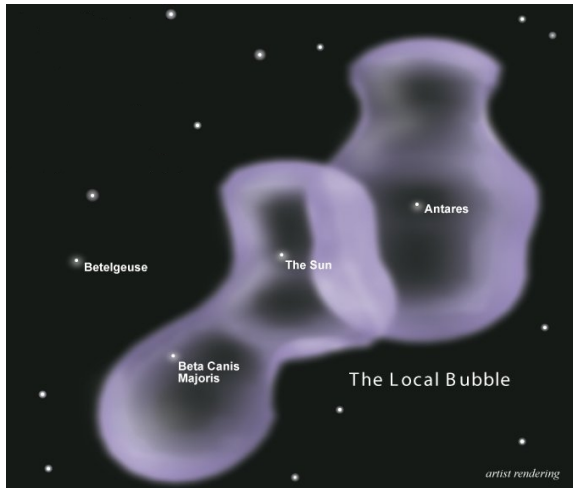


Parallax,  $\alpha \geq 10$  microarcseconds

# The Local Neighborhood $\sim 40$ pc



# The Local Bubble $\sim 100$ pc



# Apparent vs Absolute Magnitudes

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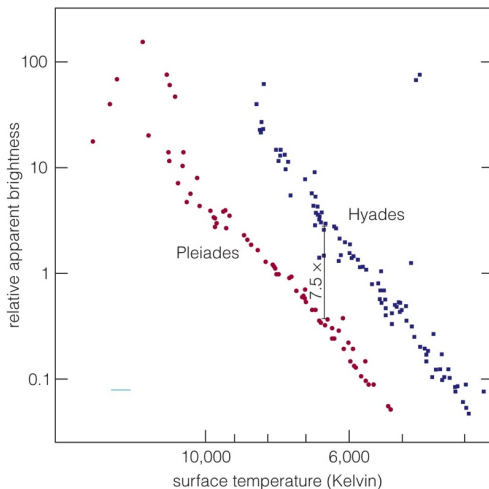
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- Distance modulus:  $m_{\star} - M_{\star} = 5 \log_{10} \left( \frac{d_{\star}}{10 \text{ pc}} \right)$

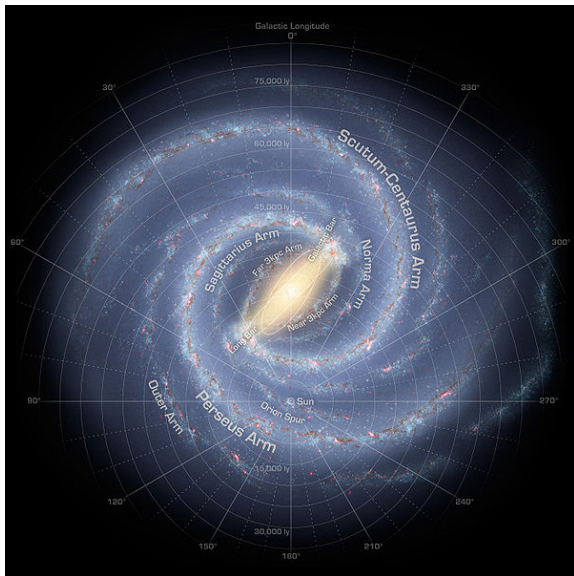
# Main Sequence Fitting

- 90% of stars are on the Main Sequence
- Look for parallel tracks on the HR diagram

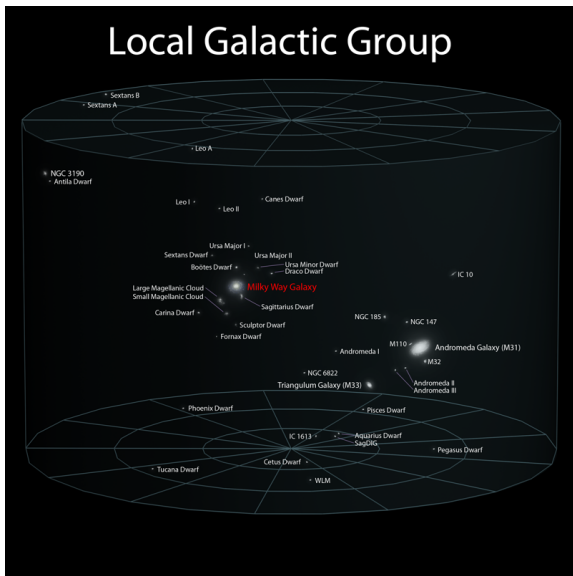


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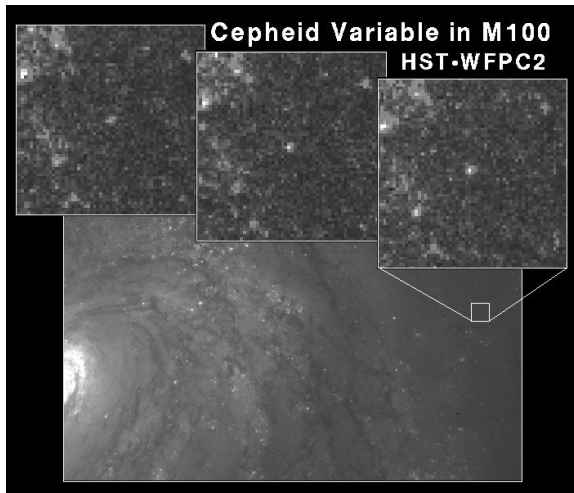
# Main Sequence Fitting



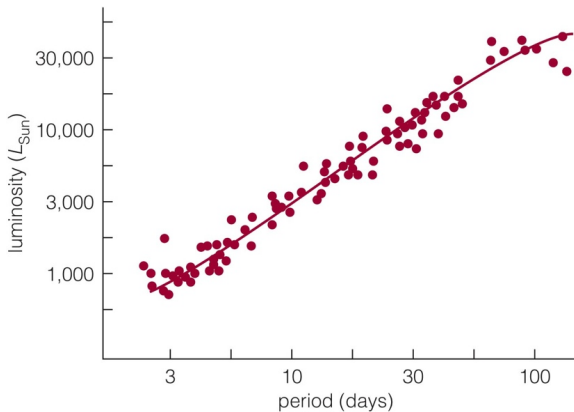
# Local Galactic Group $\sim 2$ Mpc



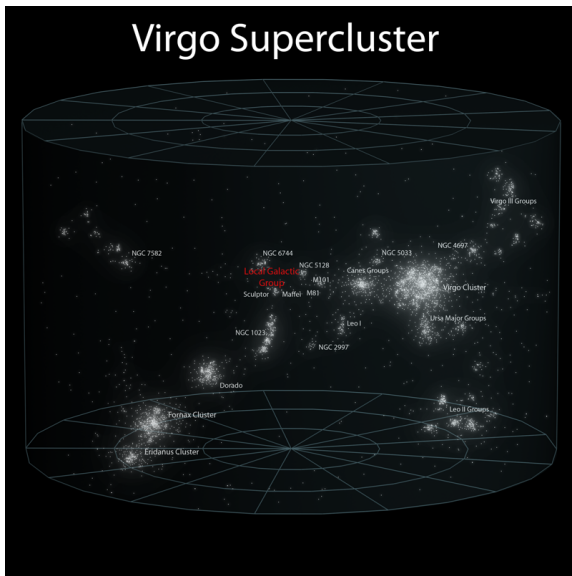
# Cepheid Variables



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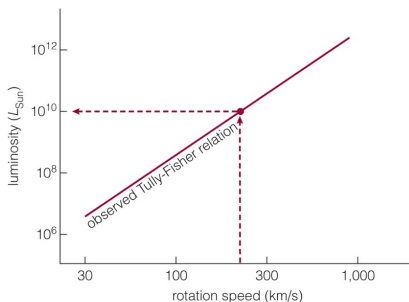
# Cepheid Variables $\sim 50$ Mpc





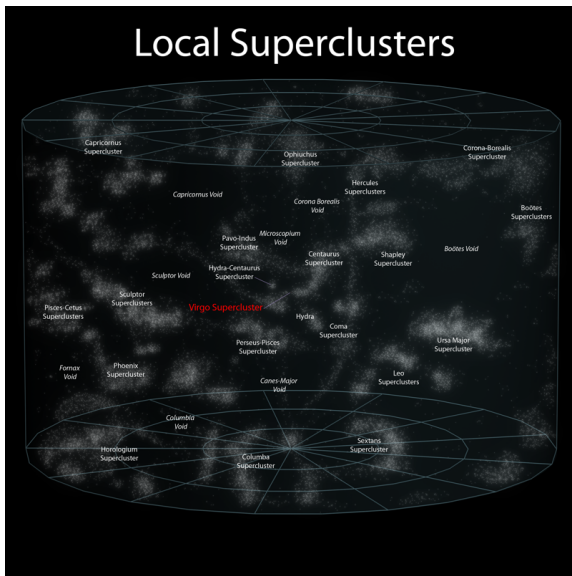
# Tully-Fisher Relation

- Empirical relationship between luminosity and line widths
- Measure width of emission lines (e.g. 21 cm), infer luminosity
- Measure apparent magnitude, calculate distance

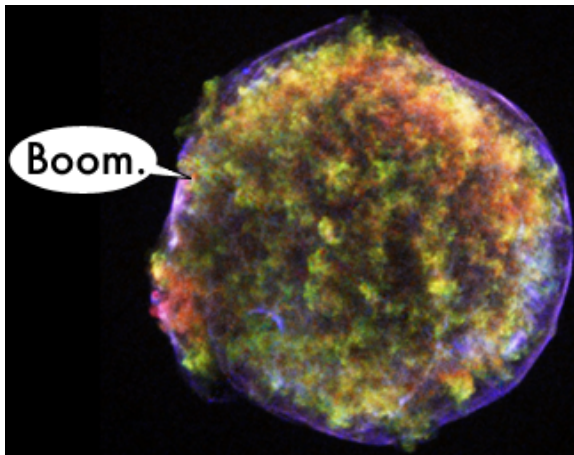


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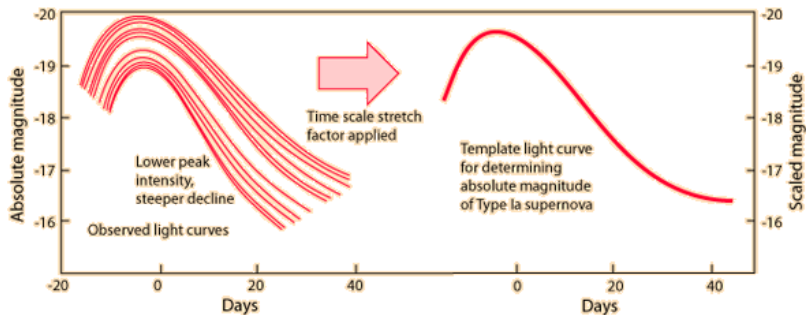
# Tully-Fisher Relation $\sim 500$ Mpc



# Type Ia Supernovae



# Type Ia Supernovae



Phillips relationship (1993):

$$M_{\max}(B) = -21.726 + 2.698\Delta m_{15}(B)$$