Morphology of the Large Magellanic Cloud using Fundamental Mode Cepheids

Fall 2014 Physics Capstone Presentations

Daniel Wysocki

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Magellanic Clouds

What are they?

- two dwarf galaxies which orbit the Milky Way

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- irregular galaxies

Large Magellanic Cloud (LMC)

- 50kpc away

Small Magellanic Cloud (SMC)

- 60kpc away

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  - can be used as a distance calibrator to more distant galaxies

Variable Stars

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- the variation can be related to physical properties of the star

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- for periodic variables, time can be transformed into phase
- shape, amplitude, and period of a star's light curve can reveal many things

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Classical Cepheids

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- obey a period-luminosity-color relationship

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- luminosity depends on surface area and temperature

$$L \propto AT^4 \tag{1}$$

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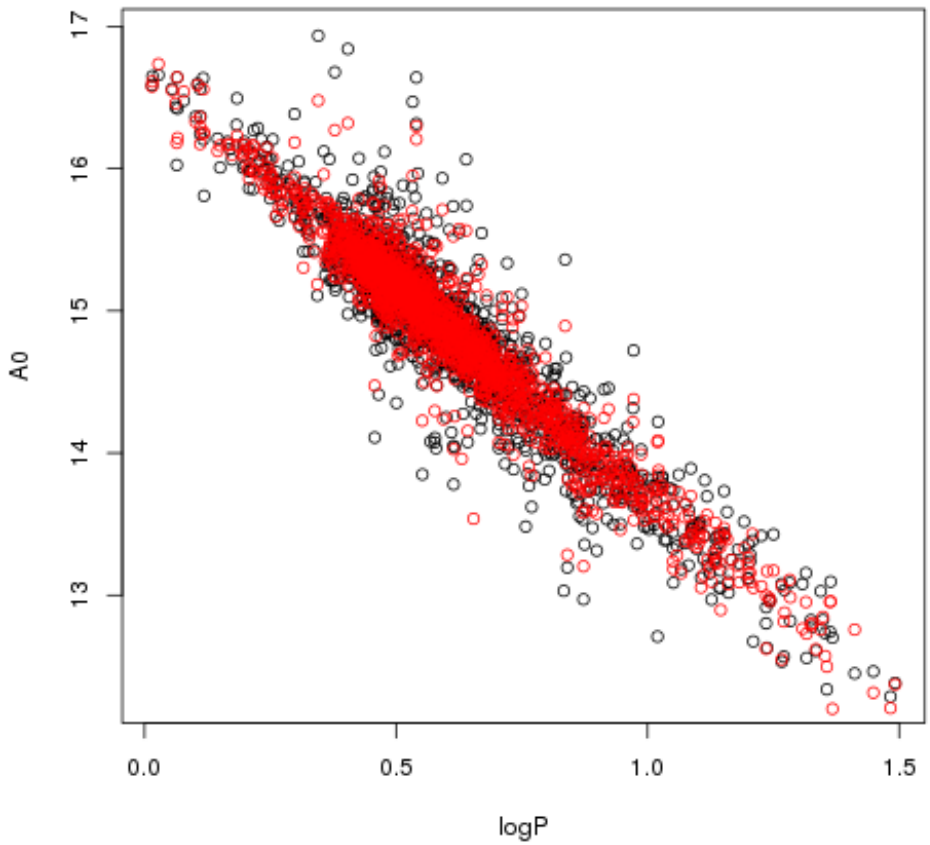
$$\overline{M}_\lambda = \alpha_\lambda \log P + \beta_\lambda + \epsilon_\lambda \tag{2}$$

Period-Luminosity-Color Relationship



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- Classical Cepheids can be used in the same way

Distance Modulus

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- for N stars, and M bands, this results in a system of NM equations with $N + 2M$ unknowns

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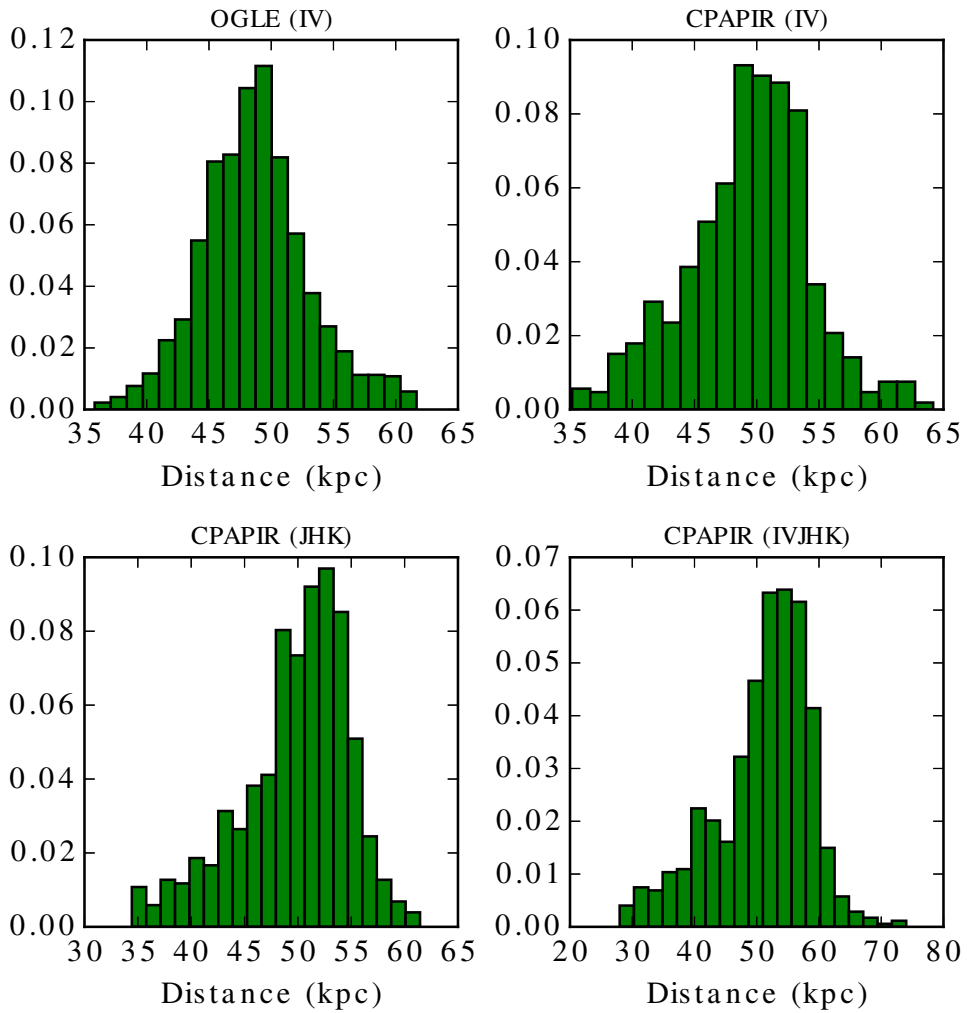
  - $J-$, $H-$, and $K-$bands (infrared)

Distance Distributions



Galactic Morphology

Equatorial Coordinate System

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- introduce distance (D), and the coordinate system now describes three dimensional space

Cartesian Coordinate System

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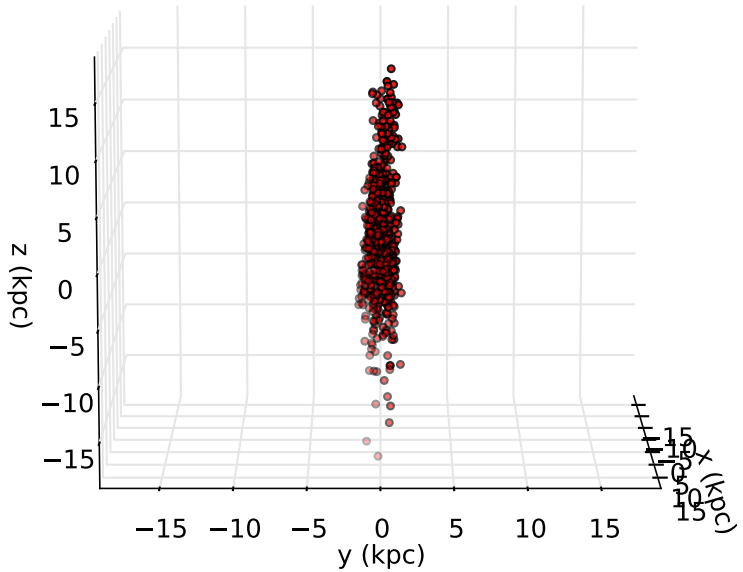
- can be obtained from equatorial coordinate system through the following transformations

$$
\begin{aligned}
x &= -D \sin(\alpha - \alpha_0) \cos\delta, \\
y &= D \sin\delta \cos\delta_0 - D \sin\delta_0 \cos(\alpha - \alpha_0) \cos\delta, \\
z &= D_0 - D \sin\delta \sin\delta_0 - D \cos\delta_0 \cos\alpha - \alpha_0 \cos\delta
\end{aligned}
$$

LMC in 3D



Inclination and Position Angles

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- does not do a very good job describing the 3D structure of the galaxy

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- principal axis transformation is performed on moment of inertia tensor
- transformation gives eigenvalues and eigenvectors, which are used to describe the size and orientation of the axes of the ellipsoid

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