A New Bayesian Method for Analyzing the Structure of the Galactic Bulge Using δ Scuti Stars

WST - the Wide-field Spectroscopic Telescope: surveying the Universe in the 2040's and beyond
March 11, 2025

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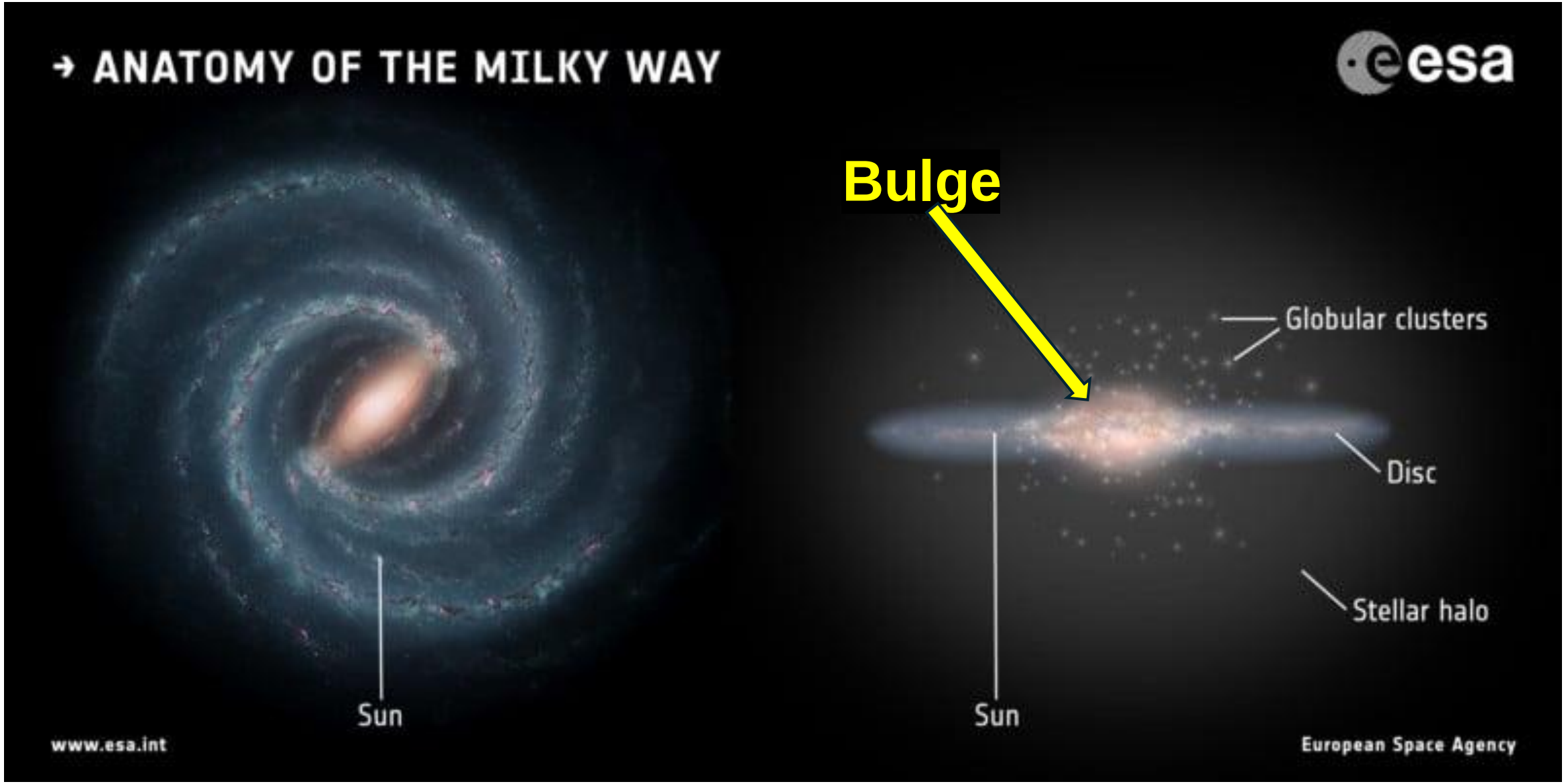
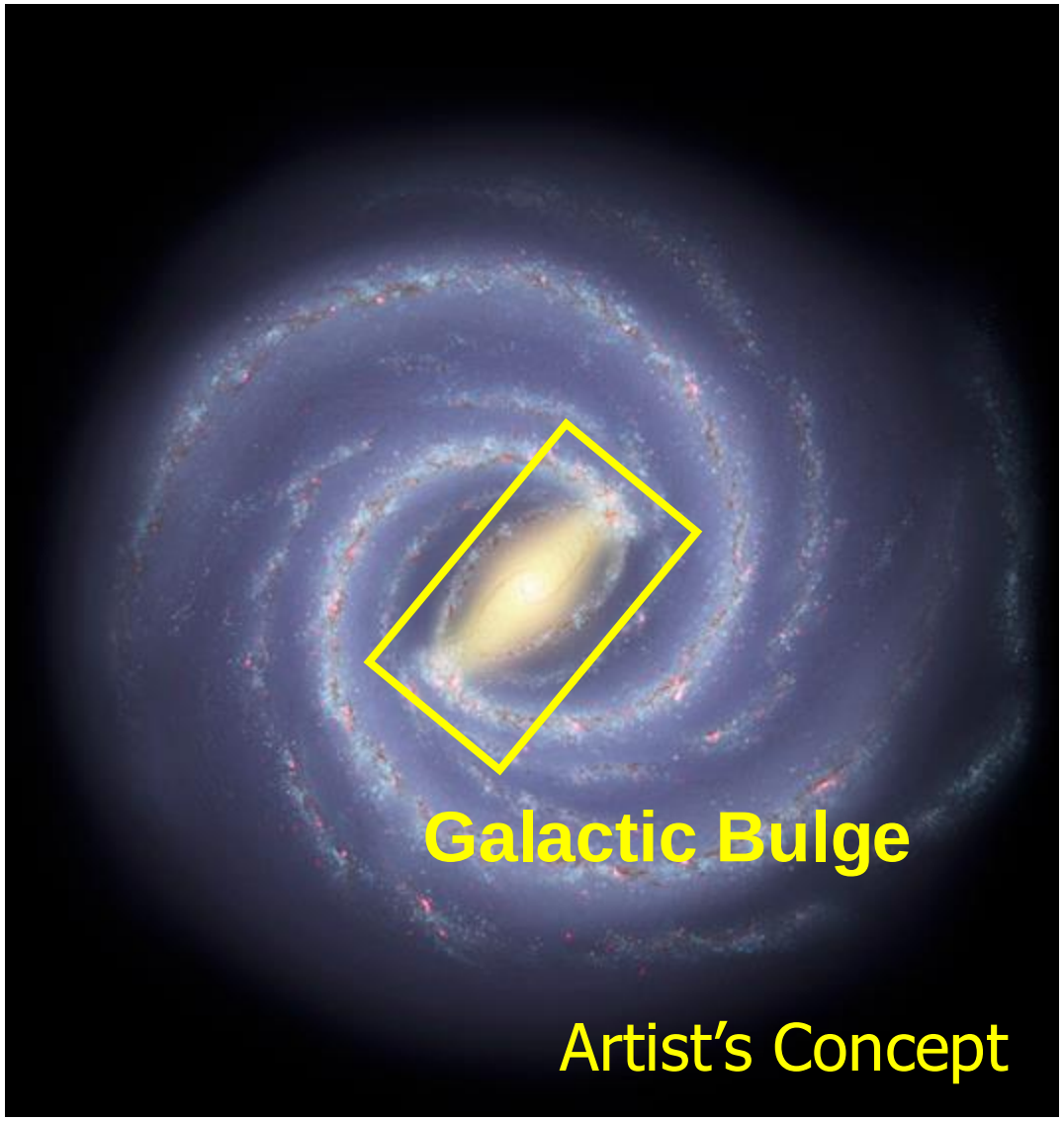
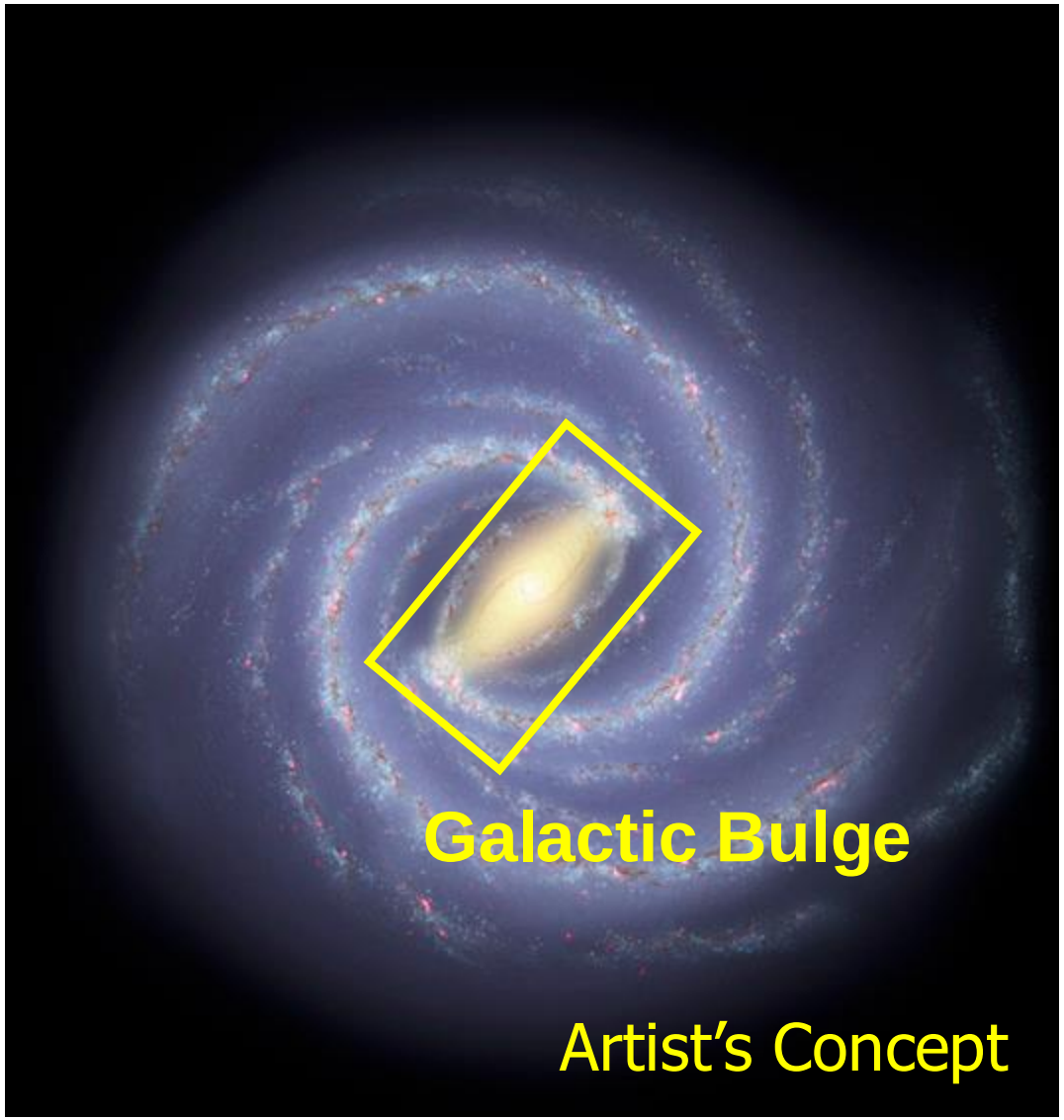


Artist's Concept



- Bar/Bulge?
- Ellipsoidal/triaxial?
- Presence of X-shaped?

Credit: NASA/JPL-Caltech/R. Hurt (SSC/Caltech)



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- RR-Lyraes: Spheroidal
- Miras: Young (5-8 Gyr): Bar
  : Old (9-10 Gyr): Spheroidal
- Type II Cepheids: Spheroidal
- Red clump stars: Bar, X-shape

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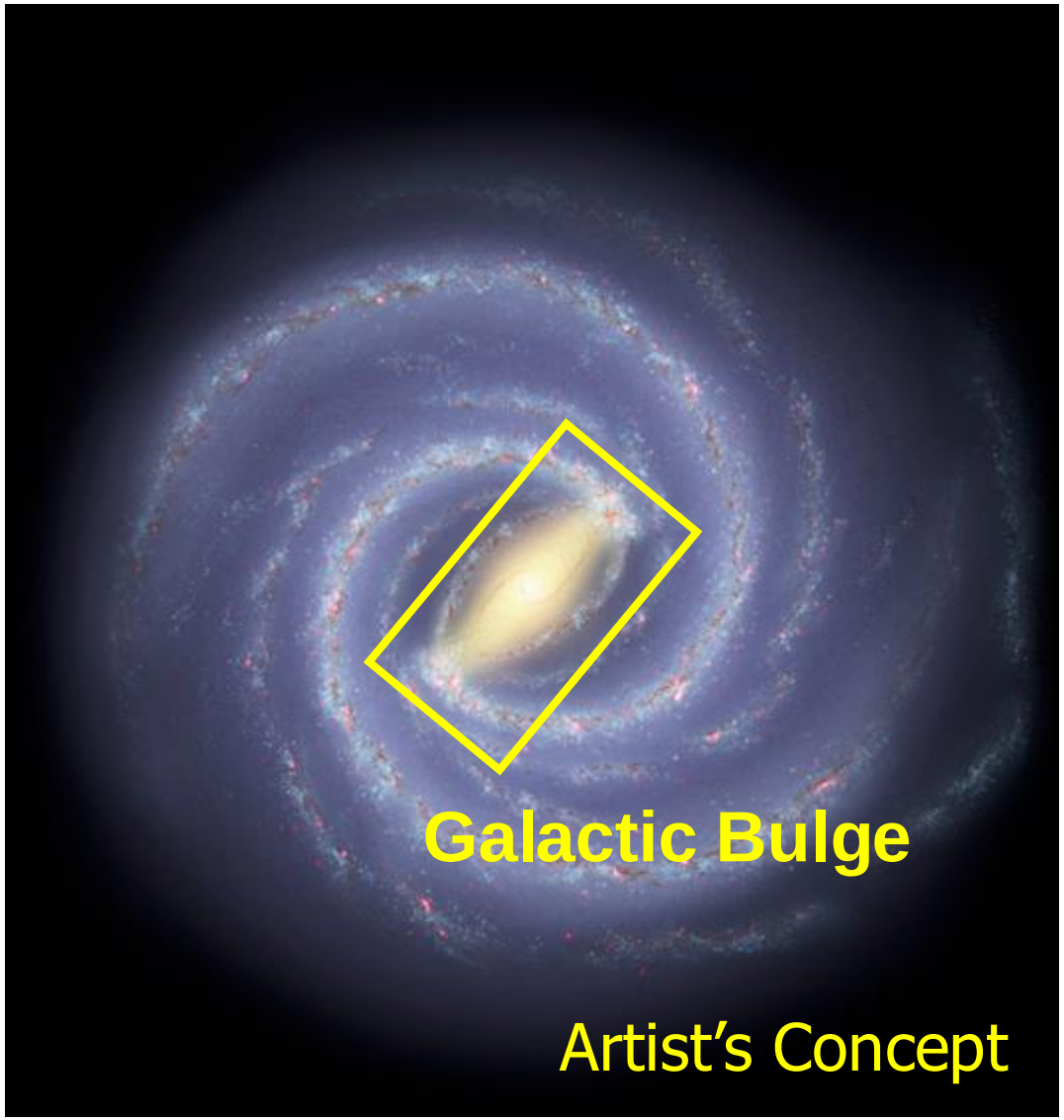

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We have studied the structure of the Galactic bulge using δ Scuti stars for the first time.

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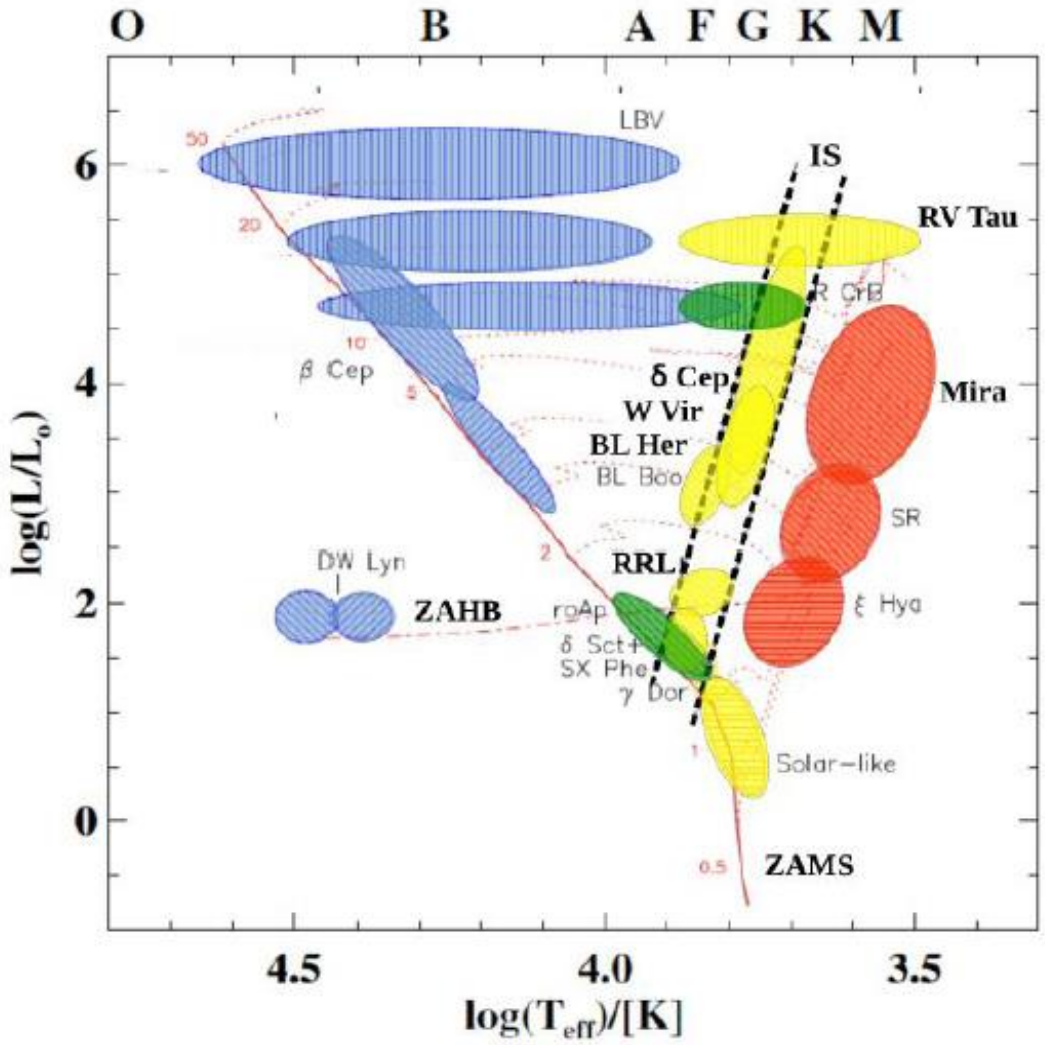
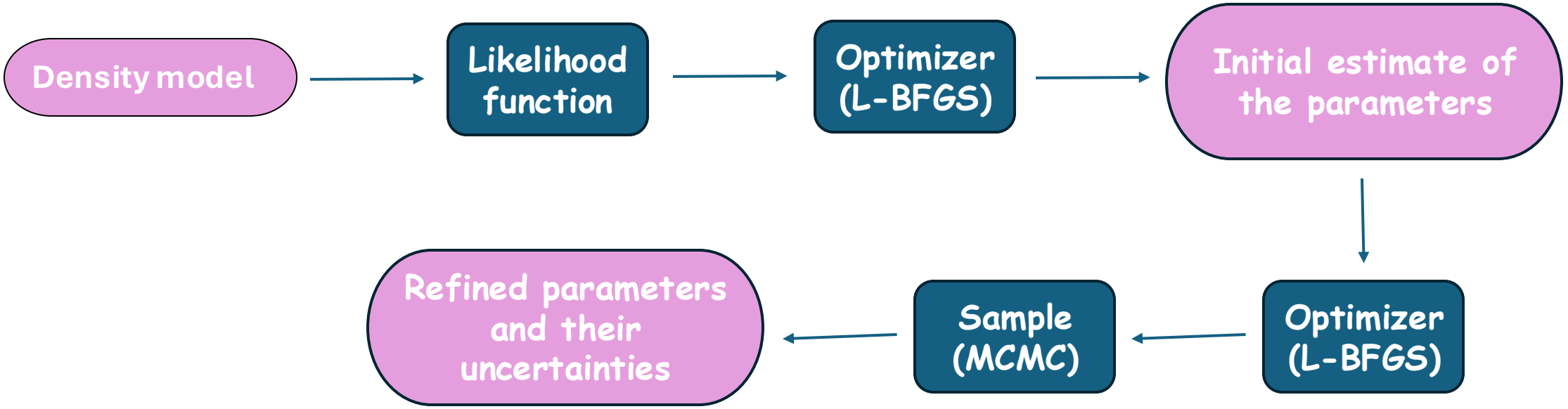
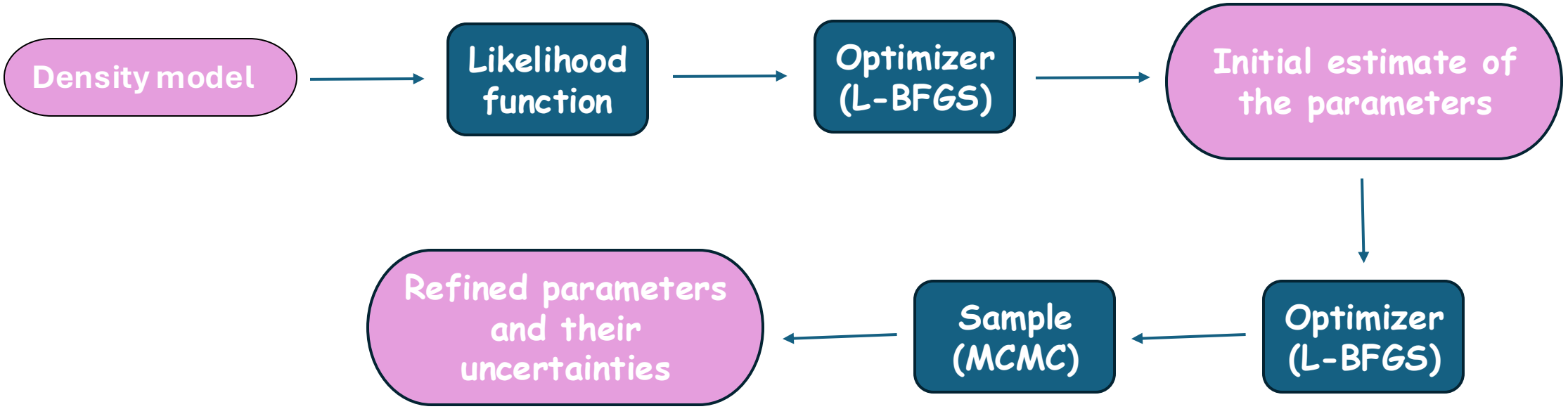
δ Scuti Stars

- Intermediate mass pulsating variables (1-3)$M_\odot$
- Period: (0.03-0.3) Days
- Pulsate both in single and multi modes
- Temperature: (6900 -8600) K



Bhardwaj (2020, review)


Density model
Likelihood function
Optimizer (L-BFGS)
Initial estimate of the parameters
Optimizer (L-BFGS)
Sample (MCMC)
Refined parameters and their uncertainties



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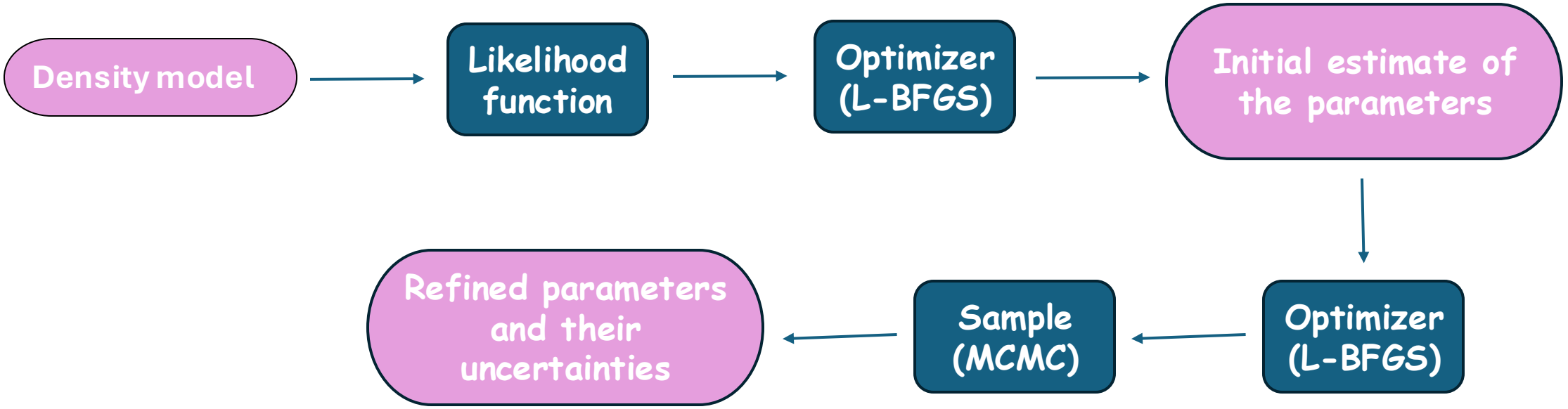
$$\theta = 22^\circ.006 \pm 2^\circ.078$$

$$a : b : c = 1.000 \pm 0.005 : 0.348 \pm 0.002 : 0.421 \pm 0.002$$



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Bar-like structure

Opportunities for deciphering the Milky Way with WST

1. **Refining Structural Parameter Estimates:**
   - Current sample includes two populations, difficult to separate.
   - Individual metallicity or statistical PLZ relations (similar to RR Lyrae/Cepheids) could improve accuracy.

2. **Exploring Disk-Bulge Connection:**
   - Presence of hundreds of thousands of δ Scutis in the disk also could offers insights into the disk-bulge relationship.

Opportunities for deciphering the Milky Way with WST

Additional Avenues for Understanding the Milky Way:

3. **Constraining Stellar Parameters:**
   - Often found in binaries, which can help constrain stellar parameters.
   - Requires both photometric and radial velocity curves for accurate modeling.

4. **Leveraging Pulsation Models:**
   - Pulsation models can further constrain parameters when combined with photometric and radial velocity data.
   - Theoretical PLZ relation.
5.
6.
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