Star Research Lab

International Conference
on
Frontiers of Cosmology, Astrophysics & Particle Physics
(FroCAP2025)

STATISTICAL APPROACHES TO EXOPLANET DETECTION AND CHARACTERIZATION USING PHOTOMETRIC TIME SERIES

STAR RESEARCH LABS

OUR AIM

to create an interactive and visual understanding of exoplanet occurence for everyone

HIERARCHICAL BAYESIAN POISSON REGRESSION MODEL.

$$\log(\lambda_i) = a\_survey[j] + \beta\_met * st\_met\_norm_i + \beta\_teff * st\_teff\_norm_i + ..$$

The Hierarchical Bayesian Poisson Regression model is used to estimate the expected number of planets around a star as a function of its metallicity and temperature, while explicitly accounting for potential differences in the detection capabilities or target selection strategies between the Kepler and TESS missions through the hierarchical structure.

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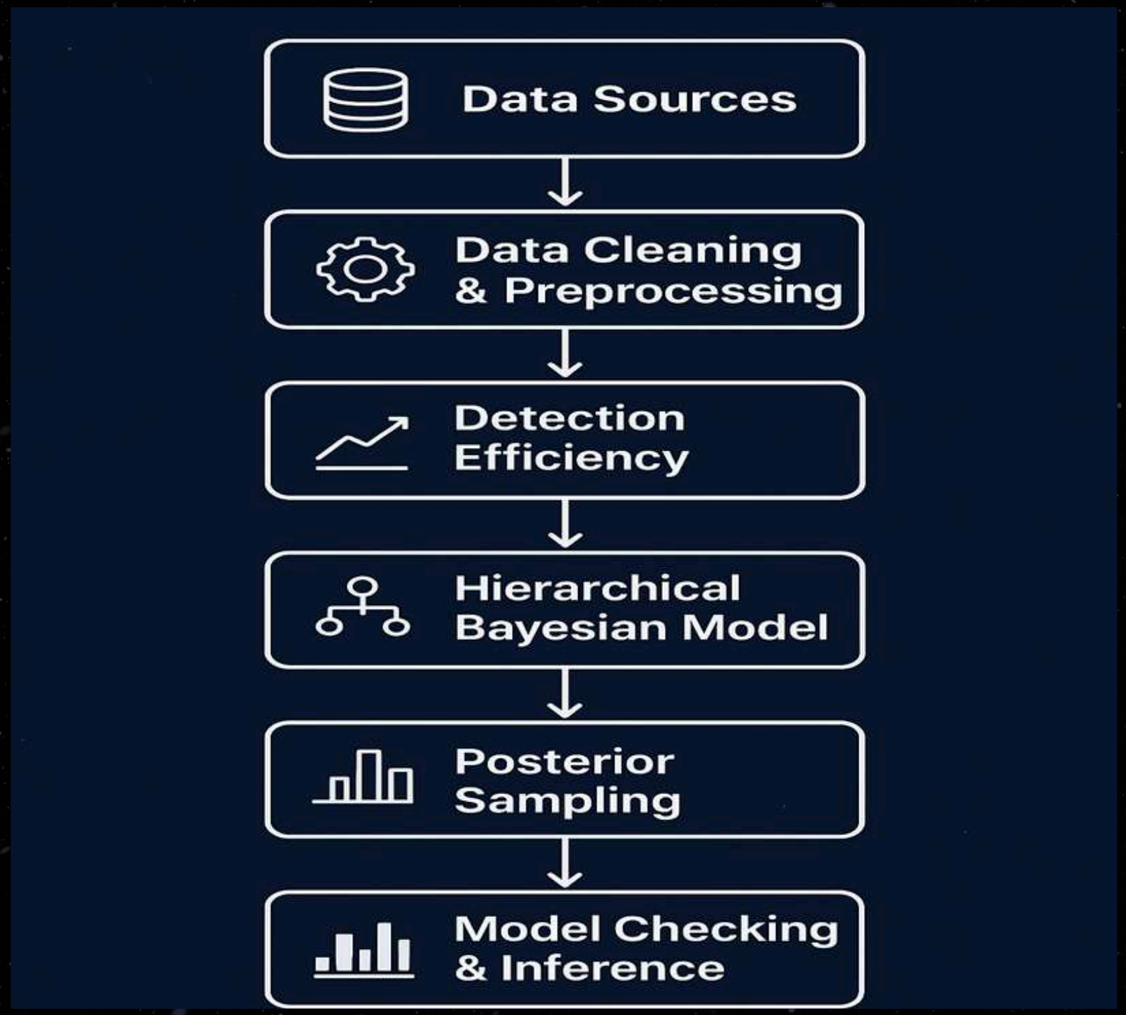
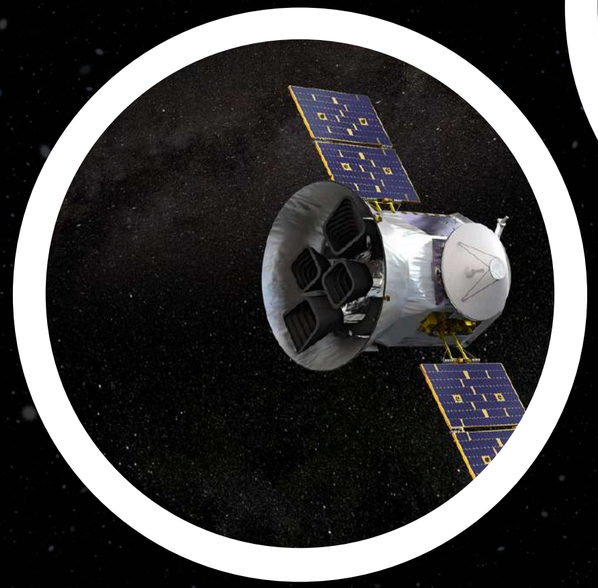
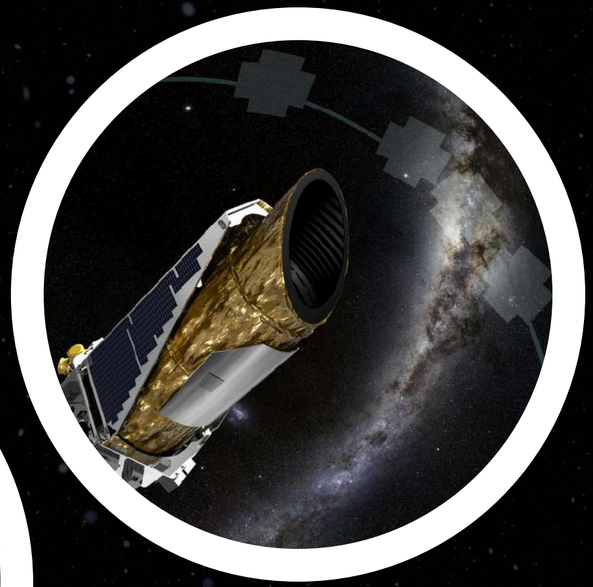
BAYESIAN FRAMEWORK FOR EXOPLANET OCCURENCE



EXOPLANET DATA



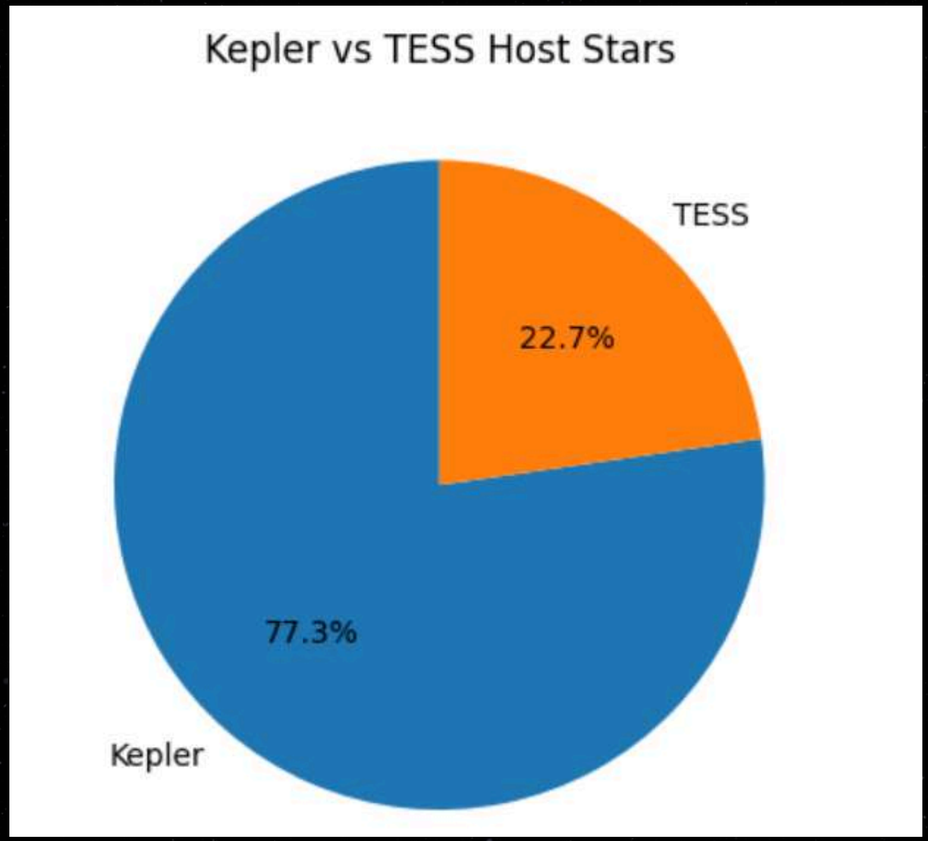


Kepler planets: 2784

TESS planets: 705

Total combined: 3489

EXOPLANET DATA



STATISTICAL MODEL PREREQUISITES

- merging datasets
- unit conversions
- normalize the parameters

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Data columns (total 21 columns):
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 2   st_met                  2566 non-null   float64
 3   st_mass                 2566 non-null   float64
 4   st_rad                  2566 non-null   float64
 5   sy_dist                 2566 non-null   float64
 6   disc_year               2566 non-null   int64
 7   discoverymethod         2566 non-null   object
 8   mission                 2566 non-null   object
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 11  st_rad_m                2566 non-null   float64
 12  planet_count            2566 non-null   int64
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 14  spectral_type           2566 non-null   object
 15  last_updated            2566 non-null   object
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 18  st_mass_norm            2566 non-null   float64
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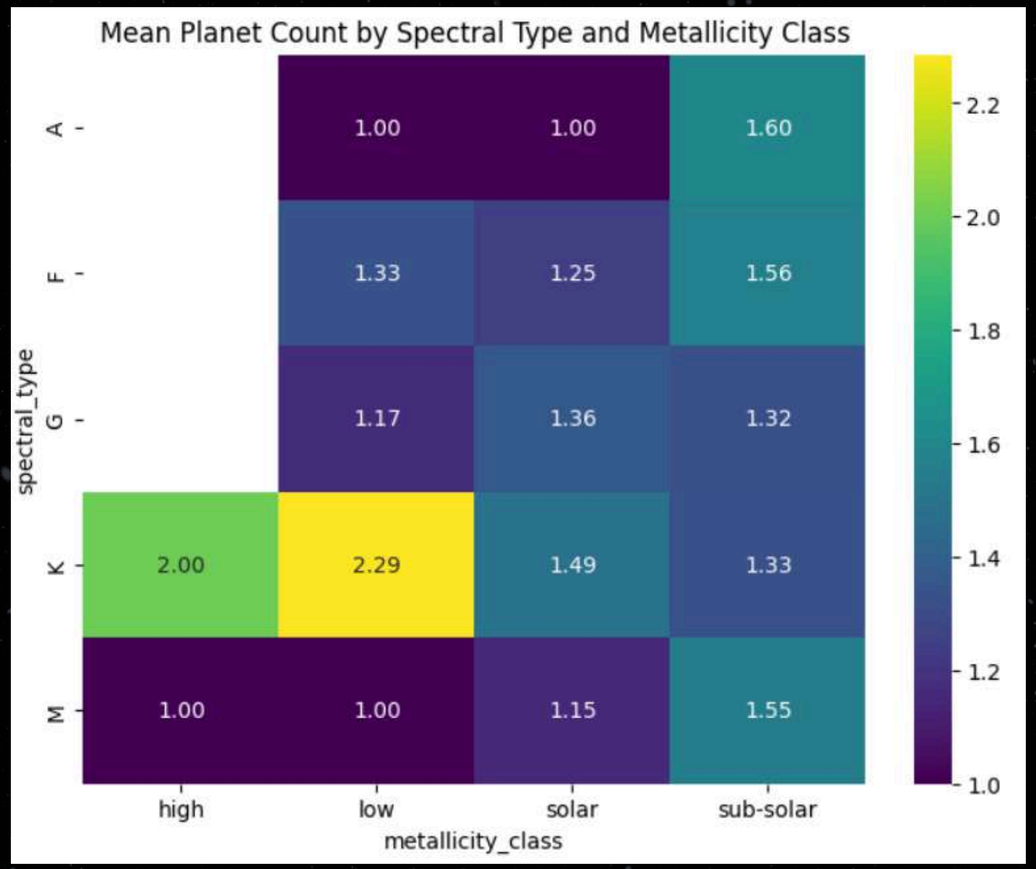
Wardiere Inc.

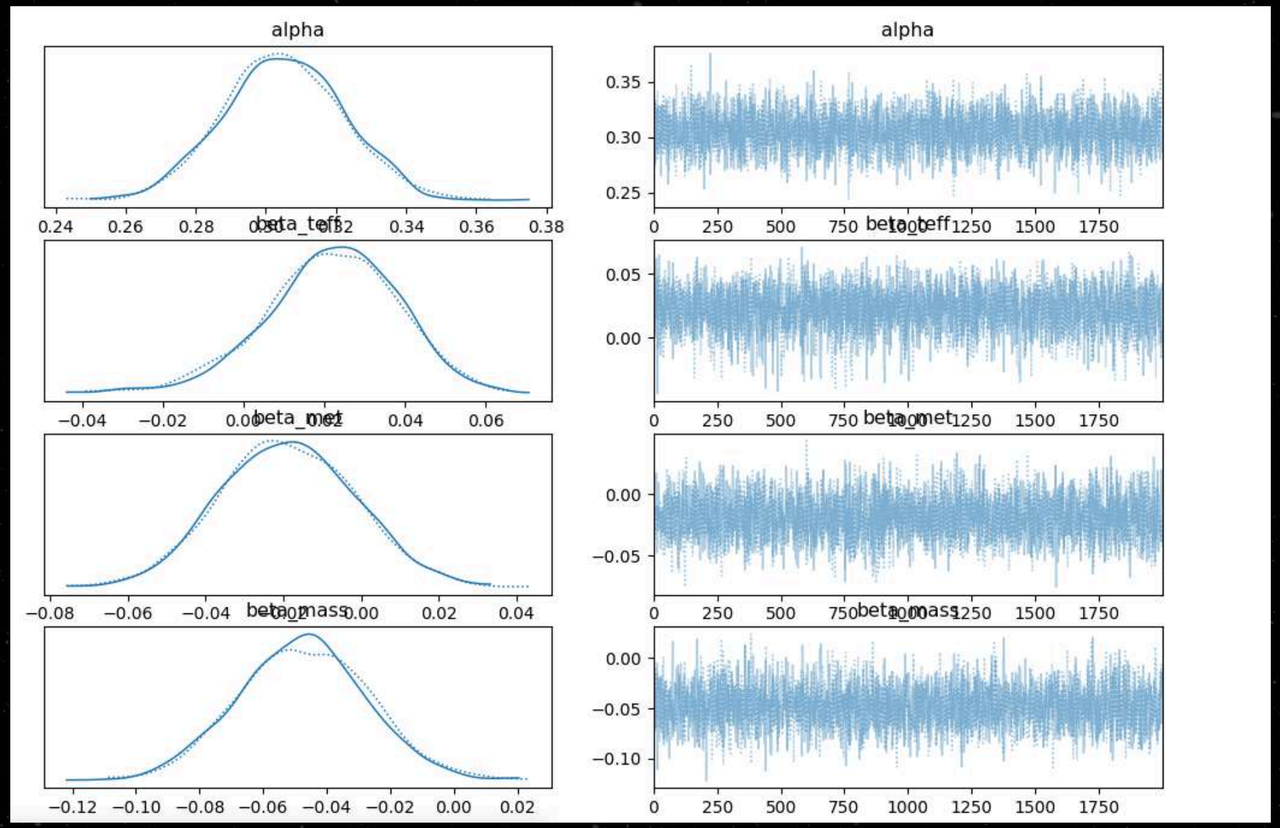
EXOPLANET DATA



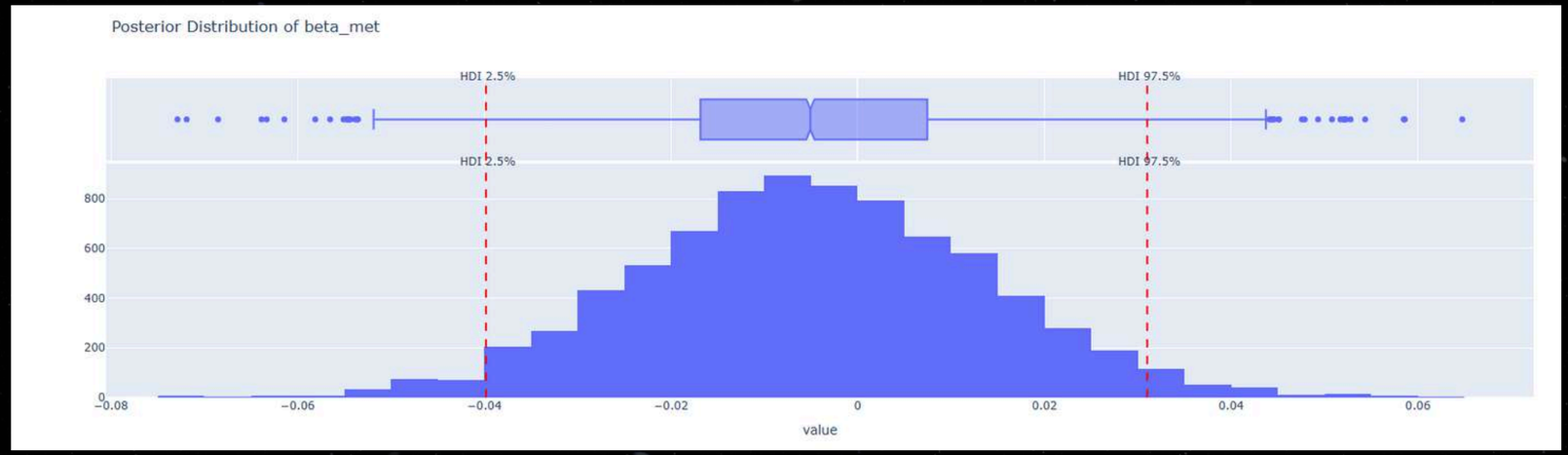
STATISTICAL MODEL

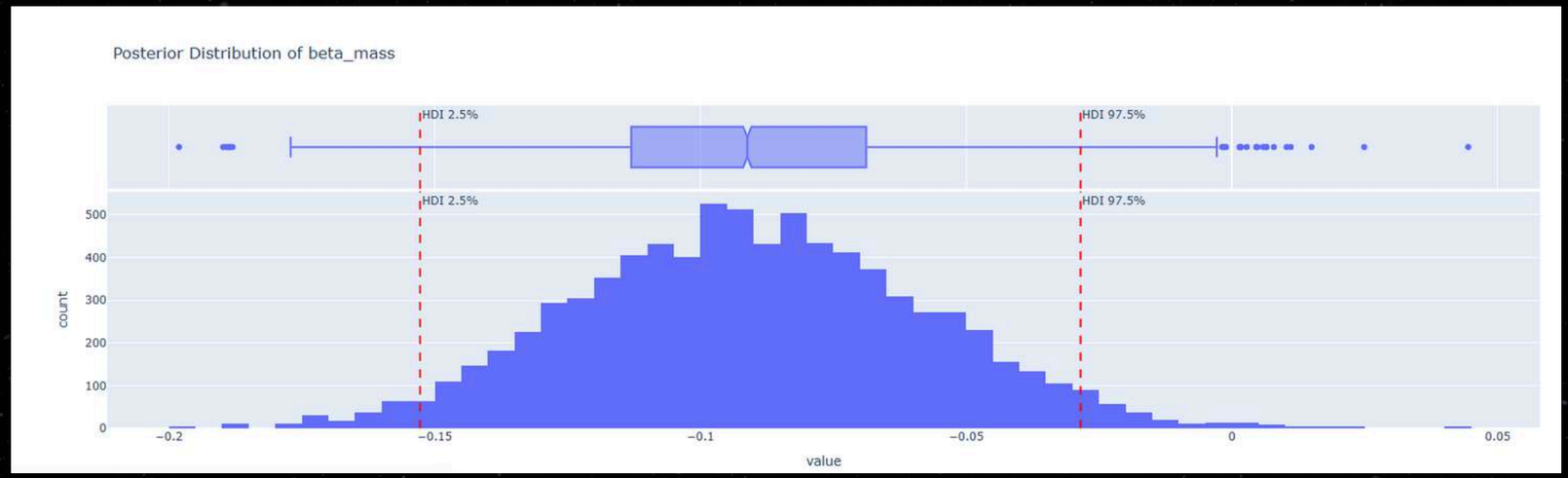
1. Model Setup
2. Posterior analysis
3. Posterior Predictor checks
4. Model comparison
5. Uncertainty and Detection bias
6. Interpretation Layer

1) MODEL SETUP

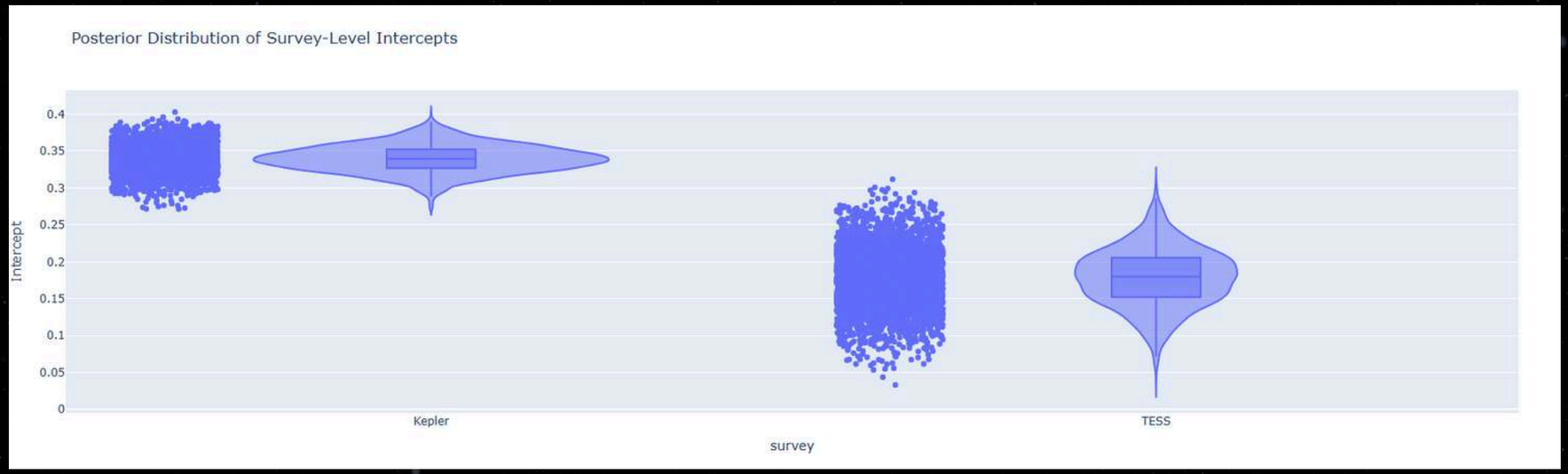


2) POSTERIOR ANALYSIS

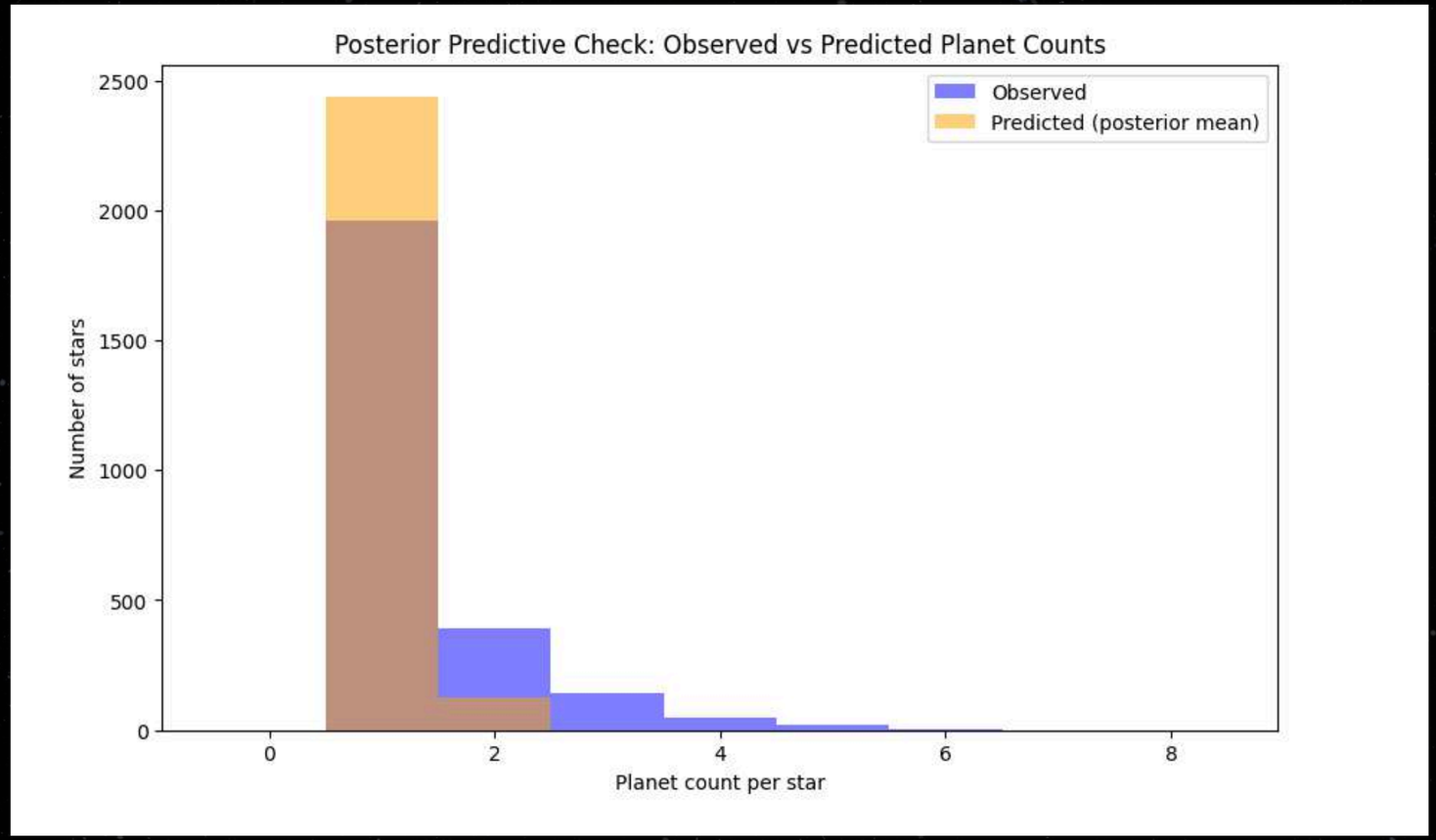




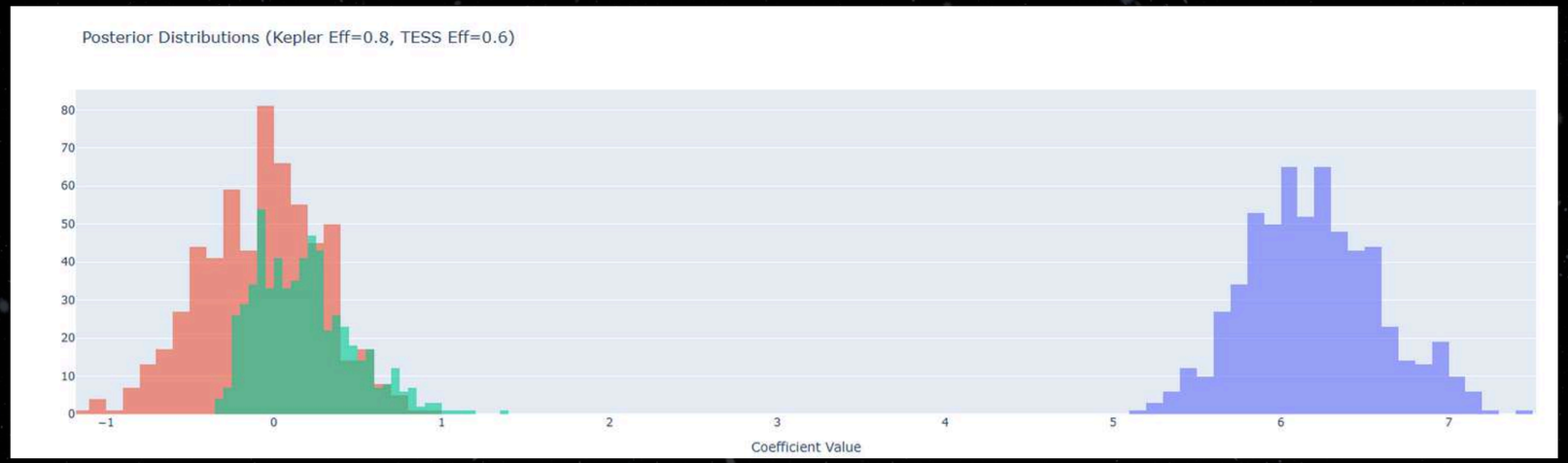
2) POSTERIOR ANALYSIS



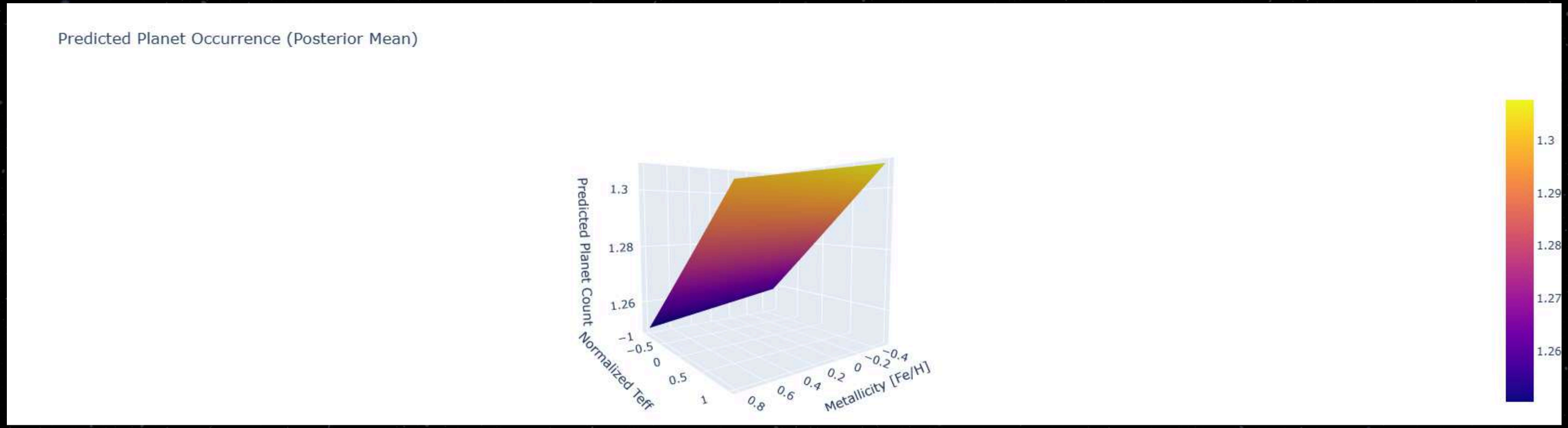
3) POSTERIOR PREDICTIVE CHECK



UNCERTAINTY AND DETECTION BIAS



PREDICTED PLANET OCCURENCE



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MEET OUR TEAM

ADIYA PREMJIT

Deepika Sree .A

Sournamalya S B

THANK YOU :)

TO MORE ACCESSIBLE AND VISUAL ASTRONOMY