

Constraining the Neutrino Magnetic Dipole Moment using Machine Learning

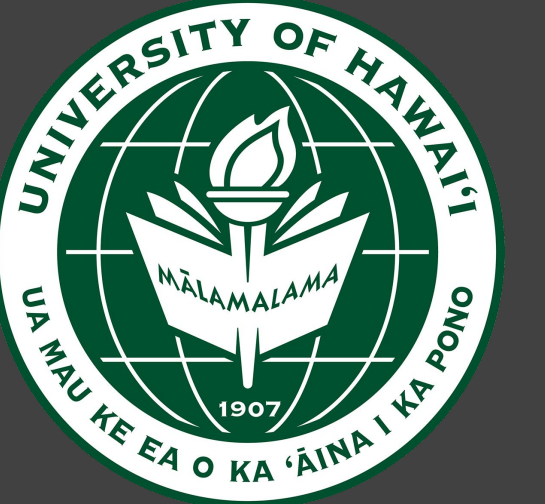


Undergraduate Research Opportunities Program

Office of the Vice Provost for Research & Scholarship
University of Hawai'i at Manoa

with Tip of the Red Giant Branch Simulations

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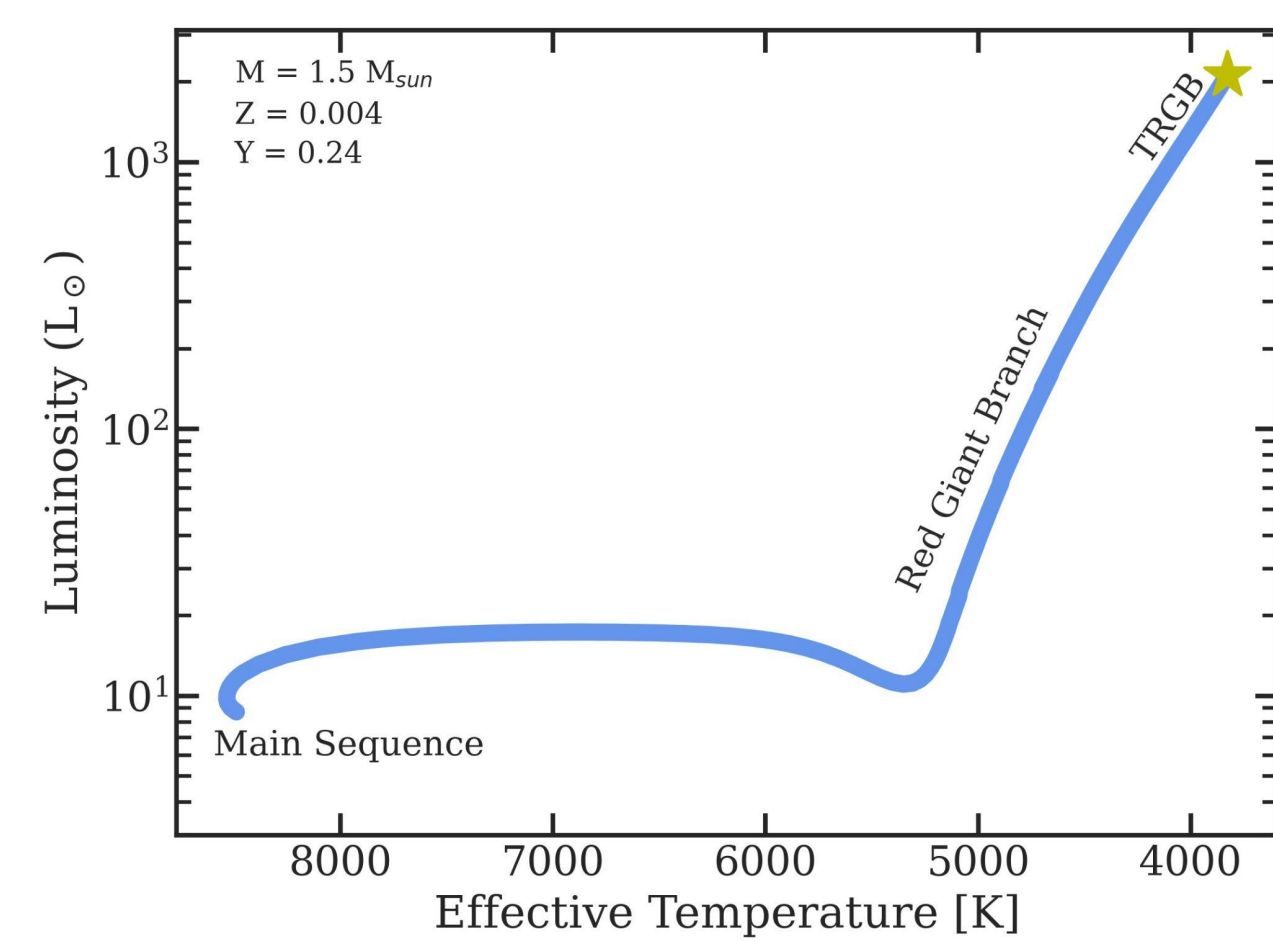
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Introduction

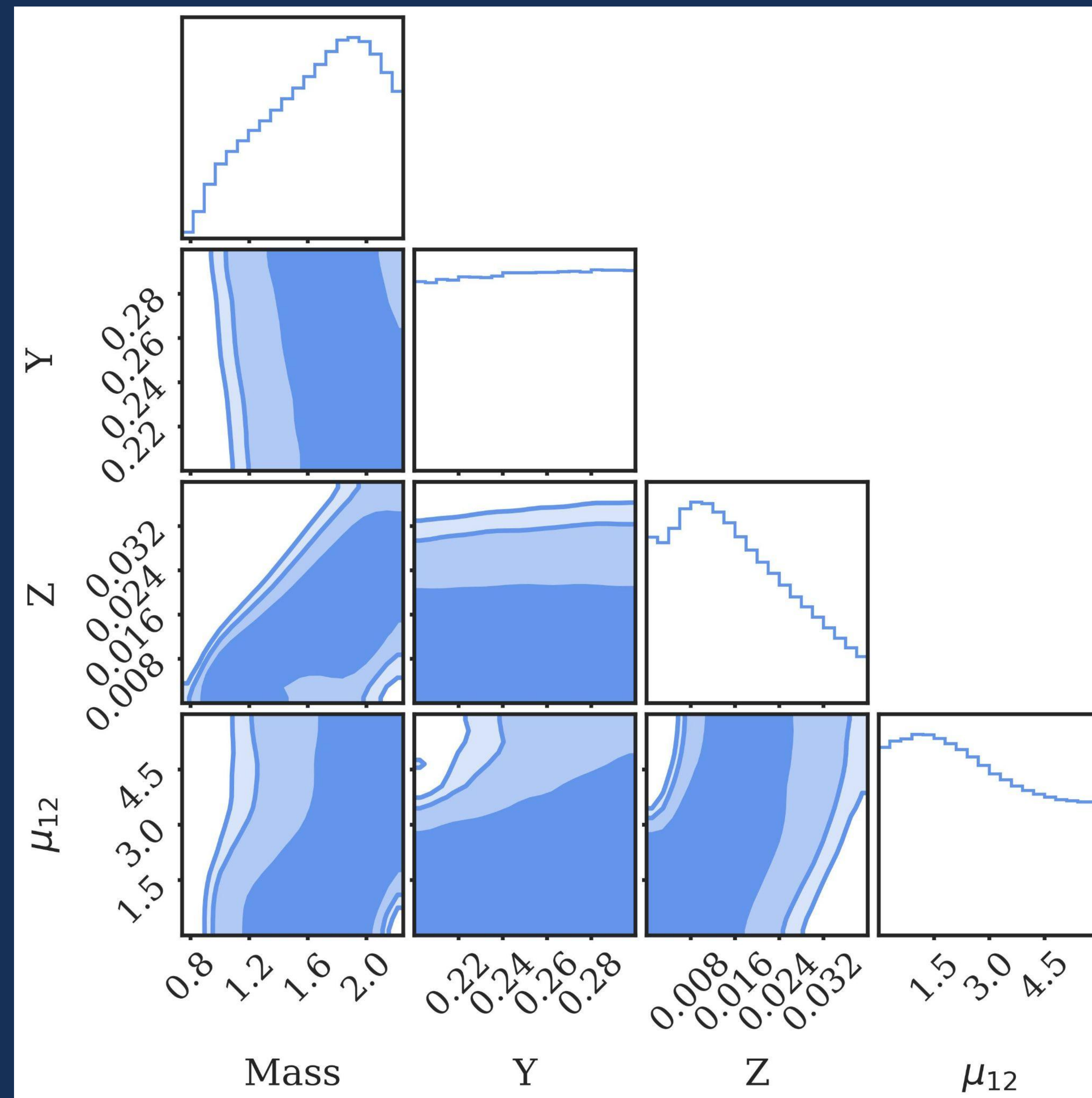
Goal: Constrain the Neutrino Magnetic Dipole Moment while accounting for modeling uncertainties using a novel methodology.

Background

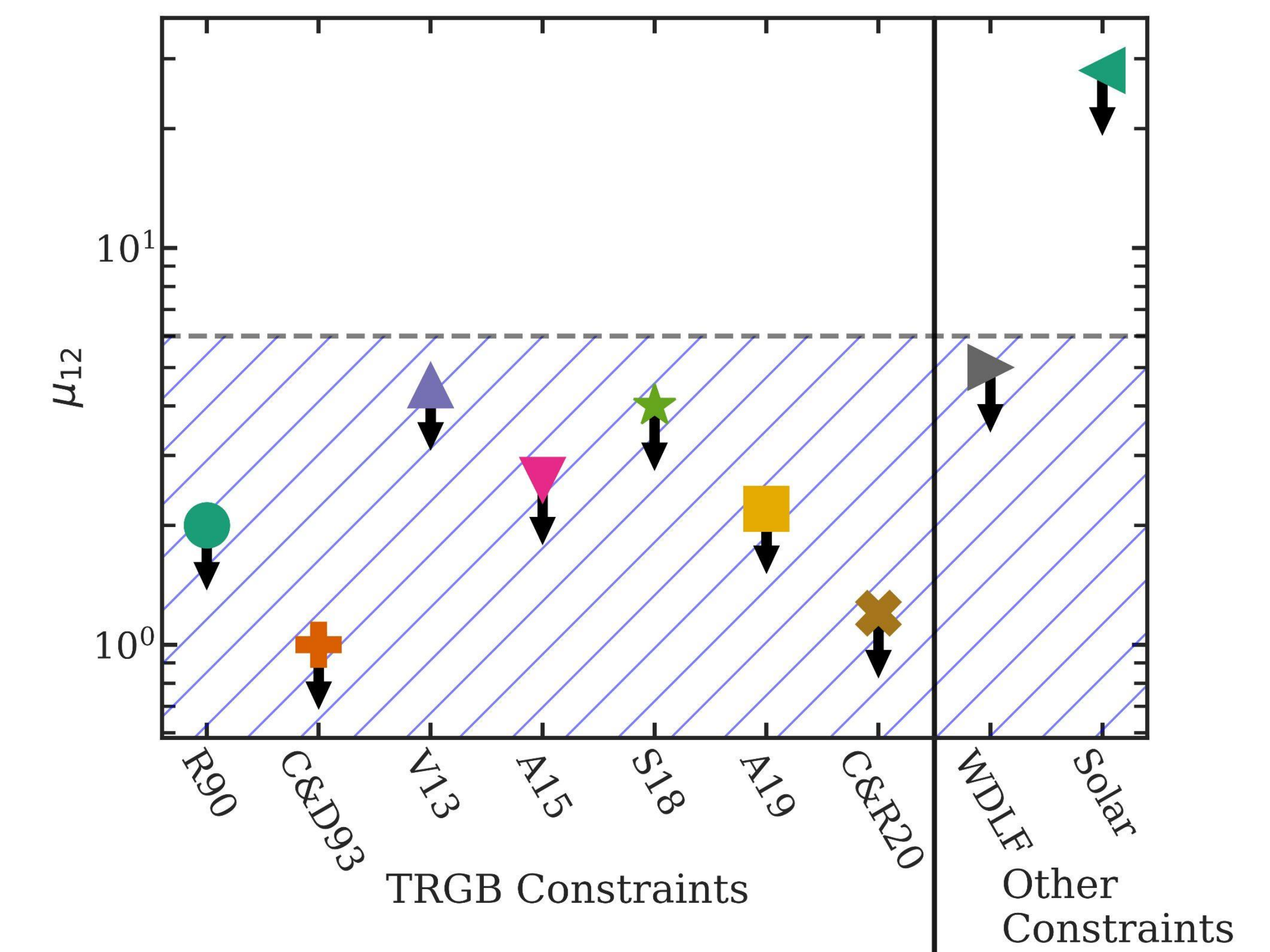
- *Neutrino Magnetic Dipole Moment:* A property of a subatomic particle called neutrinos.
- *Tip of the Red Giant Branch:* An interesting moment in stellar evolution where the I-Band brightness is relatively constant across stellar properties. See Below.



After accounting for uncertainties, we show the neutrino magnetic dipole moment can be at least as large as $6 \times 10^{-12} \mu_B$.



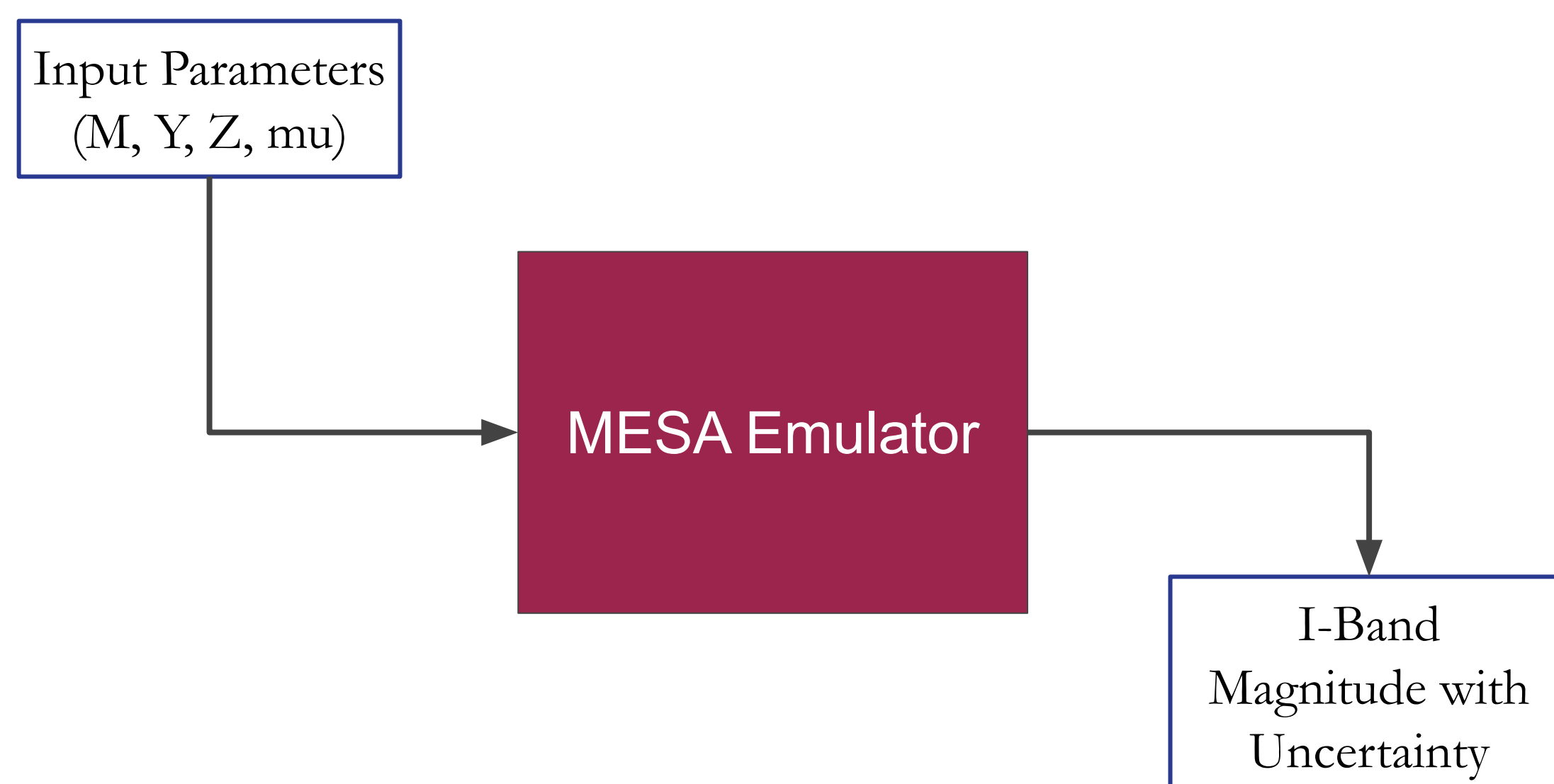
MCMC Results



We unconstrain the region $\mu_{12} < 6$ which has been previously constrained by other works, shown above.

Novel Methodology

1. Simulate $\sim 150,000$ Tip of the Red Giant Branch (TRGB) stars.
2. Train a Deep Neural Network to predict the I-Band magnitude at the TRGB.
3. Perform an Markov Chain Monte Carlo (MCMC) analysis to place constraints on neutrino magnetic dipole moment.



Conclusions

Implications of this Result

- After accounting for uncertainties, $\mu_{12} < 6$ is unconstrained.
- Recent TRGB constraints on μ_{12} are in a region that we have shown to be unconstrained.

Future Work

- Increase the μ_{12} parameter range to constrain it.
- Explore the constraints on μ_{12} from the White Dwarf Luminosity Function (WDLF).

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