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A Bayesian Approach to Calibrating Period-Luminosity Relations of RR Lyrae Stars in the Mid-Infrared

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A Bayesian approach to calibrating period-luminosity (PL) relations has substantial benefits over generic least-squares fits. In particular, the Bayesian approach takes into account the full prior distribution of the model parameters, such as the a priori distances, and refits these parameters as part of the process of settling on the most highly-constrained final fit. Additionally, the Bayesian approach can naturally ingest data from multiple wavebands and simultaneously fit the parameters of PL relations for each waveband in a procedure that constrains the parameter posterior distributions so as to minimize the scatter of the final fits appropriately in all wavebands. Here we describe the generalized approach to Bayesian model fitting and then specialize to a detailed description of applying Bayesian linear model fitting to the mid-infrared PL relations of RR Lyrae variable stars. For this example application we quantify the improvement afforded by using a Bayesian model fit. We also compare distances previously predicted in our example application to recently published parallax distances measured with the Hubble Space Telescope and find their agreement to be a vindication of our methodology. Our intent with this article is to spread awareness of the benefits and applicability of this Bayesian approach and encourage future PL relation investigations to consider employing this powerful analysis method.

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