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To Whom It May Concern:

I have read the Doctoral Thesis of Mr. Milan Pešta, entitled, "Illuminating binary star evolution with observed populations and theoretical modeling" and can attest to the quality and novelty of the work, the significance of the results, and the clear potential for follow-up work presented therein. The thesis provides strong evidence of Mr. Pešta's ability to develop and pursue scientific lines of inquiry, summarizes the background/context in a comprehensive yet digestible manner, and describes the methodologies in sufficient detail as to be reproducible by other astronomers.

The projects described in Mr. Pešta's thesis demonstrate both depth and breadth: the former is most clearly illustrated by the meticulous characterization and thorough comparative analysis of light curve models and solutions for the eclipsing binary Al Phoenicis, and the latter by the statistical analyses of contact and ellipsoidal variable binaries. I was impressed by both the large number of comparative analysis Mr. Pešta performed for Al Phe to explore how various choices in the light curve modeling process affect the determined stellar and orbital parameters: such comparisons are not quite *de rigueur* in the field, although they should be, given that modern binary star observations are sufficiently precise that systematic errors and input-model choices can have significant effects on the interpretation of a system. Mr. Pešta's work demonstrates a firm understanding of this current state of the field, and offers strong evidence of his ability to conduct similarly high quality analyses in the future.

Mr. Pešta's statistical analyses of contact and ellipsoidal variable binaries is similarly meticulous and impactful. These chapters show Mr. Pešta's clear understanding of Bayesian inference and statistics. Similar statistical and modern machine learning methods have been applied to other data sets in astronomy (differing in the details of the implementation), but Mr. Pešta's work represents a novel application of mature techniques in new contexts. In so doing, Mr. Pešta determines a mass ratio distribution for contact binary systems, thereby providing a crucial observational constraint on the evolution of these interacting binaries – which is governed by physical processes that are not yet well-understood. In the next chapter, Mr. Pešta presents the machine-learning-based identification of dark companion binaries *en masse* and their differentiation from other ellipsoidal variable binaries, Moreover, Mr. Pešta does so with an efficiency that cannot be matched by traditional methods (which either require significant computational resources, large amounts of telescope time, or both); instead, these methods would be well-suited to confirming individual objects' classifications and characterizing them in further detail.

Mr. Pešta's investigations provide clear opportunities for future work: using data from new time-series photometric surveys like the *Transiting Exoplanet Survey Satellite* (TESS), to extend Mr. Pešta's work on the mass-ratio distribution of contact binaries, and obtaining high-resolution imaging and spectroscopic follow-up of the dark companion binaries identified by the random forest classifier. Furthermore, the Al Phe analysis can be extended to try to resolve the tension between the results presented in this work and prior literature results, and it can serve as a template for (re-)analyses of other eclipsing binaries to quantify the effects of different modeling methods and input parameters on the orbital and stellar properties they produce.

My suggestions are minor, and my questions are intended to stimulate further discussion:

- In Chapter 1, the Darwin instability is first mentioned. A brief description or summary of the instability would be useful here, in addition to the provided reference to Darwin (1879).
- Figure 3.2 plots the residuals between the ellc and PHOEBE light curve models for AI Phe, which exhibit sharp changes in the size of the residuals at the orbital phases of primary and secondary eclipse (approximately 1.75 and 1.5 parts per thousand, respectively). Are these residuals significant when compared to the observed eclipse depths in the *TESS* light curve, and how do they compare to the *TESS* light curve's typical measurement uncertainties?

- In Section 4.5.1, a reference is provided for a justification for splitting the contact binary sample into subsamples with orbital periods shorter and longer than 0.3 days. Could the justification be elaborated on, and is there any worthwhile motivation (either physical or statistical) to explore a different orbital period threshold?
- Also in Chapter 4: how complete is the Kepler EB Catalog's categorization of ellipsoidal variables and contact binaries? Specifically, are there any regions of parameter space for which an EV or contact binary may be miscategorized according to the catalog's *morph* parameter – and if so, how sensitive is the determined mass ratio distribution to catalog (in)completeness?
- Related to the last question: is there an approach similar to the PCA/random-forest classification procedure from Chapter 5 (or perhaps an extension of it) that could be used to verify the reliability and purity of the Kepler EB Catalog's *morph*-based classification of detached, semidetached, and contact binaries?

Between the skill set developed for and applied to these investigations, the scientific rigor of the research, the expected impact of the results, and the quality and detail of the written dissertation itself, I believe that *Mr. Pešta's written dissertation proves his ability to conduct creative scientific work*. I commend Mr. Pešta and his thesis advisor for their accomplishments and their efforts to produce this dissertation, and I thank them for the opportunity to review it.

Sincerely:

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