However, the turmoil of Prior Options would probably have been unavoidable.

Acknowledgements

I would like to thank the following for providing input and comments on the text: Professor Jim Hough, Dr. Ian Corbett, Professor Richard Ellis, Professor Andy Lawrence, Dr. Adrian Russell, Professor Phil Charles, Professor John Peacock. I am particularly indebted to Richard Ellis for cataloguing and then digitizing a subset of his extensive archive and providing me with access to those data, without which this project would never have progressed.

REDISCUSSION OF ECLIPSING BINARIES. PAPER 30: THE SLIGHTLY EVOLVED F-TYPE SYSTEM BK PEGASI

By Ahmet Cem Kutluay & John Southworth

Astrophysics Group, Keele University, Staffordshire, ST5 5BG, UK

BK Peg is a double-lined detached eclipsing binary containing two late-F stars in an orbit with small eccentricity. We use light-curves from the *Transiting Exoplanet Survey Satellite* (*TESS*) and spectroscopic measurements from previous studies to measure the physical properties of the companions to high precision. We obtain masses of $1{\cdot}411 \pm 0{\cdot}004\,M_{\odot}$ and $1{\cdot}254 \pm 0{\cdot}004\,M_{\odot}$, and radii of $1{\cdot}990 \pm 0{\cdot}004\,R_{\odot}$ and $1{\cdot}460 \pm 0{\cdot}004\,R_{\odot}$, which are among the most precise measurements made for those quantities in normal stars. Those properties match theoretical stellar-evolution models for a solar chemical composition and an age of 2·65 Gyr. We also present an updated ephemeris of the system, as a result of our *TESS* measurements and a collection of mid-eclipse times from previous studies.

Introduction

This study is part of the on-going series[1] in which known detached eclipsing binary systems (dEBs) are re-analysed based on new photometric data, primarily obtained with the NASA *Transiting Exoplanet Survey Satellite*[2] (*TESS*). Our main objective is to exploit space-based observations[3] to refine the measurements of the stellar components' properties and to incorporate those systems into the *Detached Eclipsing Binary Catalogue*[4] (*DEBCat*[*]).

In this work, we present a study of BK Pegasi (Table I), a dEB composed of two late-F stars in a slightly eccentric orbit. The system has the unusual characteristic that its more massive and larger primary component (hereafter star A) has a slightly lower effective temperature than the secondary (star B). That is a consequence of the primary's on-going evolution toward the sub-giant stage on the HR diagram[5].

*https://www.astro.keele.ac.uk/jkt/debcat/

TABLE I

Basic information on BK Pegasi. The BV magnitudes are each the mean of 94 individual measurements[14] *distributed approximately randomly in orbital phase. The JHK_s magnitudes are from 2MASS*[15] *and were obtained at an orbital phase of 0·89.*

Property	*Value*	*Reference*
Right Ascension (J2000)	$23^h 47^m 08^s \cdot 26$	16
Declination (J2000)	$+26^\circ 33' 59'' \cdot 97$	16
Bonner Durchmusterung designation	BD+25 5003	17
Tycho designation	TYC 2254-2563-1	14
Gaia DR3 designation	2852979962499356288	16
Gaia DR3 parallax (mas)	3·2643 ± 0·0177	16
TESS Input Catalogue designation	TIC 269747005	18
B magnitude	10·46	14
V magnitude	10·04	14
G magnitude	9·835	16
J magnitude	8·892	15
H magnitude	8·643	15
K_s magnitude	8·611	15
Spectral type	F8 V + F7 V	10

Hoffmeister[6] originally identified its eclipsing character and classified the system as an Algol-type variable. The first determination of the orbital period was carried out by Lause[7,8], yielding a value of 2·745 days. Later, Popper & Dumont[9] revealed that light-curves of BK Peg contain two eclipse minima of almost identical depth (Fig. 1). They corrected the orbital period value to 5·49 days, which was later refined by Clausen *et al.*[10] (hereafter CL10).

Initial estimates of the absolute dimensions were reported by Popper[11] in his review of stellar masses, followed by spectroscopic analyses and refined determinations of the absolute parameters in a subsequent study[12]. According to those two studies, the masses (1·43 $M_\odot$ and 1·28 $M_\odot$) and luminosities (4·68 $L_\odot$ and 3·09 $L_\odot$) of the components differ significantly. Following that study, Demircan *et al.*[13] obtained UBV light-curves of the system and refined the absolute dimensions, using the radial velocities (RVs) given by Popper[12].

In addition, Demircan *et al.* discussed the evolutionary status of the system using the mass–radius (M–R), mass–luminosity (M–L), and temperature–luminosity (T–L) planes based on stellar-evolution models[19], claiming that the components are still in the core hydrogen-burning phase and best represented by high-metallicity models with an age of about 3·3 Gyr. More recently, CL10 presented high-precision absolute dimensions and spectroscopic chemical abundances for BK Peg, showing that the components have evolved to the upper half of the main-sequence band. Their comparison with scaled solar-evolution models suggested slightly younger ages (≈ 2·5 to 2·8 Gyr), with indications that the amount of convective core overshooting may affect the inferred evolutionary status.

Photometric observations

BK Peg has been observed by *TESS* in two sectors (Sector 57 in 2022 October and Sector 84 in 2024 October). For Sector 57, short-cadence data with 120-s sampling were available, whereas only full-frame images (FFIs) are available for Sector 84. Therefore, our analysis is based solely on the 120-s-cadence data from Sector 57. The data were retrieved from the NASA Mikulski Archive for Space Telescopes (MAST*) *via* the LIGHTKURVE package[20].

For our analysis, we utilized the simple aperture-photometry (SAP) light-curves produced by the SPOC data-reduction pipeline[21], excluding data points flagged as low-quality using the LIGHTKURVE 'hard' quality flag. In Sector 57, the data are not fully continuous and contain

*https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html gaps. For that reason, portions of the light-curve where the eclipses were poorly sampled or affected by gaps were manually rejected and only the remaining data were retained for further analysis. The entire sector is shown in the top panel of Fig. 1, while the manually trimmed segments are displayed in the bottom panel. The remaining data were converted into differential magnitudes and the median magnitude was subtracted for convenience.

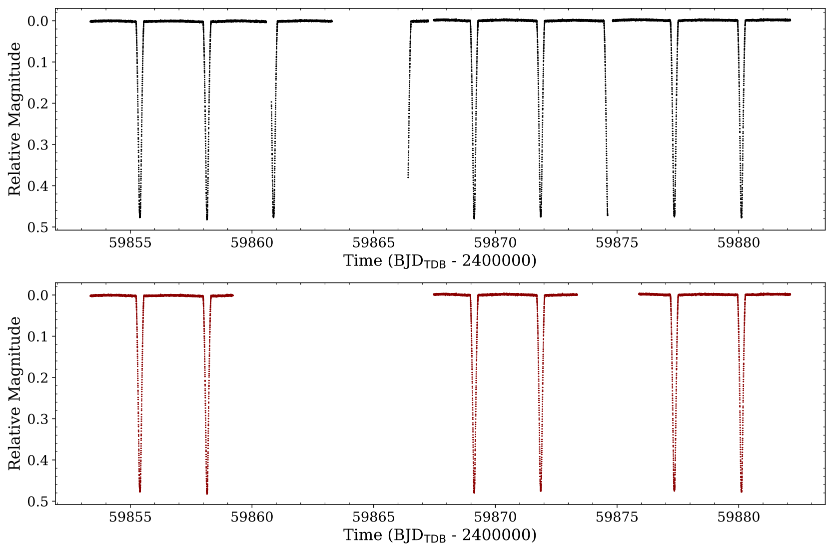

FIG. 1

Top: *TESS* sector 57 photometry of BK Peg. The flux measurements have been converted to magnitude units, and the median was subtracted. Bottom: trimmed light-curves of sector 57 for further analysis.

Light-curve analysis

As shown in Fig. 2, BK Peg is a well-detached binary system with two eclipses of nearly equal depth of approximately 0·5 mag. That makes the system a suitable target for modelling with the JKTEBOP* code[22,23]. Due to the orbital period of the system (≈ 5·5 days) and the duration of the *TESS* sector (≈ 27 days), only five orbital cycles were observed. For each eclipse, all data during the event were extracted from the *TESS* light-curve, along with additional segments immediately before and after the eclipse. Those additional segments cover at least 30 minutes and are useful for setting the out-of-eclipse brightness of the system. Each eclipse was then normalized to zero differential magnitude by fitting and subtracting a straight line to the out-of-eclipse data, thereby removing slow instrumental or astrophysical trends. Subsequently, second-order polynomial fits were independently applied to the out-of-eclipse regions in three separate portions of the *TESS* light-curve to suppress further low-frequency variations and minimize the residuals.

The fitted parameters were the fractional radii of the stars ($r_{\rm A}$ and $r_{\rm B}$), the central-surface-brightness ratio (J), third light (L_3), orbital inclination (i), eccentricity (e), argument of periastron (ω), orbital period (P), and a reference time of primary minimum (T_0). The fractional radii were expressed as their sum ($r_{\rm A} + r_{\rm B}$) and ratio ($k = r_{\rm B}/r_{\rm A}$), and the

*http://www.astro.keele.ac.uk/jkt/codes/jktebop.html

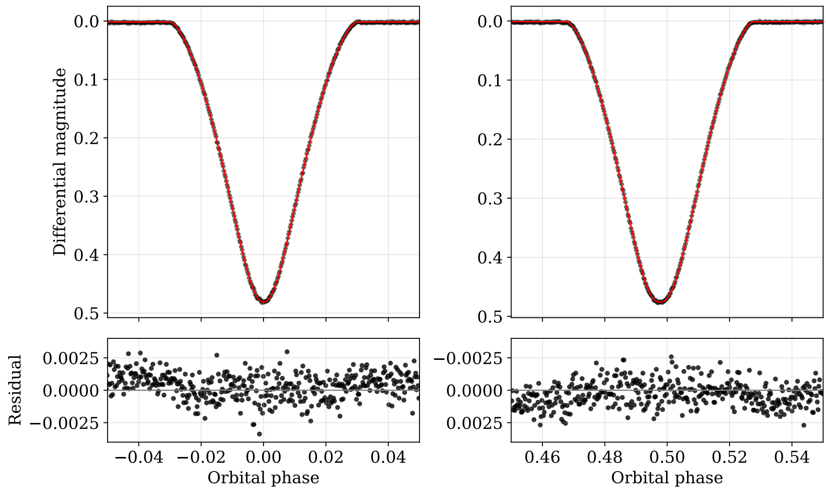

FIG. 2

Best-fit model to the *TESS* sector 57 light-curves of BK Peg for the primary eclipse (left panels) and secondary eclipse (right panels), obtained using JKTEBOP. The observed data are shown as black points, and the model fit is plotted as a red solid line. The residuals are displayed on an enlarged scale in the lower panels.

orbital-shape parameters as the combinations $e \cos \omega$ and $e \sin \omega$ to decrease correlations between parameters. Limb darkening (LD) was implemented using the power-2 law[24–26], with the linear coefficient (c) fitted and the non-linear coefficient (α) fixed at a theoretical value[27,28]. The same LD coefficients were used for both stars due to their almost identical temperature. To ensure that the adopted photometric uncertainties accurately represent the observed scatter, the *TESS* flux-measurement errors were iteratively scaled until the reduced chi-square of the fit, χ^2_ν, reached unity. An example fit is shown in Fig. 2. Our fitted light ratio is in excellent agreement with the spectroscopically-determined value of 0·57 ± 0·04 from CL10.

We calculated uncertainties in the fitted parameter values using 10 000 Monte Carlo simulations. The results of that analysis are provided in Table II with a comparison to the results from y-band light-curves of CL10. We have increased the error bars for r_A and r_B to 0·2% because it has not yet been demonstrated that light-curve models are reliable beyond that level of precision[29]. Overall, our results are in good agreement with those in CL10. The only noticeable difference is found in the eccentricity, which is lower in our solution by approximately 20%. Although the formal errors for e and ω in our table are very small, they primarily reflect the statistical precision of the fit rather than physical certainty. As a consequence of the very small eccentricity, the argument of periastron ω is highly subject to model degeneracies, and such an apparent difference between our value of ω and that reported by CL10 is probably dominated by model degeneracies rather than a physically significant change in the orbit. We leave the discussion of apsidal motion to future study, emphasizing the necessity of on-going measurements of times of primary and secondary eclipse.

TABLE II

Photometric parameters of BK Peg measured using JKTEBOP from the TESS light-curves. The error bars are 1-σ standard errors obtained from the Monte Carlo simulations applied to sector-57 data. Also, we provide the results from the y-filter light-curves in CL10 for comparison.

Parameter	*Value*	*CL10 (y)*
Fitted parameters:		
Orbital inclination (°)	88·14 ± 0·17	88·02 ± 0·05
Sum of the fractional radii	0·19001 ± 0·00009	0·1898 ± 0·0005
Ratio of the radii	0·733 ± 0·094	0·7379 ± 0·0050
Central-surface-brightness ratio	1·0432 ± 0·0038	1·0444 ± 0·0031
Third light	0·01 ± 0·10	0·0 (fixed)
$e\cos\omega$	−0·00356 ± 0·00001	−0·00364 ± 0·00006
$e\sin\omega$	−0·0010 ± 0·0022	0·00283 ± 0·00181
LD coefficient c	0·614 ± 0·009	
LD coefficient α	0·515 (fixed)	
Derived parameters:		
Fractional radius of star A	0·1096 ± 0·0002	0·1092
Fractional radius of star B	0·0804 ± 0·0002	0·0806
Light ratio ℓ_B/ℓ_A	0·5608 ± 0·0009	0·5670
Orbital eccentricity	0·00368 ± 0·00004	0·0046
Argument of periastron (°)	195·15 ± 0·12	142·1

Orbital ephemeris

This work includes only one sector of *TESS* data, which consists of three intervals of photometric observations (Fig. 1). We modelled each interval individually with JKTEBOP and determined the mid-times of primary eclipses. As those three intervals span only 25 d, we collected three times of primary minimum from previous studies[13,30] and eight times of minimum from the *VarAstro* portal of Variable Star and Exoplanet Section of the Czech Astronomical Society*. All primary minimum times are presented in Table III.

We fitted a linear ephemeris to those minimum times with PYTHON's SCIPY package[31], obtaining

$$\text{Min I} = \text{BJD}_{\text{DB}} 2450706{\cdot}46975(20) + 5{\cdot}48991130(12)E \qquad (1)$$

where E corresponds to the number of cycles since a reference time of minimum, and the numbers in parentheses show the uncertainties in the final significant figure of the corresponding measurement. The root-mean-square of the residuals is 61 s which is higher than most of the error bars suggest, and the reduced χ^2 is $\chi^2_\nu = 4{\cdot}32$. The uncertainties in the ephemeris have been multiplied by $\sqrt{\chi^2_\nu}$ to account for that high χ^2_ν.

Popper & Etzel[33] and Demircan *et al.*[13] also noted the variability of individual light-curves and suggested that one of the components of BK Peg might be a pulsating star. We checked the *TESS* data for the presence of pulsations using the PERIOD04 code[34]. We found no significant pulsation signal, to a limit of 0·2 mmag, but we see hints of starspot activity. Such activity could affect the fit of the light-curve and the times of minimum obtained from it.

Due to its slight eccentricity, BK Peg is expected to experience slow apsidal motion which could also increase the scatter when attempting to fit a linear ephemeris. However, we see no hint of that effect in Fig. 3. We leave an analysis of apsidal motion to future work.

*https://var.astro.cz/en/

TABLE III

Times of mid-eclipse for BK Peg and their residuals versus the fitted ephemeris.

Orbital cycle	*Eclipse time (BJD_{TDB})*	*Uncertainty (d)*	*Residual (d)*	*Source*
−329·0	2448900·28904	0·00056	0·00106	Demircan *et al.*[13]
0·0	2450706·47007	0·00030	0·00106	Ak *et al.*[30]
63·0	2451052·33246	0·00070	−0·00100	Ak *et al.*[30]
751·0	2454829·39325	0·00070	0·00037	Hübscher *et al.*[32]
931·0	2455817·57785	0·00001	0·00081	*VarAstro*
990·0	2456141·48076	0·00001	−0·00107	*VarAstro*
1004·0	2456218·34064	0·00001	0·00003	*VarAstro*
1398·0	2458381·36621	0·00001	0·00029	*VarAstro*
1531·0	2459111·52508	0·00001	0·00087	*VarAstro*
1543·0	2459177·40241	0·00001	−0·00073	*VarAstro*
1667·0	2459858·15185	0·00002	−0·00038	*TESS* sector 57
1669·0	2459869·13184	0·00008	−0·00021	*TESS* sector 57
1671·0	2459880·11153	0·00002	−0·00035	*TESS* sector 57

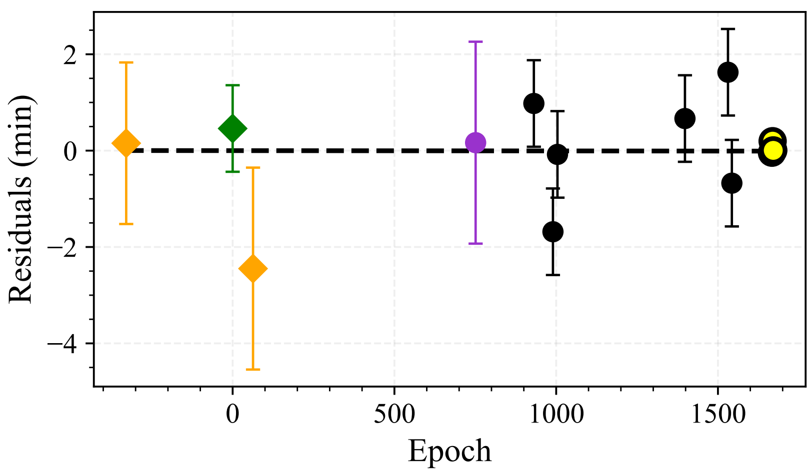

FIG. 3

Residuals of the primary minimum times from Demircan *et al.*[13] (green), Ak *et al.*[30] (orange), Hübscher *et al.*[32] (purple), *VarAstro* (black), and *TESS* (yellow), as listed in Table III. The dashed black line represents the residuals of zero according to the linear ephemeris. Diamonds represent the photoelectric observations, while circles denote the CCD observations.

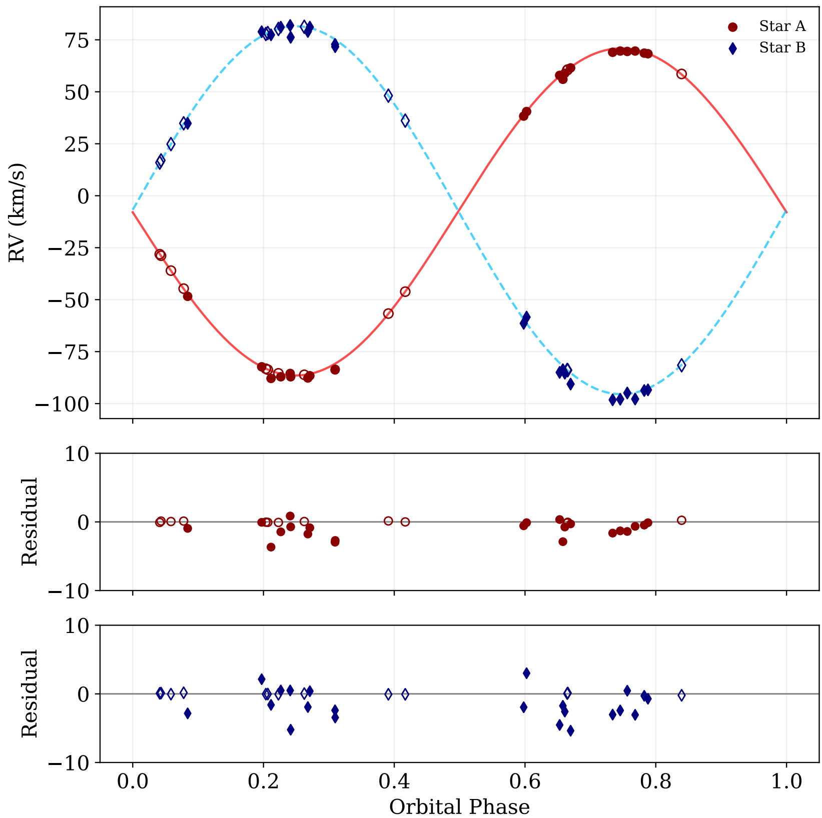

FIG. 4

RVs of BK Peg compared to the best fit from JKTEBOP (solid red and dashed blue lines). The RVs for star A are shown with dark-red colour, and for star B with blue colour. The residuals are given in the lower panels separately for the two components. RVs from Popper[12] are shown with closed circles and diamonds, and those from CL10 with open circles and diamonds.

Radial-velocity analysis

BK Peg has been the subject of two previous spectroscopic studies: Popper[12] and CL10. The former obtained 22 RV measurements for each star from photographic spectra obtained at Lick Observatory, whereas the latter provided 13 RV measurements per star from the *FIES* échelle spectrograph at the *Nordic Optical Telescope*[35]. CL10 compared their results with Popper and concluded that they are in a good agreement within errors, although the systemic velocities ($V_{\gamma,A}$, $V_{\gamma,B}$) differ by about 1 km s^{-1}.

In this study, four different analyses were performed based on the RV data source: Popper only, CL10 only, the combined RV data set with separate V_γ values for the two stars, and the combined RV data set with the same V_γ for the stars. In each case, we fitted the RV data using JKTEBOP with a fixed P but allowing for a shift in T_0. The other fitted parameters were $K_{\rm A}$, $K_{\rm B}$, $V_{\gamma,A}$, and $V_{\gamma,B}$. We kept $e\cos\omega$ and $e\sin\omega$ fixed at the photometric values provided at Table II. We present our results in Table IV and the phase-folded RV measurements from both sources, along with their model residuals, are shown in Fig. 4. In all instances, the error bars were calculated from 5000 Monte Carlo simulations. We conclude that all solutions are in agreement with the previous results of Popper and CL10 within the error bars. For our final result we took the average of the $K_{\rm A}$ and $K_{\rm B}$ values from our two fits to the combined data, but added the difference between the values for the two fits to the quoted uncertainties. That provided an additional uncertainty on the results stemming from our choice of which model to apply.

Physical properties and distance to BK Peg

Physical properties of BK Peg were calculated using the JKTABSDIM code[37] with the photometric properties from Table II and the spectroscopic properties from Table IV. We adopted the effective temperatures $T_{\rm eff,A} = 6265 \pm 85$ K and $T_{\rm eff,B} = 6320 \pm 90$ K from CL10. We present our results in Table V. We have achieved a precision of 0·3% in both mass and radius, and our measurements also agree with those from CL10 and Popper.

We measured the distance to BK Peg using the BV magnitudes from Tycho[14], JHK_s magnitudes from 2MASS[15] corrected onto the Johnson system, and the surface-brightness calibrations of Kervella *et al.*[38] We adopted an interstellar reddening of 0·04 ± 0·02 mag to equalize the distance measurements in optical and infrared passbands. As a result, our best distance estimate, in the K_s band, is 301·2 ± 3·6 pc. That is slightly lower than the distance of 306·3 ± 1·7 pc from the inverse of the *Gaia* DR3 parallax[16].

Comparison with theoretical models

We compared the measured properties of BK Peg to theoretical predictions from the PARSEC 1.2 stellar-evolution models[39]. We initially set the fractional metal abundance by mass to be $Z = 0{\cdot}014$ to match the mildly sub-solar metallicity found by CL10 in their spectroscopic chemical-abundance analysis. In that case, an age of 2500 ± 50 Myr fits the masses and radii of the stars, but both are significantly cooler than the models predict. Increasing the Z improves the match with the temperatures of the stars: for $Z = 0{\cdot}017$ we obtain good agreement in mass, radius, and $T_{\rm eff}$ for an age of 2650 ± 50 Myr.

In Fig. 5 we compare the properties of BK Peg to the predictions of the PARSEC models in a Hertzsprung–Russell diagram. That shows that both components are on the main sequence, although star A is nearing the end of its main-sequence lifetime.

Summary and Conclusions

BK Peg is a dEB containing two late-F–type stars in a slightly eccentric orbit of period 5·49 days. We used the light-curves from *TESS* sector 57 and RV data from Popper and CL10

TABLE IV

Spectroscopic orbits for BK Peg from the literature and from the current work. All quantities are given in km s^{-1}. The error bars are 1-σ standard errors obtained from the Monte Carlo simulations.

Source	K_A	K_B	$V_{\gamma,A}$	$V_{\gamma,B}$	σ_A	σ_B
Popper[12]	79·14 ± 0·33	88·86 ± 0·56	−8·51 ± 0·30	−8·35 ± 0·51	1·36	2·30
CL10	78·77 ± 0·11	88·59 ± 0·21	−7·39 ± 0·08	−7·20 ± 0·15	0·26	0·50
This work (Popper RVs)	79·02 ± 0·26	88·86 ± 0·49	−8·59 ± 0·24	−8·93 ± 0·45	1·08	2·13
This work (CL10 RVs)	78·70 ± 0·04	88·51 ± 0·04	−7·47 ± 0·03	−7·29 ± 0·03	0·11	0·09
This work (all RVs, separate V_γ)	78·70 ± 0·06	88·51 ± 0·05	−7·49 ± 0·04	−7·30 ± 0·03	1·00	2·14
This work (all RVs, common V_γ)	78·75 ± 0·06	88·55 ± 0·04	−7·37 ± 0·03	−7·37 ± 0·03	1·31	2·11
Adopted spectroscopic orbit	78·72 ± 0·11	88·53 ± 0·09	−7·43 ± 0·16	−7·34 ± 0·10	1·00	2·14

TABLE V

Physical properties of BK Peg defined using the nominal solar units given by IAU 2015 Resolution B3 (ref. 36).

Parameter	*Star A*	*Star B*
Mass ratio M_B/M_A	0·8892 ± 0·0015	
Semimajor axis of relative orbit ($\mathcal{R}^N_\odot$)	18·158 ± 0·016	
Mass ($\mathcal{M}^N_\odot$)	1·4109 ± 0·0035	1·2545 ± 0·0037
Radius ($\mathcal{R}^N_\odot$)	1·9901 ± 0·0040	1·4599 ± 0·0038
Surface gravity (log[cgs])	3·9898 ± 0·0016	4·2079 ± 0·0022
Density ($\rho_\odot$)	0·1790 ± 0·0010	0·4032 ± 0·0030
Synchronous rotational velocity (km s^{-1})	18·340 ± 0·036	13·454 ± 0·036
Effective temperature (K)	6265 ± 85	6320 ± 90
Luminosity $\log(L/\mathcal{L}^N_\odot)$	0·740 ± 0·024	0·486 ± 0·025
M_{bol} (mag)	2·890 ± 0·059	3·524 ± 0·062
Interstellar reddening $E(B-V)$ (mag)	0·04 ± 0·02	
Distance (pc)	301·2 ± 3·6	

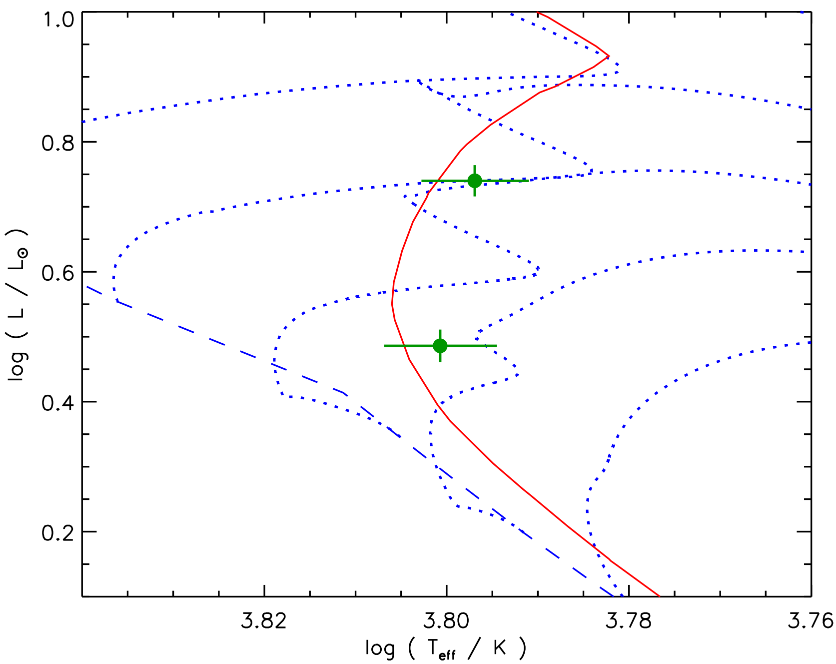

FIG. 5

Hertzsprung–Russell diagram for the components of BK Peg (filled green circles) and the predictions of the PARSEC 1·2 models[39]. The dashed blue line shows the zero-age main sequence for $Z = 0{\cdot}0170$. The dotted blue lines show evolutionary tracks for $Z = 0{\cdot}017$ and masses of 1·1 $M_\odot$ to 1·5 $M_\odot$ in steps of 0·1 $M_\odot$ (from bottom-right to top-left). The solid red line shows an isochrone for $Z = 0{\cdot}017$ and an age of 2650 Myr; it is not a perfect match in this diagram because it was chosen as the best fit to the masses and radii of the components of BK Peg.

to measure the mass and radii of the companions. We measured the distance to the system using published $T_{\rm eff}$ values and surface-brightness calibrations, finding a value close to but slightly shorter than the *Gaia* DR3 parallax distance.

The physical properties of the companions match theoretical models for a slightly super-solar metallicity and an age of 2650 Myr. That conflicts with the spectroscopic metallicity measurement of [Fe/H] = −0·12 ± 0·07 given by CL10.

Since there were only three mid-eclipse-time measurements available from the *TESS* data, we also collected mid-eclipse times from previous literature works or open databases such as the *VarAstro* portal. The eclipse times have an excess scatter around our fitted ephemeris. We conclude that further times of eclipse should be obtained to refine the ephemeris and measure its apsidal-motion period.

Acknowledgements

This research makes use of data obtained with the *TESS* mission and accessed *via* the MAST archive at the Space Telescope Science Institute (STScI). The *TESS* mission is supported by NASA's Science Mission Directorate. STScI is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS 5–26555. This study further makes use of data from the European Space Agency (ESA) mission *Gaia*[*], processed by the *Gaia* Data Processing and Analysis Consortium (DPAC[†]), with funding provided by national institutions, particularly those participating in the *Gaia* Multilateral Agreement. Additional resources employed in this work include the NASA Astrophysics Data System, the *Simbad* database operated at CDS, Strasbourg, France, and the *arXiv* scientific preprint server maintained by Cornell University. ACK gratefully acknowledges the financial support of UK Science and Technology Facilities Council (STFC) and the Faculty of Natural Sciences, Keele University, in the form of a PhD studentship. JS acknowledges support from STFC under grant number ST/Y002563/1.

References

(1) J. Southworth, *The Observatory*, **140**, 247, 2020.
(2) G. R. Ricker *et al.*, *Journal of Astronomical Telescopes, Instruments, and Systems*, **1**, 014003, 2015.
(3) J. Southworth, *Universe*, **7**, 369, 2021.
(4) J. Southworth, in S. M. Rucinski, G. Torres & M. Zejda (eds.), *Living Together: Planets, Host Stars and Binaries*, *Astronomical Society of the Pacific Conference Series* (ASP), **496**, 2015, p. 321.
(5) J. V. Clausen, *A&A*, **246**, 397, 1991.
(6) C. Hoffmeister, *AN*, **242**, 1931.
(7) E. Lause, *AN*, **257**, 75, 1935.
(8) E. Lause, *AN*, **263**, 115, 1937.
(9) D. M. Popper & P. J. Dumont, *AJ*, **82**, 216, 1977.
(10) J. V. Clausen *et al.*, *A&A*, **516**, 14, 2010 (CL10).
(11) D. M. Popper, *ARA&A*, **18**, 115, 1980
(12) D. M. Popper, *AJ*, **88**, 1242, 1983.
(13) O. Demircan, Y. Kaya & Z. Tüfekçioğlu, *AP&SS*, **222**, 213, 1994.
(14) E. Høg, *et al.*, *A&A*, **355**, L27, 2000.
(15) R. M. Cutri *et al.*, *2MASS All Sky Catalogue of Point Sources* (The IRSA 2MASS All-Sky Point Source Catalogue, NASA/IPAC Infrared Science Archive, Caltech, US), 2003.
(16) *Gaia* Collaboration, *A&A*, **674**, A1, 2023.
(17) F. W. A. Argelander, *Bonner Durchmusterung des nördlichen Himmels* (A. Marcus and und E. Weber's Verlag), 1903.
(18) K. G. Stassun *et al.*, *AJ*, **158**, 138, 2019.
(19) G. Schaller *et al.*, *A&ASS*, **96**, 269, 1992.

[*] https://www.cosmos.esa.int/gaia

[†] https://www.cosmos.esa.int/web/gaia/dpac/consortium

(20) Lightkurve Collaboration, *Lightkurve: Kepler and TESS time series analysis in Python* (Astrophysics Source Code Library), 2018.
(21) J. M. Jenkins *et al.*, in G. Chiozzi & J. C. Guzman (eds.), *Software and Cyberinfrastructure for Astronomy IV*, *Society of Photo-Optical Instrumentation Engineers Conference Series*, **9913** (SPIE), 2016, p. 99133E.
(22) J. Southworth, P. F. L. Maxted & B. Smalley, *MNRAS*, **351**, 1277, 2004.
(23) J. Southworth, *A&A*, **557**, A119, 2013.
(24) D. Hestroffer, *A&A*, **327**, 199, 1997.
(25) P. F. L. Maxted, *A&A*, **616**, 13, 2018.
(26) J. Southworth, *The Observatory*, **143**, 71, 2023.
(27) A. Claret & J. Southworth, *A&A*, **664**, 6, 2022.
(28) A. Claret & J. Southworth, *A&A*, **674**, 7, 2023.
(29) P. F. L. Maxted *et al.*, *MNRAS*, **498**, 332, 2020.
(30) H. Ak, F. F. Özeren & F. Ekmekçi, *Information Bulletin on Variable Stars*, **5361**, 1, 2003.
(31) P. Virtanen *et al.*, *Nature Methods*, **17**, 261, 2020.
(32) J. Hübscher, *et al.*, *Information Bulletin on Variable Stars*, **5941**, 1, 2010.
(33) D. M. Popper & P. B. Etzel, *AJ*, **86**, 102, 1981.
(34) P. Lenz & M. Breger, *Communications in Asteroseismology*, **146**, 53, 2005.
(35) J. H. Telting *et al.*, *AN*, **335**, 41, 2014.
(36) A. Prša *et al.*, *AJ*, **152**, 41, 2016.
(37) J. Southworth, P. F. L. Maxted & B. Smalley, *A&A*, **429**, 645, 2005.
(38) P. Kervella *et al.*, *A&A*, **426**, 297, 2004.
(39) A. Bressan *et al.*, *MNRAS*, **427**, 127, 2012.

The Editors congratulate David E. Holmgren (first author of the following article) on having an asteroid named after him this year: (587299) Holmgren = 2005 WJ_{209} (see the IAU WGSBN (Working Group on Small Bodies Nomenclature) Bulletin **6**, #2, 2026 February 2, p. 12).

LONG-TERM STUDIES OF EARLY-TYPE BINARY STARS: THE SPECTROSCOPIC ORBIT OF NY CEPHEI

By D. E. Holmgren[1] *& S. Yang*[2]

[1]*Calgary, Canada,* `david.e.holmgren@gmail.com`
[2]*Victoria, Canada,* `syang@uvic.ca`

A new spectroscopic orbit and set of absolute dimensions are presented for the early-type eclipsing binary system NY Cephei. Those results are based on 30 years of CCD spectral data obtained at the Dominion Astrophysical Observatory (DAO). A search for apsidal motion was also attempted by combining those data with older Reticon data to extend the time-base to 40 years. We present a tentative detection of apsidal motion with a period of 13 500 yr.