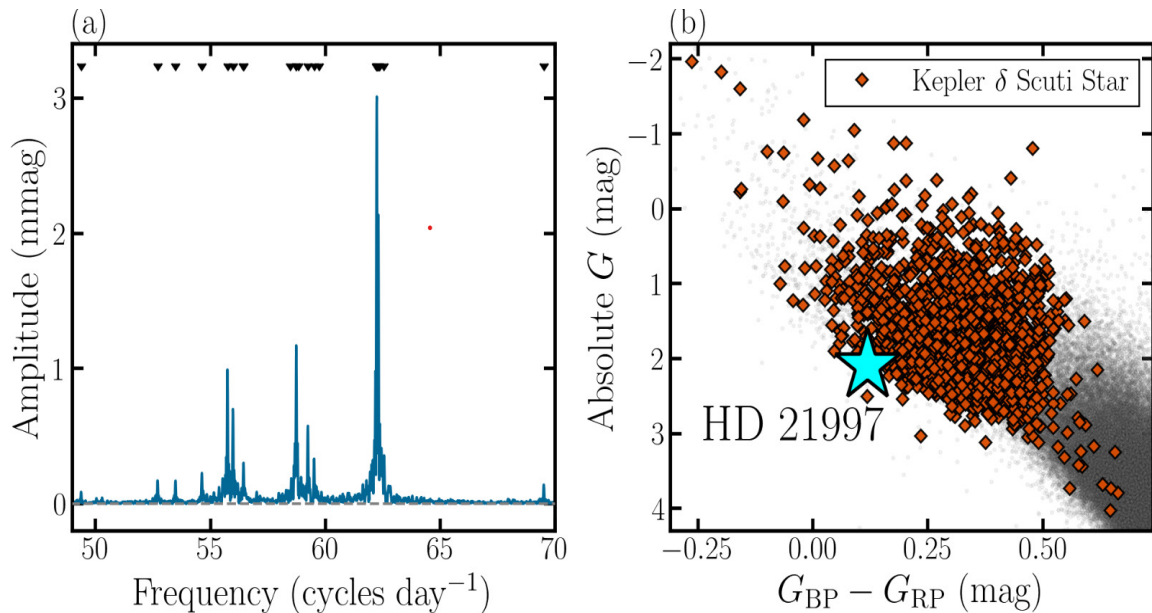




The above figure is taken from a paper by Sepulveda et al on delta Scuti pulsations in HD 21997. Panel (a) shows the TESS amplitude spectrum of HD 21997 zoomed in on the region of significant pulsations. Significant frequencies from their prewhitening procedure are denoted by black downward triangles. Panel (b) shows a Gaia DR3 color-magnitude diagram generated following Sepulveda et al. (2022). Orange diamonds are a sample of Kepler δ Scuti stars from Murphy et al. (2019) and small grey dots are non-pulsating KIC stars. HD 21997, whose color and absolute magnitude were calculated using $A_V = 0.075$ (Chen et al. 2014), is overplotted as a large cyan star. See the review article on page 10. To see why I have a non-VSS member's work in this issue, read my editorial on page 3.

Contents

From the Director - <i>Mark Blackford</i>	2
Editorial - <i>Phil Evans</i>	3
South polar sequence; BV data for CPD stars in Polar Cap - <i>Mati Morel</i>	4
Mass calculation of proposed third body in CP Scl system – <i>Jeff Byron</i>	7
Errata.....	9
HD 21997 is a high-frequency Delta Scuti pulsator – <i>Chat GPT</i>	10
Collaboration project for the observation of RR Lyrae stars – <i>Pierre Traverse, Jean-Louis Virlicchie, Hervé Roy</i>	12
Publication watch	14
About.....	16

From the Director – *Mark Blackford*

Welcome to the third edition of the newsletter for 2024. VSS will hold a symposium in conjunction with the RASNZ conference in Whakatane next May. More information will be provided in following newsletters, but please consider attending and presenting your work.

Recently Pierre Traverse contacted me to see if any VSS members would be interested in participating in a project which aims to monitor RR Lyrae type stars (see his short article elsewhere in this newsletter). This request was posted on the VSS Google Group and received positive responses from 5 members, one each from New Zealand, South Africa and Western Australia, and two from NSW (including myself). If you would like more information, please contact me so I can put you in touch with Pierre.



I am currently in the middle of an AAVSO online course titled “Observational Best Practices” presented by Arne Henden. The aim is to improve the quality of CCD/CMOS photometry by applying best practices when undertaking photometry projects. This includes target and comparison star selection, image acquisition, quality assessment, calibration and measurement, transformation and reporting, amongst many other things. The first 4 weeks have been very informative and I’m looking forward to the final few weeks. I highly recommend you consider enrolling when the course is next offered.

As mentioned in previous Newsletters, 2024 will be Phil Evans’ last year as editor. We need someone to take on this important role in 2025. Phil will provide any assistance the new editor might need. Please contact Phil and/or me.

Congarinni Observatory has seen no action recently as I’ve been travelling for most of the last 3 months. However, the roof is operational again after sustaining damage during a storm on Christmas night, so I’m looking forward to resuming observing after a long hiatus.

Wishing you all clear skies and good health,

Mark Blackford

Editorial

This edition of our newsletter is a bit thinner than usual and contains an article by an unusual author – *ChatGPT*. I was scratching around trying to find an interesting article to include with this issue when I came across Sepulveda’s paper on a Delta Scuti variable, and some of us are interested in those. The trouble was I didn’t have time to write a proper review of the paper, having more pressing domestic matters and being behind with my TESS SG1 submissions. Having previously played around with some of these so-called large language models I asked ChatGPT to write a review of the paper for me in about 1000 words. I think I used ChatGPT 4o-mini but I can’t be sure. The result is on page 9.

I’ve had a good look at what ChatGPT produced and do not find fault with the content, though I wasn’t entirely happy. I didn’t like the formulaic layout with so many headings. I got the clear impression that the AI simply wasn’t interested in the article. The language was OK and so was the grammar but I did have a very petty complaint about the phrase “software tools like Lightkurve” – it wasn’t some other software similar to Lightkurve, it was Lightkurve! I’ve changed “like” to “such as”. A very petty complaint. Of course I have now spent much more time on the article than I would have if I had just done the review myself straight away.

Now my question to VSS members is ‘how did you react to this?’ Were you happy with it or did it annoy you? Did you check the original paper and the review to see how accurate it was, given the 1000 words limit? Can you see more use for AI in our newsletter – bearing in mind that the next newsletter will be my last and it will be up to a new editor as to whether they make use of an AI or not.

I can see a possible use in that our interests are varied and there will be newly published papers in different subjects that readers may not be aware of but would like to be told about. ChatGPT or one of its cousins or rivals could easily do the job of providing short reviews for publication in the newsletter. What do you think? Would you trust the reviews? If you wouldn’t trust an AI to do a review would you be willing to write one yourself? There’s many new papers published each day on the arXiv, have a look and pick one - try writing a review. Give yourself a word limit. If you think you’ve done a good job send your review in for the next newsletter.

Phil Evans

Editor (until October)

Many years ago I noted the *North Polar Sequence*, a sequence of 96 carefully calibrated stars on a photographic scale (Leavitt 1917). This was a reference work for photometry up till about 1950 when it fell out of use, being superseded by photoelectric photometry, especially the UBV standards. Being centred on the north pole, the NPS was not viable for far southern skies. Perhaps an equivalent SPS would have been useful, centred on the south pole. It may be a moot point now, but nevertheless I have made a list of more than 60 CPD stars, all within one degree of $-90^{\circ}00'$ (equinox 1875.0), most having APASS data. Other sources are given, such as Tycho-2 and GCPD, usually for stars brighter than $V=10.0$. Full APASS data is given, to three decimal places, with errors, fainter than $V=10.0$. There are 62 CPD stars in the -89° zone, plus several outside that zone.

Of course APASS contains many stars fainter than the cut-off I have adopted, about magnitude 12.0. This ensures that the list is of manageable length, while providing a platform for deeper studies. Working on the polar cap can be a bit tricky!

Sources

- Tycho-2 I/250 The Tycho-2 catalogue of the 2.5 million brightest stars (Hog et al 2000).
- GCPD II/167/catalog General Catalogue of Photometric Data Version April 1990
- Seqplot www.aavso.org/apass

Errors

Errors are provided for all APASS data, the unit being ± 0.001 in V and B-V respectively. Tycho-2 are not given here, but are of the order of ± 0.020 (or better) for bright stars. For fainter stars errors are worse, about ± 0.05 at $V=10.5$, and even greater for stars below $V=11.0$ (see Hog et al., 2000).

Published BV sequences near SCP

- GSPC S001 (BV, 6 stars 7.85 - 14.60V) Lasker and Sturch 1988. Their lettered bright stars are identifiable as, SA=CPD-88 127, SB=CPD-88 133, SC=CPD-88 132.
- SCP sequence (UBV, 9 stars 6.53 - 12.66V). Soonthornthum and Tritton (1980).

Table of SCP stars

The complete roster of 62 CPD stars for the -89° zone (equinox 1875.0) is listed. The corresponding Cordoba Dm. (CoD) numbers are also given when existing. The CPD stars are labelled accordingly on the accompanying chart.

- Coordinates are given for equinox J2000.0
- Tycho-2 mags. (V and B-V) are given, rounded to two decimal places. Errors are omitted.
- GCPD mags are given, rounded to two decimal places.
- APASS mags. (V and B-V) are given, to three decimal places, with accompanying errors.
- REMARKS column provides other ids., HD numbers and variable star names, and MK types.

References

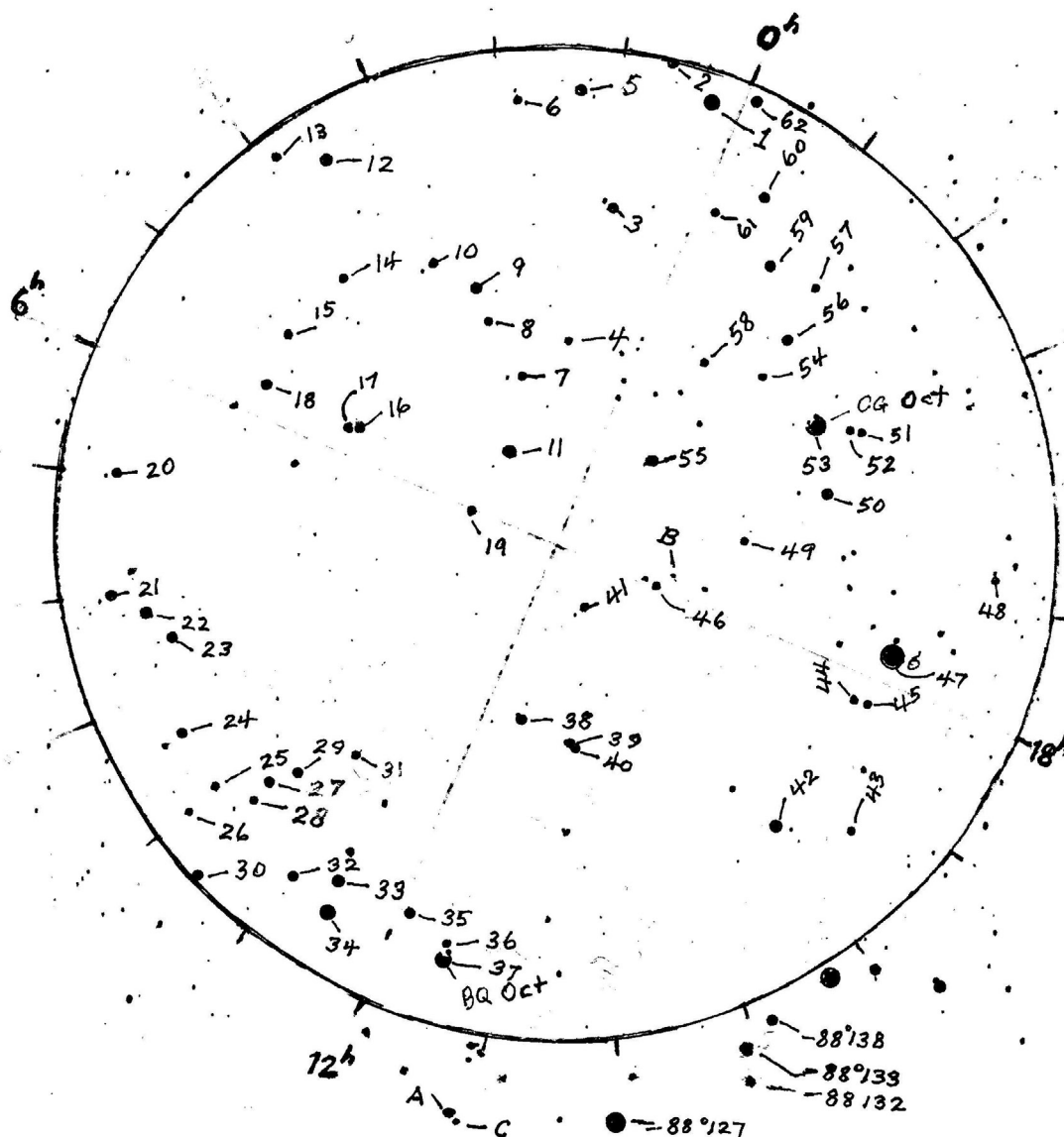
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Lasker, B.M. , Sturch, C.R. et al 1988 Astrophys.J. Suppl. 68,1
Leavitt, H.S. 1917 Harvard Ann. 71,2
Soonthornthum, B. and Tritton, K.P. 1980 Observatory 100,4

Table 1. SOUTH POLAR SEQUENCE. Sources of photometry for South Polar CPD stars.

	CPD	CoD	RA			J2000			Dec			Tycho-2		GCPD		APASS		Verr		B-Verr		REMARKS
			h	m	s	°	'	"	V	B-V	V	B-V	V	B-V	0.001	B-V	0.001					
-89°	1	1	0	12	33.9	-88	21	47	7.21	0.05											HD1348, B9.5IV	
-89°	2		0	26	9.6	-88	19	6.8	10.14	1.36						10.171	14	1.335	29			
-89°	3	2	0	33	52.3	-88	37	19.7	9.31	0.59			9.30	0.60							HD5325, F7/8V	
-89°	4		0	31	15.8	-88	55	17.9	11.24	0.49			var		11.067	10	0.623	38			CSTAR 099529	
-89°	5	3	0	48	51.4	-88	24	52.8	9.03	1.08			9.03	0.82							HD7296, K0III	
-89°	6	4	1	7	30.4	-88	27	28.5	9.24	0.26			9.24	0.26							HD10522, A7IV	
-89°	7		0	55	0.0	-89	1	25.3	11.33	0.40					11.153	15	0.548	26				
-89°	8		1	7	7.4	-88	55	6.0	11.56	0.62					11.663	13	0.570	33				
-89°	9		1	14	6.3	-88	51	17.2	10.54	0.92					10.609	13	0.827	34				
-89°	10		1	35	51.7	-88	49	31.2	10.43	0.99			10.46	1.06	10.443	9	1.029	28			HD17579, K5	
-89°	11	5	0	45	31.7	-89	10	8.7	9.62	0.69											HD12697, G2V:	
-89°	12		2	6	51.6	-88	35	1.9	9.96	0.73			9.95	0.75							HD20281. G8/K0	
-89°	13		2	22	55.7	-88	33	39.9	11.23	0.66					11.436	38	0.691	57				
-89°	14		2	7	14.4	-88	50	1.4	11.06	0.58					10.982	23	0.586	34				
-89°	15		2	33	57.5	-88	55	31.5	11.38	0.64					11.302	23	0.761	35				
-89°	16	6	2	9	17.0	-89	8	12.8	10.15	0.64					10.221	16	0.534	39			HD29328, K	
-89°	17		2	13	5.3	-89	8	3.8	11.66	0.54					11.125	50	0.562	57			Double	
-89°	18		2	48	58.7	-89	0	39.0	10.90	0.86					10.758	19	1.080	40				
-89°	19		1	2	21.7	-89	17	56.4	10.30	0.68					10.353	9	0.574	34			HD23641, F7/G0	
-89°	20		4	15	30.6	-89	0	46.9	11.49	0.38					11.486	12	0.441	31				
-89°	21		5	4	56.2	-89	11	6.8	10.30	1.04					10.265	16	1.070	38				
-89°	22	7	4	52	23.2	-89	16	26.2	8.83	0.30			8.86	0.26							HD63013, A2m...	
-89°	23		4	53	53.7	-89	20	49.3	9.72	1.45			9.71	1.62							sp. M	
-89°	24		5	53	26.3	-89	28	20.0	9.82	1.27			9.82	1.28							HD77799, K	
-89°	25		6	32	14.8	-89	34	25.8	10.56	1.15					10.709	22	1.166	56				
-89°	26		7	3	10.2	-89	32	3.6	11.03	0.48					10.597	35	0.637	65				
-89°	27		6	2	9.4	-89	40	30.7	10.72	1.12					10.729	14	1.179	60				
-89°	28		6	33	30.7	-89	39	26.0	11.13	0.72					11.206	21	0.654	62				
-89°	29		5	31	59.4	-89	42	56.1	10.75	0.77					10.880	19	0.599	58				
-89°	30		8	4	48.5	-89	33	19.4	10.56	1.27					10.504	4	1.198	55				
-89°	31		3	48	13.7	-89	46	22.3	10.92	0.73					10.995	17	0.664	36				
-89°	32		8	24	44.5	-89	44	42.7	10.52	0.79					10.586	24	0.578	62				
-89°	33	8	8	58	44.9	-89	49	52.4	8.75	1.09			8.75	1.10							HD98784, K0/1III	
-89°	34	9	9	56	49.2	-89	46	56.6	7.82	0.11			7.82	0.10							HD99685, A0IV	
-89°	35		13	17	4.6	-89	52	39.0	10.73	0.49					10.748	27	0.347	52			11.3V comp 41"sp	
-89°	36		14	50	23.9	-89	47	59.9	10.56						10.776	30	1.241	56				
-89°	37	10	14	35	26.4	-89	46	18.1	6.86	1.70					var						HD110994, M4,BQ Oct	
-89°	38	11	23	3	14.1	-89	39	40.4	10.28	0.50					10.299	58	0.463	64			HD116751, K0	
-89°	39		21	55	49.8	-89	37	26.0	10.61	0.47					10.672	22	0.427	40			HD129371, K0	
-89°	40		21	48	8.3	-89	37	12.7	11.04	0.40					10.945	8	0.459	36				
-89°	41		23	23	52.0	-89	25	17.5	11.26	0.69					11.377	15	0.654	33				
-89°	42	12	19	54	9.7	-89	16	17.6	9.61	1.05			9.61	1.06							HD151667,K0/2(III)	
-89°	43		19	48	56.4	-89	7	14.0	10.93	0.13			var		10.779		0.289				HD156092, A5?	
-89°	44		20	54	10.8	-89	3	44.8	10.85	0.80					10.692	15	1.016	52				
-89°	45		20	50	32.0	-89	2	32.0	10.95	0.79					10.807	14	0.797	58			HD170447, K0	
-89°	46		22	51	40.2	-89	16	12.1	10.92	1.01					11.032	14	0.961	39				
-89°	47	13	21	8	46.2	-88	57	23.4	5.45	0.28			5.47	0.27	var						HD177482,F0III,σ Oct	
-89°	48		21	22	58.0	-88	41	55.4	11.09	0.51					11.198	12	0.393	49				
-89°	49		22	33	12.8	-89	4	52.6	11.50	0.28					11.495	16	0.255	41				
-89°	50	14	22	23	39.3	-88	53	42.7	9.72	0.49			9.71	0.48	var						HD199624, A5	
-89°	51		22	31	52.7	-88	45	46.6	10.42	0.49					10.370	17	0.468	39			HD203972, G5	
-89°	52		22	34	59.5	-88	46	35.7	10.54	0.30					10.520	5	0.293	39			HD204557, K0	
-89°	53	15	22	45	28.6	-88	49	6.2	6.56	0.29			6.53	0.29	var						HD206553,A7,CG Oct	
-89°	54		23	13	49.8	-88	48	45.6		0.58					11.365	11	0.597	41				
-89°	55		23	37	1.6	-89	5	15.6	10.86	1.43					10.785	10	1.248	40				
-89°	56		23	14	40.6	-88	43	14.5	10.08	1.11			10.08	1.11	10.020	17	1.040	45			HD214540, K2	
-89°	57		23	17	4.6	-88	36	14.8	11.22	0.40					11.250	8	0.469	24				
-89°	58		23	36	37.4	-88	51	8.7	11.68	0.37					11.693	15	0.395	35				
-89°	59		23	33	17.5	-88	36	52.0	10.88	1.26					10.800	9	1.363	27				
-89°	60		23	46	39.8	-88	29	46.9	10.96	0.96					10.806	17	1.169	27				
-89°	61		23	57	58.3	88	34	1.3	11.52	0.69					11.384	11	0.613	24				
-89°	62	16	0	0	50.5	-88	19	42.0	9.40	0.36			9.39	0.36							HD224697, A4III	
-88°	127	38	16	5	52.8	-89	18	30	7.83	0.40			7.85	0.40							HD125371, F2/F3V	
-88°	132		17	20	2.0	-89	10	47	10.20	0.69			10.34	0.60	10.325	48	0.566	68			sp. G	
-88°	133	41	17	34	12.2	-89	13	44	9.27	1.49			9.29	1.41							HD136509, K3/4	
-88°	138		17	58	28.0	-89	12	22	10.69	0.32			10.62	0.52	10.562	38	0.521	62				
	A		14	4	38.8	-89	27	35	10.71	1.23			10.73	1.23	10.702	33	1.217	56				
	B		22	48	4.8	-89	13	26					12.66	0.72							Errors: 0.025,<0.02	
	C		14	8	41.4	-89	25	50	11.96	0.47					12.115	36	0.495	55				

SOUTH POLAR SEQUENCE

Identification of CPD stars in the South Polar Cap,
CPD -89° 1 to 62, plus several stars beyond the limit.



See Table for photometric data.

Equinox 1875.0.

Abstract

Building on papers by Bembrick and Richards in VSS Newsletter 2024-2, this paper demonstrates that, if the observed O-C behaviour of CP Sculptoris is due to a dark companion, it is possible to establish a lower limit for the mass of such a body using existing data and that it must be too massive to be a planet.

Introduction

VSS Newsletter 2024-2 includes two excellent papers describing what has been learned about CP Sculptoris based on multi-band light curves. Bembrick (2024-a) demonstrates how parameters such as temperatures, mass ratio and probable spectral types (K0 and G5 for stars 1 and 2 respectively) are determined.

Richards (2024-a) updates his previous paper Richards (2023) and concludes, referring to his Figure 3, that “The (sinusoidal O-C) curve exhibits equal maxima and minima (no residual slope) which indicates no period change for the binary. It indicates the presence of a third object in the system with the binary in a circular orbit around the system’s barycentre (maxima occur halfway between minima). The curve’s amplitude of 0.0061 d equates to an orbital radius of the binary around the system’s barycentre of 1.05 AU. Without radial velocity data it is not possible to estimate the mass or orbital radius of the hypothesized third body. However Bembrick’s light curve analysis does not suggest contamination by a third light, suggesting it would be a relatively faint star (unlikely) or a planet.”

However, it is suggested here that it is possible to estimate a lower limit for the mass of such an object and, as shown below, that mass certainly suggests that the object is not a planet. (Note that, to be a planet, an object would need to have a mass less than about 0.01 solar masses.)

Note: Subsequently to their papers being published in VSS Newsletter 2024-2, Richards (2024-b) has revised the amplitude to be 0.0044 days and the period to be 4513 ± 5.11 days. Also, Bembrick (2024-b) placed a luminosity constraint on the third body, indicating that his modelling suggests that the dark companion must be no more than 1% of the binary luminosity. He also reported that the combined mass of the binary pair is about 1 solar mass.

Calculations & discussion

Richards indicates above that the binary (combined mass M_B) and the “dark” companion (mass M_C) are in circular orbits around the common centre of gravity. (See comment below on sensitivity test and consideration of elliptical orbits.) If we let R_B and R_C be their respective orbital radii and ω be the angular velocity of the orbits, for each (binary and companion) we can equate the centripetal force with the gravitational attraction between them:

$$M_B \cdot R_B \omega^2 = G \cdot M_B \cdot M_C / (R_B + R_C)^2 \quad (1a)$$

$$M_C \cdot R_C \omega^2 = G \cdot M_B \cdot M_C / (R_B + R_C)^2 \quad (1b)$$

To obtain a simple value for G , consider the Earth’s rotation around the Sun, for which we have:

$$M_E \cdot R_E \omega_E^2 = G \cdot M_E \cdot M_S / (R_E)^2$$

giving

$$G = R_E^3 \omega_E^2 / M_S \quad (2)$$

where M_E is the mass of Earth; R_E is the radius of Earth’s orbit; ω_E is the angular velocity of Earth in its orbit and M_S is the mass of the Sun.

Adopting a system of units where mass is expressed in solar masses; distance is expressed in astronomical units (A.U.) and time is measured in years, we then have $R_E = 1$ and $M_S = 1$ so

$$G = \omega_E^2 = (2\pi)^2$$

For the case of CP Scl orbiting the dark companion, Richards gives:

$$R_b = 0.76 \text{ (0.0044 light days expressed in A.U.)}$$

$$\text{Orbital period with dark companion} = 4513 \text{ days} = 12.36 \text{ years}$$

$$\text{Thus } \omega = 2 \cdot \pi / 12.36 = 0.5085 \text{ (in units of year}^{-1}\text{)}$$

From (1b) we obtain:

$$R_c = G \cdot M_b / \{(R_b + R_c)^2 \omega^2\} \quad (3)$$

But as both binary and dark companion are rotating about the common centre of gravity,

$$M_b \cdot R_b = M_c \cdot R_c$$

From which we obtain

$$R_c = M_b \cdot R_b / M_c \quad (4)$$

Equating (3) and (4) yields

$$G / \{(R_b + R_c)^2 \omega^2\} = R_b / M_c \quad \text{or}$$

$$M_c = (R_b / G) \omega^2 (R_b + R_c)^2 = (R_b / G) \omega^2 (R_b + M_b \cdot R_b / M_c)^2$$

That is:

$$M_c = (R_b^3 \cdot \omega^2 / G) (1 + M_b / M_c)^2 \quad (5)$$

Substituting numerical values for R_b , ω & G into (5) gives

$$M_c = 0.76^3 \times 0.5085^2 / (2 \cdot \pi)^2 (1 + M_b / M_c)^2$$

$$M_c = 0.00288 (1 + M_b / M_c)^2 \quad (6)$$

Numerical solutions are plotted below (Figure 1), with all masses in solar mass units. Taking Bembrick's combined mass of the binary pair to be about 1 solar mass, from Figure 1 below the mass of the dark companion is about 0.16 solar masses, well above the limit for planetary mass.

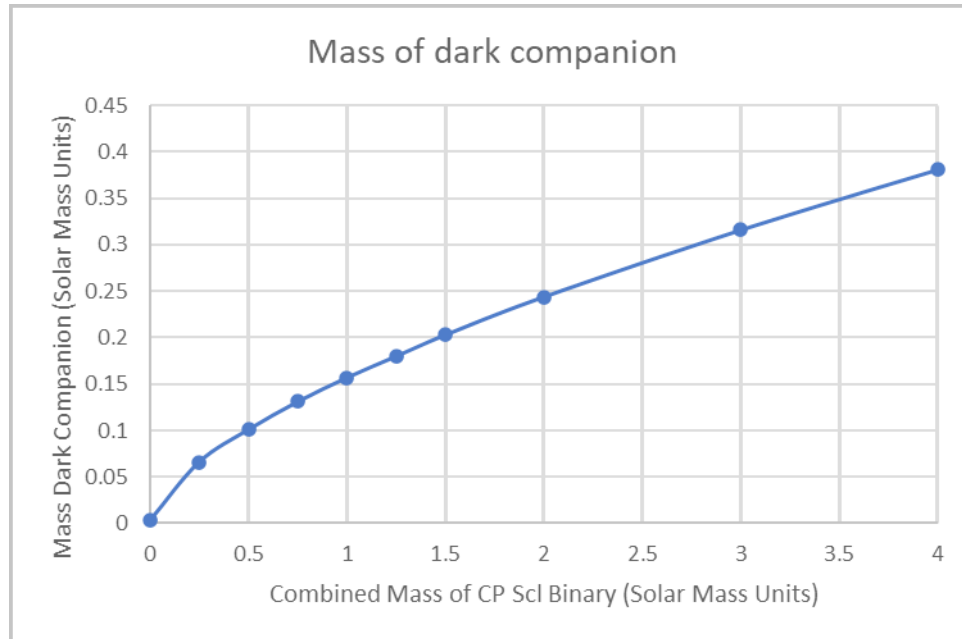


Figure 1. Mass of dark companion as a function of combined mass of binary for the case of binary orbital radius of 0.76 AU and orbital period of 4513 days (around system barycentre). Bembrick reports that combined mass of binary is 1 solar mass implying that dark companion has mass of at least 0.16 solar masses.

A sensitivity test was made by varying both period and amplitude in the direction to minimise the calculated mass of the dark companion. The period was doubled to 9026 days and the amplitude halved to 0.0022 days resulting in the mass of the dark companion being re-calculated to be 0.046 solar masses, still a factor of four too large to be a planet. This test gives some assurance that as a large change to amplitude and period do not change the conclusion that the proposed third body must be stellar, even if the orbits are significantly elliptical, that conclusion would still be valid.

Note that, if we incorporate a $\sin i$ term along with RB to allow for the line of sight inclination of the orbit, then the physical distances will be correspondingly larger than assumed here and the mass of the dark companion must be even greater than calculated here. In other words, the dark companion masses calculated here should be considered to be “lower limits” for the actual mass.

Conclusion

If the O-C variation observed is due to the binary and a dark companion being in orbit around some system barycentre with orbital radius and period of values suggested by Richards’ paper, this paper has demonstrated that it is possible to deduce a lower limit for the mass of that dark companion. In this case of CP Sculptoris it is clear that the proposed third body in the system would be too massive to be a planet, but it could conceivably be an M class star and still meet Bembrick’s luminosity constraint. For example, a star similar to GJ 699 (Barnard’s Star) with an absolute magnitude of 13.2 (more than eight magnitudes fainter than CP Scl) and a mass of 0.16 solar masses (Pineda et al 2021) would suit.

However, note that Richards’ paper also gives the warning that “It is reasonable to doubt that it (the sinusoidal fit) approximates a “true” periodic change in minima times”. In other words, the O-C variation may not be due to a third body at all. For example, Richards (2024-b) suggests the Applegate mechanism may be responsible.

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- Richards, T. 2023. Period change in CP Sculptoris, a study in period analysis. Newsletter of Variable Stars South, RASNZ, 2023-3. Online at www.variablestarssouth.org
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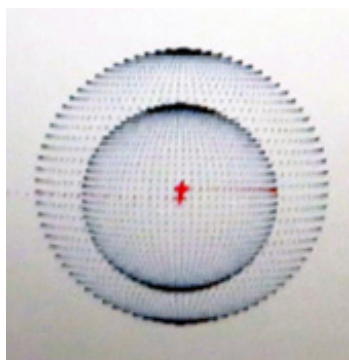
Errata

There are some corrections to Col Bembrick’s paper in the previous newsletter. Please note the following:

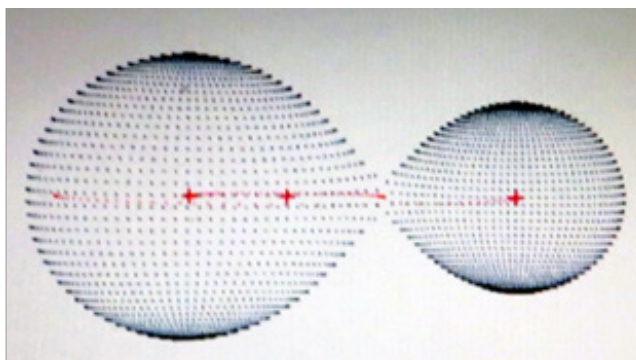
Page 11 fourth para: Figure 4 shows should read Figure 3 shows

In Results and Analysis second para: In Figure 3 should read In Figure 2

Page 13 Figure 5. The graphic panels have been swapped left to right above the caption. The correct order is:



a) 0.5 phase



b) 0.75 phase

Page 14 References. Add: Richards, Tom 2023. Period Change in CP Sculptoris, a study in period analysis. VSS NL, July.

HD 21997 is a high-frequency Delta Scuti pulsator – *Chat GPT*

The paper “The Hybrid Debris Disk Host Star HD 21997 is a High-Frequency Delta Scuti Pulsator” (arXiv:2403.19741v1) explores the properties of HD 21997, a star that hosts a debris disk with significant amounts of CO gas and has been identified as a Delta Scuti pulsator. Here’s a detailed summary of the findings and methodologies discussed in the paper:

This article was written by an AI, ChatGPT, in response to my query:

“Summarize arXiv: 2403.19741v1.pdf in 1000 words”,

More information: Aldo G. Sepulveda et al, The Hybrid Debris Disk Host Star HD 21997 is a High-Frequency Delta Scuti Pulsator, *arXiv* (2024). DOI: [10.48550/arxiv.2403.19741](https://doi.org/10.48550/arxiv.2403.19741)

Background and motivation

HD 21997 is classified as an A3 star with a mass approximately 1.8 times that of the Sun. It features a debris disk rich in CO gas, a characteristic unusual for its age and dust properties. This star belongs to a subset of systems termed “hybrid” debris disks due to the potential coexistence of second-generation dust and primordial gas. Understanding the age of HD 21997 is crucial for interpreting the evolutionary state of both its dust and gas components. Asteroseismic modeling of Delta Scuti stars can provide precise age estimates, prompting an investigation into whether HD 21997 exhibits Delta Scuti pulsations.

Data and methods

The study utilizes data from the Transiting Exoplanet Survey Satellite (TESS), focusing on two-minute cadence light curves to analyze the star’s pulsations. The light curve of HD 21997, observed over a span of several weeks, was processed to identify significant frequencies using software tools such as Lightkurve and SigSpec.

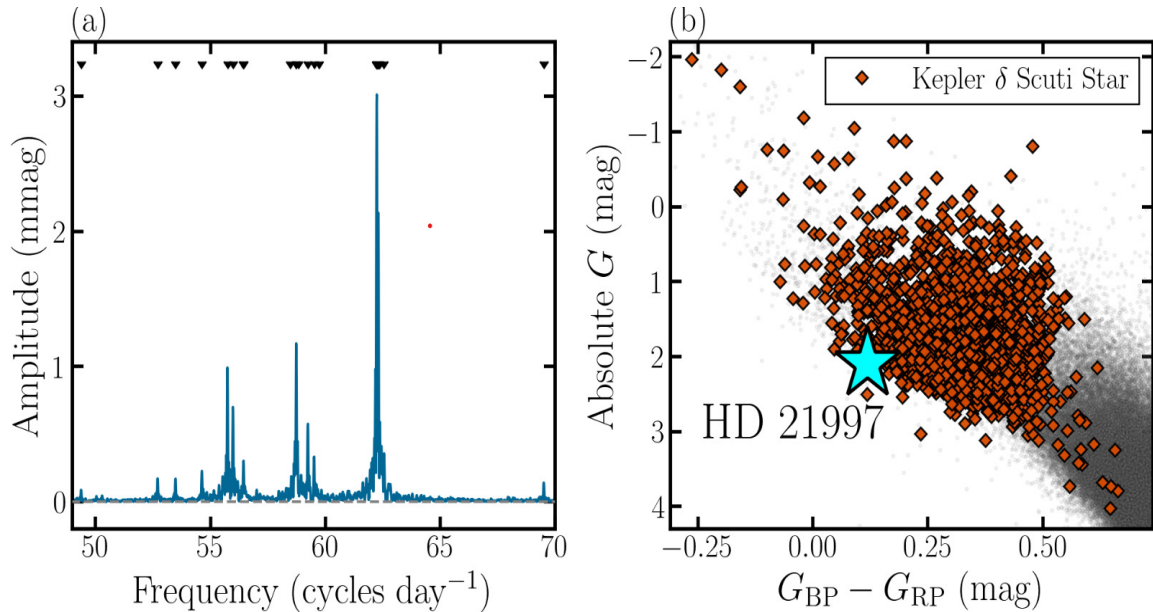


Figure 1. (a): TESS amplitude spectrum of HD 21997 zoomed in on the region of significant pulsations. Significant frequencies from our prewhitening procedure are denoted by black downward triangles. (b): Gaia DR3 color-magnitude diagram generated following Sepulveda et al. (2022). Orange diamonds are a sample of Kepler δ Scuti stars from Murphy et al. (2019) and small grey dots are non-pulsating KIC stars. HD 21997, whose color and absolute magnitude were calculated using $AV = 0.075$ (Chen et al. 2014), is overplotted as a large cyan star.

Results

The analysis identified 25 significant frequencies in the range of 49-70 cycles per day, (Figure 1) consistent with the pressure modes characteristic of Delta Scuti stars. These findings were supported by compar-

ing the star's properties with known Delta Scuti stars from the Kepler mission. The frequency spectrum and the position of HD 21997 in the Gaia color-magnitude diagram further supported its classification as a Delta Scuti pulsator.

Age estimation

Determining an accurate age for HD 21997 is challenging due to uncertainties in isochrone fitting and the potential influence of the star's rotation period. Previous studies estimated the star's age to be around 38.5 million years, placing it within the Columba young moving group, which has an age range of 20-40 million years. However, the precision of these estimates is limited, and asteroseismic modeling offers a potential improvement, aiming for age precision within 10-20%.

Discussion and implications

The detection of high-frequency pulsations in HD 21997 provides independent evidence for its youth, aligning with its placement in the Gaia color-magnitude diagram. The study emphasizes the need for accurate mode identification to leverage asteroseismic modeling fully, which could significantly refine the age estimates for HD 21997 and improve our understanding of hybrid debris disks.

Conclusion

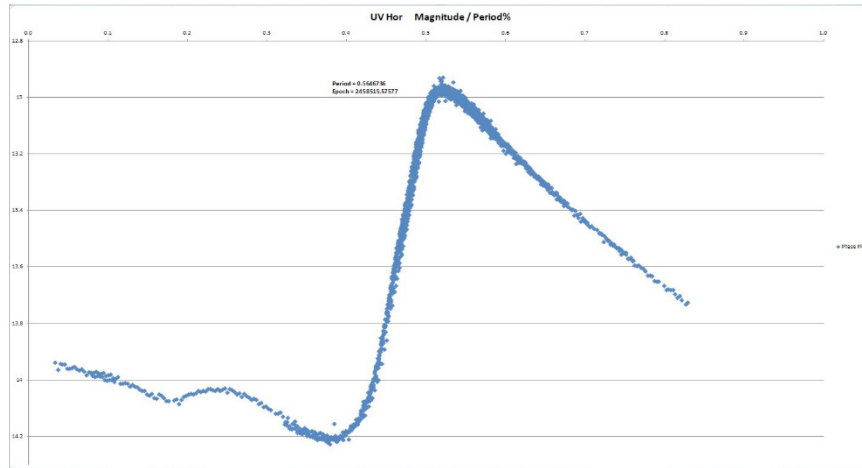
HD 21997 is confirmed as a high-frequency Delta Scuti pulsator, contributing valuable data for the study of hybrid debris disks. The findings underscore the potential of asteroseismic techniques to provide precise age estimates, which are crucial for interpreting the evolutionary dynamics of such systems.

For further details and in-depth analysis, the full paper can be accessed on arXiv.

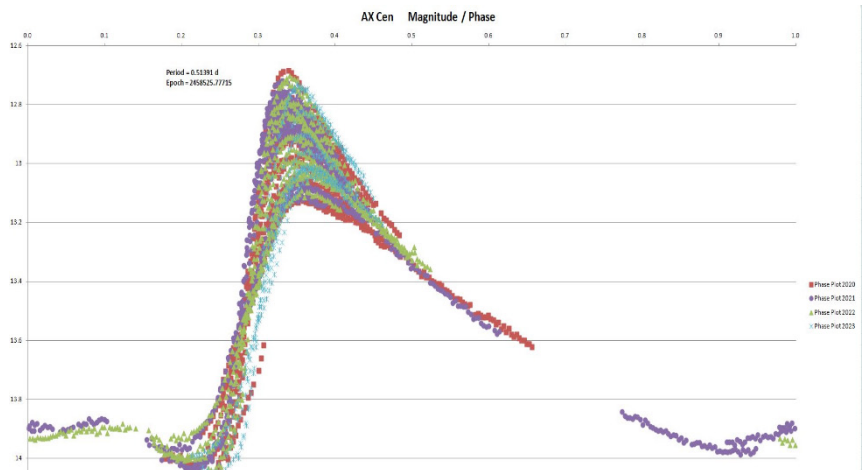
Collaboration project for the observation of RR Lyrae stars

– Pierre Traverse, Jean-Louis Virlichie, Hervé Roy

We are three amateurs living in France and observing from Chile. Our targets are RR Lyrae variable stars; we observed 40 stars since 2019 in the frame of the GEOS RR Lyr survey (GRRS). We are members of the association SADR that allow us to use a 14in Newton telescope for about 120 good nights a year. We have enough measurements of each stars to verify the presence of modulations or multiple pulsation frequencies.



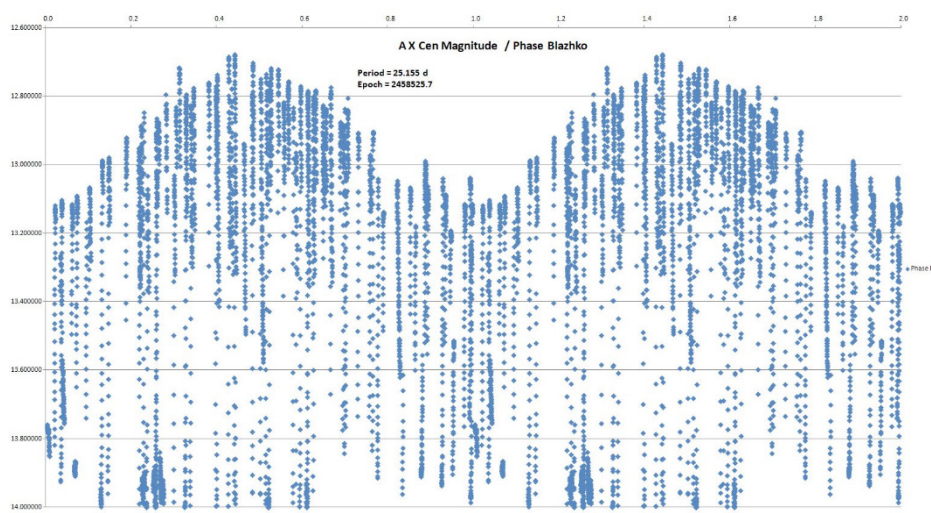
For example UV Hor is a regular one pulsating on a single frequency; we use the magnitude versus phase to check this characteristic. The light curve folded on pulsation period is “thin”. The pulsation period is 0.56467 days. AX Cen, on the other hand, appears to be very irregular. It is affected by a modulation called the Blazhko effect.



This is a folded light curve with about 2000 points on the pulsation period 0.5139 days.

The horizontal axis is phase according to pulsation frequency. The vertical axis is magnitude. The amplitude in brightness and varies from 0.9 to 1.3 mag

If we fold the data points on the Blazhko period (25.155 days), the amplitude modulation appears clearly:



The Blazhko effect which is also a modulation in frequency may also appears when plotting times of maximum O-C (observed minus calculated) versus time.

We belong to the pro-am association GEOS in which we participate to the GRRS, observing programme targets, process the images and finally report.

The GEOS database is a product of GRRS where to find a target according to your wishes and equipment. This is also a place to store and then find O-C values for many RR Lyrae stars. Jean-François Le Borgne is the manager of the site and PI of GRRS. See <http://rr-lyr.irap.omp.eu/dbrr/index.php>

One of the aim of GRRS is to find and to study RR Lyr stars with unknown Blazhko effect. One of the results we obtained recently on AX Cen is a suspicion of the presence of an effect called “period doubling” which appears as the alternation of high and low maxima. This is a phenomenon which has been first observed on the star RR Lyr itself by the space telescope Kepler. It is difficult to observe from ground because of the period of the RR Lyrae stars being close to half a day.

The goal of the collaboration would be to achieve coordinated observations, between west and east Pacific in order to compare the amplitude of successive maxima, which needs observing sites at very different longitudes.



We are aware of the challenge of such a project because comparing observations from different equipment is not straightforward. We shall need an observation protocol and a specific calibration procedure. We shall start with AX Cen and another star with no modulation for comparison, but the project might be extended to other stars if this first tentative results positive.

We are confident that we can achieve this goal, at least partially. This is the challenge.

Of course we will share all aspects of the project.

Phil Evans has co-authored one new journal article, one new arXiv article, had two arXiv articles updated to journals and contributed to three data sets for a VizieR Online Data Catalog.

Noguer, Federico R et al. *Enhancing Exoplanet Ephemerides by Leveraging Professional and Citizen Science Data: A Test Case with WASP-77 A b* (2024-07-19) bibcode: 2024PASP..136f4401N

Abstract.

We present an updated ephemeris, and physical parameters, for the exoplanet WASP-77 A b. In this effort, we combine 64 ground- and space-based transit observations, 6 space-based eclipse observations, and 32 radial velocity observations to produce this target's most precise orbital solution to date aiding in the planning of James Webb Space Telescope and Ariel observations and atmospheric studies. We report a new orbital period of $1.360029395 \pm 5.7 \times 10^{-8}$ days, a new mid-transit time of $2459957.337860 \pm 4.3 \times 10^{-5}$ Barycentric Julian Date in the Barycentric Dynamical Timescale (BJDTDB) and a new mid-eclipse time of $2459956.658192 \pm 6.7 \times 10^{-5}$ BJDTDB. Furthermore, the methods presented in this study reduce the uncertainties in the planet's mass $1.6654 \pm 4.5 \times 10^{-3} M_{\text{Jup}}$ and orbital period $1.360029395 \pm 5.7 \times 10^{-8}$ days by factors of 15.1 and 10.9, respectively. Through a joint fit analysis comparison of transit data taken by space-based and citizen science-led initiatives, our study demonstrates the power of including data collected by citizen scientists compared to a fit of the space-based data alone. Additionally, by including a vast array of citizen science data from ExoClock, Exoplanet Transit Database, and Exoplanet Watch, we can increase our observational baseline and thus acquire better constraints on the forward propagation of our ephemeris than what is achievable with Transiting Exoplanet Survey Satellite data alone.

Christian, Sam, et al. *Wide Binary Orbits are Preferentially Aligned with the Orbits of Small Planets, but Probably Not Hot Jupiters* (2024-07-19). arXiv: 2405.10379.

Abstract

Studying the relative orientations of the orbits of exoplanets and wide-orbiting binary companions (semimajor axis greater than 100 AU) can shed light on how planets form and evolve in binary systems. Previous observations by multiple groups discovered a possible alignment between the orbits of visual binaries and the exoplanets that reside in them. In this study, using data from \textit{Gaia} DR3 and TESS, we confirm the existence of an alignment between the orbits of small planets ($R < 6R_{\oplus}$) and binary systems with semimajor axes below 700 AU ($p=10^{-6}$). However, we find no statistical evidence for alignment between planet and binary orbits for binary semimajor axes greater than 700 AU, and no evidence for alignment of large, closely-orbiting planets (mostly hot Jupiters) and binaries at any separation. The lack of orbital alignment between our large planet sample and their binary companions appears significantly different from our small planet sample, even taking into account selection effects. Therefore, we conclude that any alignment between wide-binaries and our sample of large planets (predominantly hot Jupiters) is probably not as strong as what we observe for small planets in binaries with semimajor axes less than 700 AU. The difference in the alignment distribution of hot Jupiters and smaller planets may be attributed to the unique evolutionary mechanisms occurring in systems that form hot Jupiters, including potentially destabilizing secular resonances that onset as the protoplanetary disk dissipates and high-eccentricity migration occurring after the disk is gone.

The following previously published arXiv articles have been updated to journal publications:

Hord, Benjamin J. et al. *Identification of the Top TESS Objects of Interest for Atmospheric Characterization of Transiting Exoplanets with JWST* (2024-07-19)

- o bibcode: 2024AJ....167..233H
- o doi: 10.3847/1538-3881/ad3068
- o arxiv: 2308.09617

Schulte, Jack et al. *Migration and Evolution of giant ExoPlanets (MEEP). I. Nine Newly Confirmed Hot Jupiters from the TESS Mission* (2024-07-19)

- o bibcode: 2024AJ....168...32S
 - o doi: 10.3847/1538-3881/ad4a57
 - o arxiv: 2401.05923
-

Contributions from previously published papers have been added to Vizier Online Catalog:

- Vizier Online Data Catalog: *Best-in-class TOIs for atmospheric characterisation* (Hord+, 2024) (2024-07-19)
 - bibcode: 2024yCat..51670233H
- Vizier Online Data Catalog: *FEROS spectra for 3 giants exoplanets* (Eberhardt+, 2023) (2024-07-19)
 - bibcode: 2024yCat..51660271E
- Vizier Online Data Catalog: *TOI-1994 radial velocities with MINERVA & CHIRON* (Page+, 2024) (2024-07-19)
 - bibcode: 2024yCat..51670109P

About

Variable Stars South is an international association of astronomers, mainly amateur, interested in researching the rich and under-explored myriad of southern variable stars.

Renamed from the Variable Star Section of the Royal Astronomical Society of New Zealand, it was founded in 1927 by the late Dr Frank Bateson, OBE, and became the recognised centre for Southern Hemisphere variable star research.

VSS covers many areas and techniques of variable star research, organised into projects such as Beginners' Visual Observations and Dual-Maxima Miras. The goal of each project is to obtain scientifically useful data and results. These may be published in recognised journals, or supplied to international specialist data collection organisations.

VSS is entirely an internet based organisation, working through our website <http://www.VariableStars-South.org> and its e-group <http://groups.google.com/group/vss-members>. It also encourages members to work in with major international organisations such as the British Astronomical Association, the Center for Backyard Astrophysics and the American Association for Variable Star Observers.

To find out more, please visit our website, where, incidentally, you will find PDF copies of all our newsletters. Our website has a great deal of information for VSS members, and for anyone interested in southern hemisphere variable star research. All VSS project information and data is kept here too.

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After you've joined and received your membership certificate, you will be signed up to the VSS-members egroup (see above), and you will also receive a password to access the members' areas of our website.

Newsletter items

These are welcomed and should be sent to the Editor (phil@astrofizz.com). I'd prefer Microsoft Word (or compatible) files with graphics sent separately. Don't use elaborate formatting or fancy fonts and please do not send your contribution as a fully formatted PDF file.

Publication dates are January, April, July and October, nominally on the twentieth day of these months and the copy deadline is the thirteenth of the month though earlier would always be appreciated.

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