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RECOVERY OF W Dor & SS Pav

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Abstract: Innes (1921) reported a list of 11 stars as being variable. A careful examination of the material presented by Innes in his paper, in its entirety, allows me to draw some conclusions about the quality of certain plates used. Two variables, W Dor and SS Pav, which have been hitherto unidentifiable, can now be identified.

Introduction.

Innes (1921) reported the results of blinking pairs of plates taken at least 20 years apart. He was looking for stars with significant proper motion on plates taken at the observatory of Melbourne, Victoria, Australia. All first-epoch plates were taken between 1894 and 1898, and second-epoch ("new") plates between 1918 and 1919. All work focused on the -66° zone, from the Astrographic Catalogue, allotted to Melbourne Observatory. Proper motion and positional work were the main activities at Union Observatory, South Africa. Discovery of variables was an incidental result, a byproduct of the main program. The variables found by Innes were detected when blinking one or two pairs of plates. However, his published positions are approximate, RAs being accurate to only ±0.2m and Declinations to ± 1', normally. At least two stars in Innes' list have never been identified with certainty. The present paper examines Innes' work in *Circ. 53 of Union Obs.* closely, and resolves some long-standing issues.

Quality of Melbourne Plates.

The Union Observatory was set up in 1905 (Morel and Di Scala 2007) for meteorological research. It branched into proper motion studies in 1912, using plate material from other institutions, Cape, Sydney and Melbourne in particular. I made a request to the Museum of Victoria to peruse the record books and correspondence from the time (up to 1920) between Innes and J. M. Baldwin, Director of Melbourne Obs. Innes complimented the Melbourne staff on the excellent quality of their sky photographs (Gillespie 2008). Innes must have been referring to photographs taken before 1918, and at periods when the Melbourne sky was not tainted with smoke from wildfires (called bushfires in Australia). Remarks made by Innes about many 2nd-epoch plates tell a somewhat different story. He records many remarks about the poor quality of certain plates, but these remarks are widely scattered. In Table 1, I list the plates flagged by him as of inferior image quality.

Table 1. Second-Epoch Plates from Melbourne Observatory. -66° Zone.

Exposure Date	Plate No.	R.A. (1875)	Blink Interval	Quality (from UOC53).
1918 Oct. 2	4125	01h12m	22.9 years	Poor plate
1918 Oct. 2	4126	01 48	20.9	Poor plate, limit ~11mag
1919 Jan. 31	4142	04 30	22.1	Images poor; very faint
1919 Jan. 31	4143	05 06	20.3	Images too poor/too faint
1919 Jan. 31	4144	05 42	22.0	Very poor images
1919 Jan. 31	4145	06 18	23.0	
1919 Jan. 31	4146	06 54	23.9	Images too poor
1919 Feb. 4	4150	07 12	22.0	Plate v. poor in stars. Very faint
1919 Mar. 1	4153	07 30	23.0	
1919 Mar. 1	4154	08 06	23.9	Images very faint.
1919 Mar. 1	4155	08 42	25.0	
1919 Mar. 2	4156	07 48	23.9	(Stars) almost invisible
1919 Mar. 24	4157	08 24	20.1	
1919 Mar. 24	4158	09 00	20.1	
1919 Mar. 24	4159	09 36	25.0	
1919 Mar. 24	4160	10 12	25.0	
1919 Mar. 24	4161	10 48	21.9	
1919 Mar. 29	4162	09 18	24.0	Poor plate
1919 Mar. 29	4163	09 54	25.05	Poor plate
1919 Mar. 29	4164	10 30	24.0	
1919 Mar. 29	4165	11 06	22.95	Poor plate (images too poor)

These plates are all second-epoch. First-epoch plates all date from the 1890s and none of them attracted adverse comments such as we see above. Plates with quality problems are confined to the time period 1918 Oct. 2 to 1919 Mar. 29, bracketing bad bushfire events in 1919.

Correlation with Victorian Bushfires of Jan. - Feb. 1919.

Wildfires (known in Australia as bushfires) occur frequently in the eucalypt forests of southeast Australia, including the state of Victoria. Particularly intense and catastrophic fires are known from the following years, with the date of highest intensity (Romsey Australia, 2009):

1851 Feb. 6
1898 Feb. 1
1905 Dec. 1
1913 Jan. 1
1919 Feb. 1 Otway Ranges
1919 Nov. 11 Grampians
1923 Jan. 1
1926 Feb. 1

The majority of bushfires occur in the hot, dry summer months, December to March, and can persist for many weeks. The date of maximum intensity may not have been easy to determine in historical times. The period 1851 to 1898 appears to have been one of low bushfire activity, and hence rather favourable for astrophotography, as little or no bushfire smoke was put into the atmosphere, attested to by the good quality of the first-epoch plates used by Innes. However, summer 1918/19 was marked by major bushfires. A fire in the Otway Ranges (southwest of Melbourne) reached maximum intensity around 1919 Feb. 1. At least 6 second-epoch plates, exposed from Jan. 31-Feb. 4 coincided very closely with this event, and most exposures turned out to be of poor quality. One can be fairly certain that bushfire smoke in skies over Melbourne, swept in from the southwest by prevailing winds, were responsible for the poor seeing.

Archival Observations of W Doradus.

Table 2. Original observations of W Dor (Innes,1921).

Date	Plate No.	Mag. (ptg)	Quality of Plate
1897 Jan. 29	1639	13	Satisfactory
1897 Dec. 26	1764	13	Satisfactory
1918 Dec. 11	4141	13	Satisfactory
1919 Jan. 31	4144	invisible	Poor images

W Dor lay in the overlap region of two pairs of blinked plates - 1639/4144 and 1764/4141. Though the estimates by Innes are only rough, he found the object seemingly constant on three plates. The final plate failed to show it at all, but it has been shown that this plate, among others, was exposed on a night of poor seeing. An examination of DSS blue and red plates reveals an object, GSC 8891-1606 (nonstar), lying just 30" north of Innes' nominal position. This is the most likely candidate within 60" of the nominal position. GSC 8891-1606 is not in UCAC2 or 2MASS; it is actually a triple, with a close companion preceding, and another closely following the central star, which I call star "A". See Fig. 1. On DSS blue plate, the GSC 8891-1606 triple shows up very strongly, much as it would have on the photoblue plates used by Innes. On DSS red plate however, star A of the triple shows up relatively faint, compared to star "B", the following component. This suggests that star A is a blue star, possibly a supergiant member of the LMC, though it is not listed in any catalogues of LMC supergiants.

Atmospheric smoke is well-known as an attenuating factor, as it preferentially aborbs shorter optical wavelengths. I would surmise that on 1919 Jan. 31 the limiting magnitude of the (blue) plates would be significantly limited, and W Dor would therefore be rendered "invisible". I estimate the combined magnitude of W Dor and its attendants as 13.9B. It is also possible that W Dor is a small, compact star cluster. A search of the literature however fails to turn up any reference to a star cluster at this position.

Adopted positions : W Dor = GSC 8891-1606 : (2000) 05h30m24.79s -66°38'21.5" GSC2.2 (Star A).
05 30 24.90 -66 38 21.4 GSC2.2 (Star B).

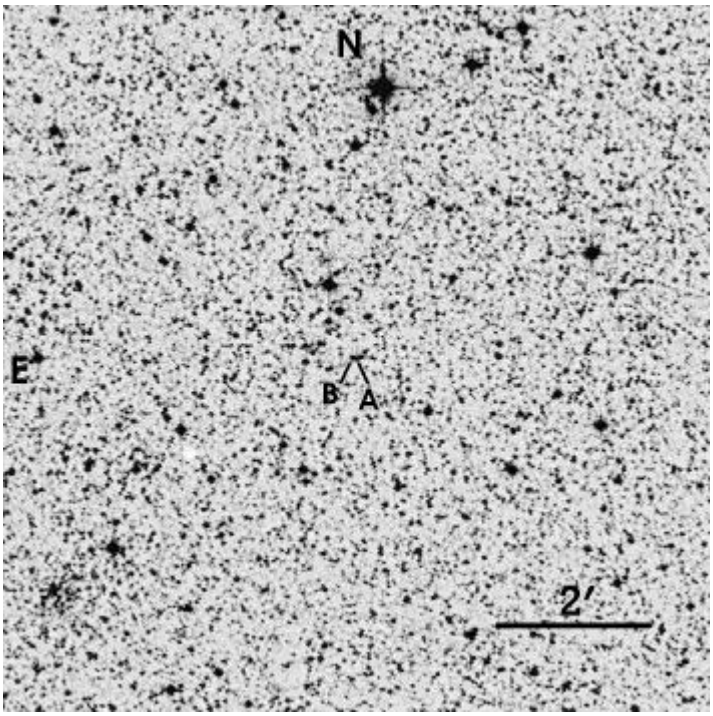

Fig. 1. Field of W Doradus. Star A is the central star in a tight group of three stars, identified as W Dor. From a blue plate of the "Southern Sky Survey", © 1993-95 by the Anglo- Australian Observatory Board.

SS Pav = NSV 11787?

The position of SS Pav, according to Innes (1921), is (1875) 19h0.8m -66° 3'. Inspection of DSS prints (blue and red) shows no star at this position, merely an empty field. It was determined by the writer that SS Pav lay in the overlap region of two pairs of blinked plates : 1888/4106 centred at 18h54m -66.0°, and 1577/4115 centred at 19h12m -66.0°. Working on the assumption that the published position contained an error, the writer then confined the search to a strip between 18h57.5m and 19h03m, -65°10' to -67°00', looking for a close pair of stars matching Innes' description. Just 30' south, and very slightly east, lies NSV 11787 = BV 1295, range 12.7-13.4p, type unknown. Given the roughness of Innes' magnitudes, the ranges of SS Pav and NSV 11787 are not dissimilar. A field star is offset from NSV 11787, similar to that quoted by Innes. This star is GSC 9083-0118, B =12.6, taken from USNO-A2.0. It appears that Innes has greatly overestimated its brightness (10½). Probably as a consequence his estimate of 1898 July 13 is badly skewed. Position of GSC 9083-0118 : (2000) 19h13m26.90s -66°20'48.6" UCAC2. The original observations of SS Pav (Innes, 1921) in Table 3.

Table 3. Original observations of SS Pav (Innes,1921).

Date	Plate No.	Mag. (ptg)	Quality of Plate
1896 Sep. 2	1577	13	Satisfactory
1898 Jul. 13	1888	10.6	Satisfactory
1918 Sep. 10	4106	14½	Satisfactory
1918 Sep. 11	4115	12½	Satisfactory

[A 10½ mag star is 1' N. N.f. (Innes, 1921).]

The accepted position of SS Pav (Innes, 1921) undoubtedly contains a typographical error. Other pieces of data point to a single identity, SS Pav = NSV 11787, at (2000) 19h13m25.54s -66°21'29.7" UCAC2. The ASAS-3 lightcurve indicates a rapidly varying star, range 12.45-13.6V.

Astrometric Positions of Innes' Variables.

In the course of this work, all of Innes' variables were examined, and astrometric positions determined. Only in the case of W Dor and SS Pav is there significant improvement on positions given in GCVS (Kholopov, 1985). See Table 4.

Table 4. Astrometric Positions for 11 variables (Innes, 1921).

No.	RA (2000)	DEC (2000)	Source	GCVS Name	Type	Note
	h m s	° ' "				
1.	04 57 45.05	-65 42 30.1	U	V Dor	DCEP	a
2.	05 30 24.90	-66 38 21.4	G2	W Dor		b
3.	06 57 47.94	-67 07 25.8	T2	T Vol	M	
4.	07 00 22.80	-66 13 00.7	T2	U Vol		
5.	07 42 52.55	-66 05 56.2	U	V Vol	M	
6.	09 47 55.56	-67 27 06.9	U	CM Car	M	
7.	19 13 25.54	-66 21 29.7	U	SS Pav		c
8.	21 04 03.16	-65 15 23.4	A2	ST Pav		d
9.	22 49 48.76	-64 59 30.5	U	X Tuc		e
10.	23 17 17.86	-64 16 42.4	U	Y Tuc	M	
11.	23 57 26.34	-65 23 04.9	U	R Tuc	M	

Catalogue Codes: A2 = USNO-A2.0; G2 = GSC2.2; T2 = Tycho-2; U = UCAC2

Notes: a : LMC member. b : Close triple; position refers to middle star.
c : Apparent error of +30' in Dec.; matches with NSV 11787.
d : Declination off by +1.3'. Double. e: Close companion to south, d = 8".

Summary:

The claimed variability of W Dor rests on one plate, exposed 1919 Jan. 31. However, Innes' own notes show that this night had poor seeing, most likely due to bushfire smoke. My suggested identification is a blue star in a triple, and likely to be very sensitive to poor seeing due to atmospheric smoke. Variability is spurious.

SS Pav is undoubtedly the same as NSV 11787. Their magnitude ranges are consistent with each other, and it seems likely that the declination given by Innes was in error by +30'. It appears to vary rapidly.

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