PHOTOELECTRIC PHOTOMETRY WITH A COMMERCIALLY AVAILABLE SOLID-STATE PHOTOMETER

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Abstract

A commercially available photometer and visual filter has been used to measure pairs of stars in the Arizona-Tonantzintla catalog. Differential magnitudes are compared to the catalog values to determine the transformation to V of the UBV system.

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Considerable interest has been expressed by AAVSO members and others in the solid-state photometer offered by DOAA Enterprises (now known as OPTEC). Basically, the design is a solid-state silicon diode detector of the type described by Johnson (1977).

For the last year or so I have been making photoelectric observations with a DOAA photometer using my Celestron 8 and an HP strip-chart recorder. Howard Landis suggested that I get an idea of its performance by measuring differentially pairs of stars in the Arizona-Tonantzintla catalog in an effort to compare differential magnitudes with differences derived from the catalog values. I chose pairs of stars of differing spectral types and reasonably close together in the sky, and observed on clear nights when the stars were fairly close to the meridian. My procedure was to measure the two stars in each pair sequentially (i.e., 1,2,1,2,.....), getting at least six traces of each star during each night.

Differential instrumental visual magnitudes, Δv, in the sense of star 1 minus star 2, were computed with the simple equation:

$$\Delta v = -2.5\log_{10}(L_1/L_2),$$

where L_1 and L_2 are the net (i.e., sky background substracted) light readings adjusted for amplifier gain selection. The correction for differential atmospheric extinction was small so none was applied. Each Δv value is uncertain by about ± 0.01. These are entered in the table alongside the corresponding magnitude difference, ΔV, derived from the values of V in the Arizona-Tonantzintla catalog.

An instructive way to discuss these results is to use them to derive the transformation coefficient, ε, defined by the equation:

$$\varepsilon = \frac{\Delta V - \Delta v}{\Delta (B-V)} \quad ,$$

where Δ is again in the sense star 1 minus star 2, and B-V color indices are taken from the Arizona-Tonantzintla catalog.

The values of ε derived from each pair were averaged, giving higher weight to those with large Δ(B-V) differences. The result was $\varepsilon = -0.01$. The fact that this value is so small shows that the DOAA photometer with the visual filter provided can yield magnitudes quite close to V of the standard UBV system. The particular value $\varepsilon = -0.01$, however, is applicable only to my particular telescope-photometer-filter combination. Other observers should independently

determine the value of ε appropriate for their systems. All measures were made using the visual filter supplied by the manufacturer and described as an interference filter with a Gaussian curve, a center wavelength of 540 nm, a transmission of 60% at peak, and a bandwidth of 50 nm.

B.S.	STAR PAIRS	SPEC.	V(Ariz)	B-V(Ariz)	1978 DATE	ΔV	Δv
7420	ι Cyg (1)	A5	3.79	0.14	Nov.3-4	+0.92	+0.90
7528	δ Cyg (2)	B9.5	2.87	-0.02			
165	δ And (1)	K3	3.30	1.30	Nov.3-4	-1.09	-1.08
163	ε And (2)	G8	4.39	0.87			
21	β Cas (1)	F2	2.28	0.34	Nov.9-10	-2.46	-2.45
123	λ Cas (2)	B8	4.74	-0.10			
834	η Per (1)	K3	3.79	1.69	Nov.9-10	-0.95	-0.93
123	λ Cas (2)	B8	4.74	-0.10			
799	θ Per (1)	F7	4.13	0.49	Nov.9-10	-0.61	-0.63
123	λ Cas (2)	B8	4.74	-0.10			
834	η Per (1)	K3	3.79	1.69	Nov.9-10	-0.34	-0.29
799	θ Per (2)	F7	4.13	0.49			
8162	α Cep (1)	A7	2.47	0.21	Nov.10-11	-0.76	-0.77
8238	β Cep (2)	B2	3.23	-0.21			

In addition to the stars in the table, Landis and I measured differentially Upsilon Piscium (A3) and Beta Andromedae (MO). Landis used his 1P21 photomultiplier and visual filter, a combination for which he knows his value of ε is zero to within ± 0.01. The intention was to compare the 1P21 with the solid state equipment on a pair of stars widely differing in color. The results were

McFaul (solid state) $\Delta v = 2^{m}.70$

Landis (1P21 PMT) $\Delta v = 2^{m}.69$

where Δ is in the sense Upsilon Piscium minus Beta Andromedae.

With the Celestron 8 and the DOAA visual filter, measures yielding deflections of at least one-quarter full scale can be made down to about $8^{m}.0$. Somewhat fainter stars can be measured by adjusting the input voltage selector of the chart recorder to a lower value to obtain greater scale. Measures down to about $10^{m}.0$ can be taken without the filter--useful for asteroid light curves, times of minimum for eclipsing binaries, etc., wherever standard UBV magnitudes are not necessary.

At the present time, OPTEC designer and builder Jerry Persha is working on a filter with significantly higher transmission. This is a good idea since the V band pass in the UBV system traditionally has a much broader halfwidth and does not need to be defined with an interference filter. With the new filter a gain of about $1^{m}.0$ is expected.

Current projects using this equipment include observing a number of program stars in Dr. Douglas Hall's RS CVn project.

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