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V AND UV PHOTOMETRY OF HD 159176

HD 159176 is a bright ($< V > = +5\overset{m}{.}70$), early (O6 V + O6 V), non-eclipsing binary in the center of the open galactic cluster NGC 6383. Thomas (1975) reported an ellipsoidal variability in the V bandpass and in this contribution we communicate that photometry supplemented by optical and UV data derived from a number of spectral images secured by the International Ultraviolet Explorer (*IUE*).

Table I: V differential photometry of HD 159176

1975	UT	ΔV	s.d.	N	Phase
March	15.367	−1.568	0.004	11	0.244
	16.390	−1.543	0.003	16	0.548
	19.395	−1.539	0.003	11	0.441
	20.328	−1.558	0.003	15	0.718
	21.332	−1.534	0.004	8	0.016
	22.340	−1.563	0.004	7	0.315
	23.293	−1.556	0.003	19	0.590
	24.322	−1.541	0.004	8	0.904
	26.363	−1.547	0.002	15	0.510
	27.243	−1.562	0.004	20	0.772
	29.337	−1.551	0.002	18	0.394
	31.325	−1.534	0.003	16	0.984
April	01.293	−1.557	0.003	16	0.272
	02.297	−1.553	0.003	20	0.570

The Thomas (1975) differential photoelectric photometry, with HD 158859 ($V = +7\overset{m}{.}20$) used as a comparison star, is listed in Table I. N is the number of magnitude differences that were averaged to obtain each tabulated magnitude difference, and *s.d.* is their standard deviation. The photometry used the V filter of the UBV system and a 1P21 photomultiplier tube. The magnitudes were derived from capacitor charge integrations displayed on strip chart paper, acquired with the Lowell 0.6 meter telescope at the Cerro Tololo Inter-American Observatory. A second comparison star provided a check on the possible variability on HD 159176. Each tabulated magnitude difference in Table I (HD 159176 minus HD 158859) represents an observing time interval of about 20 minutes. Corrections for extinction did not enter into the calculations. Offset by $+20\overset{m}{.}68$ in the ordinate in order to bring it on scale, this photometry appears as triangles in Figure 1, revealing an ellipsoidal variation with an amplitude of about $0\overset{m}{.}05$.

Table II: V magnitudes and UV data from *IUE* images

Image *SWP*	Phase	1270Å–1350Å ($\times 10^{-10}$)	1420Å–1480Å ($\times 10^{-10}$)	1650Å–1850Å ($\times 10^{-10}$)	FES m_V
45704	0.0467	3.366	2.591	1.801	+5.76
45705	0.0539	3.388	2.608	1.811	+5.77
45708	0.0796	3.379	2.609	1.810	+5.76
45709	0.0880	3.403	2.628	1.810	+5.72
45711	0.1205	3.357	2.599	1.795	+5.77
45712	0.1288	3.423	2.623	1.812	+5.71
45715	0.1535	3.415	2.621	1.809	+5.75
45716	0.1616	3.315	2.558	1.794	+5.77
45719	0.1859	3.421	2.639	1.823	+5.74
45720	0.1937	3.451	2.665	1.857	+5.75
45723	0.2190	3.463	2.672	1.849	+5.73
45724	0.2268	3.478	2.701	1.866	+5.73
45727	0.2521	3.444	2.674	1.848	+5.73
45729	0.2757	3.486	2.693	1.855	+5.75
45731	0.2947	3.489	2.678	1.857	+5.78
45733	0.3203	3.476	2.695	1.849	+5.77
45735	0.3378	3.463	2.656	1.841	+5.78
45794	0.4220	3.233	2.522	1.750	+5.75
45795	0.4294	3.293	2.542	1.768	+5.78
45746	0.6247	3.402	2.591	1.802	+5.76
45748	0.6429	3.423	2.638	1.827	+5.74
45680	0.6826	3.400	2.639	1.817	+5.72
45683	0.7173	3.481	2.675	1.846	+5.73
45686	0.7503	3.512	2.684	1.856	+5.73
45687	0.7574	3.519	2.696	1.861	+5.75
45693	0.9003	3.340	2.570	1.761	+5.76
45694	0.9086	3.383	2.600	1.802	+5.76
45697	0.9333	3.422	2.612	1.811	+5.75
45698	0.9410	3.408	2.610	1.815	+5.72
45701	0.9639	3.376	2.609	1.806	+5.77

Column 1 of Table II lists the image numbers of 30 *IUE* spectra that were secured during three consecutive periods of the binary. These high resolution images were obtained by the *SWP* (Short Wavelength Primary) camera aboard the spacecraft through the large aperture. Phases for the photometry data in the present paper were calculated from the following constant–period ephemeris kindly provided by R. H. Koch:

$$\text{Pri.Min.} = \text{HJD}\, 2,448,886.263 + 3^{\text{d}}.366764 \times \text{E},$$

which is consistent with the optical photometry of Thomas and the accurate radial velocity solution of Stickland et al. (1992) based on the IUE material.

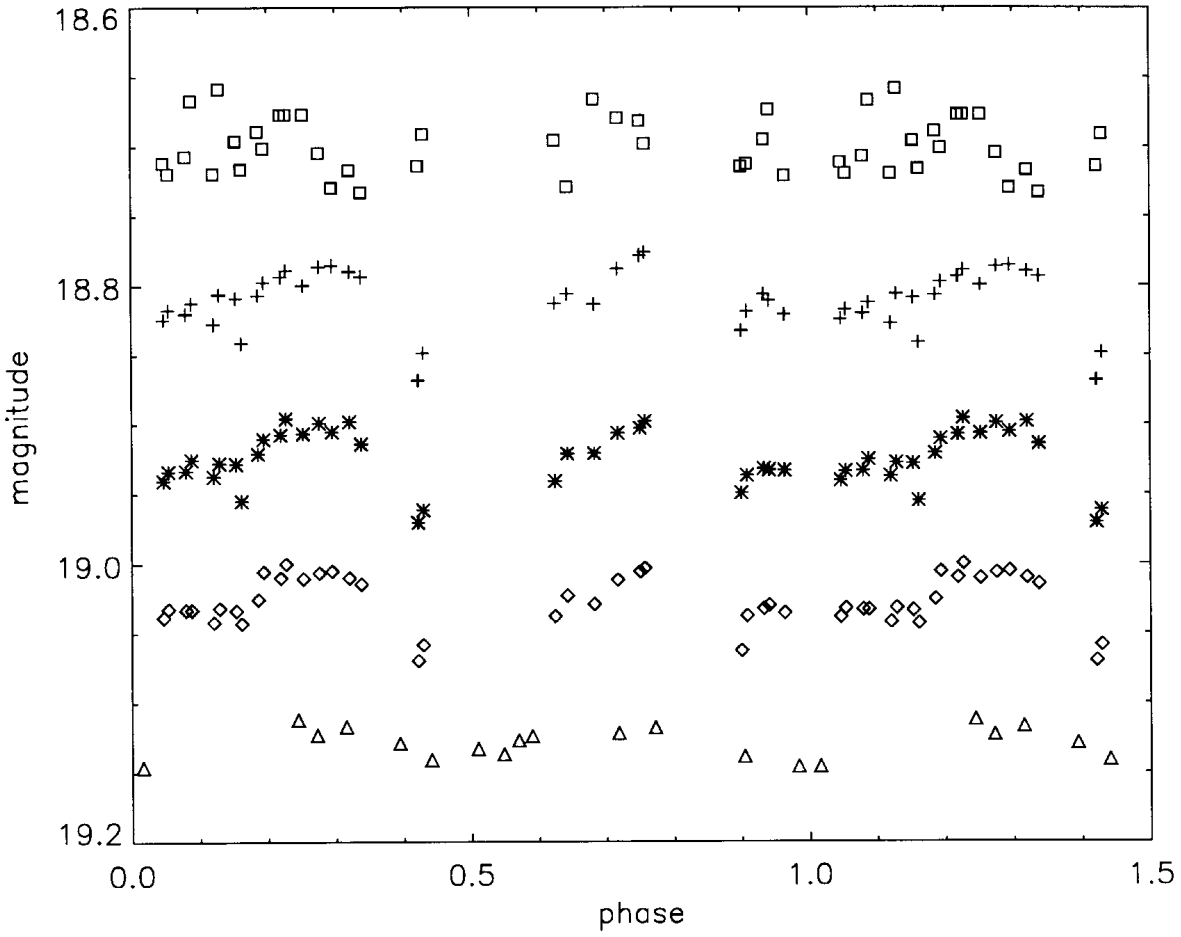

Figure 1

UV light curves were derived from the *IUE* spectral images in the following way. A square filter [1270Å–1350Å] applied on a given spectral image integrated all flux between 1270Å and 1350Å *ie*, filter transmittance is 100% within the bandpass and zero outside). This integrated flux was then divided by the bandwidth (in this case 80Å) to yield average monochromatic flux (in units of MFU) over that bandpass. These measures are listed in column 3, Table II. Two additional data sets, derived in the [1420Å–1480Å] and [1650Å–1850Å] bandpasses, are also listed in Table II. This UV photometry was restricted to the 30 most recent large-aperture, high-dispersion SWP spectral images, since the other archival images were obtained through the small aperture, or span a different (LWP) spectral region, or are of low resolution.

UV magnitudes in each bandpass were computed from the listed fluxes by first multiplying by the bandwidth (yielding fluxes in FU), and then calculating $m_{UV} = -2.5 \cdot log(flux)$. The light curves so computed are displayed in Figure 1, displaced in the ordinate scale by the following quantities to bring them on scale:

crosses: [1270Å–1350Å], by $-0\overset{m}{.}10$

stars: [1420Å–1480Å], by $-0\overset{m}{.}58$

diamonds: [1650Å–1850Å], by $+0\overset{m}{.}43$.

None of the three bandpasses is contaminated by wind lines and the estimated accuracy of the measures is better than $\pm\ 0\overset{m}{.}01$.

All three UV light curves are remarkably similar, even though they span almost 600Å. The ellipsoidal variability evidenced in the optical light curve is also present in all three UV data sets at a level of $0^{m}.05$ to $0^{m}.08$, depending on the significance attributed to the two fainter measures near phase 0.42 and to the one near phase 0.9.

The Fine Error Sensor (*FES*) is an optical sensor aboard the *IUE* spacecraft intended for target acquisition rather than photometry. Nevertheless, each *IUE* image is supplemented with "*FES* counts" from the source which were converted to the V magnitudes listed in Table II, column 6, using *IUE* Data Analysis Center (*IUEDAC*) software. This *FES*-derived photometry, displaced by $+12^{m}.95$ in the ordinate scale, is displayed in Figure 1 by squares. The errors, commonly claimed to be $\pm\ 0^{m}.10$, clearly hide the ellipsoidal variability revealed in the Thomas data and in the UV light curves.

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