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Photographic measures of double stars made on plates taken with the 40-inch refractor of the Yerkes Observatory

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Citation

Wesselink, A. J. (1941). Photographic measures of double stars made on plates taken with the 40-inch refractor of the Yerkes Observatory. *Bulletin Of The Astronomical Institutes Of The Netherlands*, 9, 223. Retrieved from <https://hdl.handle.net/1887/6292>

Version: Not Applicable (or Unknown)

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Note: To cite this publication please use the final published version (if applicable).

TABLE 4 (concluded).

J. D. Hel. M.A.T. Grw. — 2420000	phase	magni- tude	J. D. Hel. M.A.T. Grw. — 2420000	phase	magni- tude	J. D. Hel. M.A.T. Grw. — 2420000	phase	magni- tude	J. D. Hel. M.A.T. Grw. — 2420000	phase	magni- tude
plate 5390											
9880 ^d 40973	P	+ '05	9880 ^d 44298	P	+ '24	9880 ^d 46791	P	+ '01	9929 ^d 28799	P	+ '47
41112	'8425	+ '08	44436	'3870	+ '07	46929	'7955	+ '10	28938	'6203	— '43
41250	'8651	+ '18	44575	'4098	+ '18	47068	'8182	+ '02	29076	'6429	— '36
41389	'8878	+ '19	44713	'4324	+ '02				29215	'6657	— '28
41527	'9105	+ '28	44852	'4552	— '14	plate 5434			29353	'6883	— '22
41666	'9332	+ '26	44990	'4778	— '27	9929 ^d 26929	'2911	+ '27	29492	'7110	— '15
			45129	'5006	— '39	27068	'3139	+ '31	29630	'7336	— '08
plate 5391			45267	'5232	— '45	27276	'3480	+ '26	29769	'7564	— '07
9880 ^d 42912	'1374	+ '24	45406	'5460	— '45	27414	'3706	+ '15	29907	'7790	— '02
43051	'1601	+ '26	45544	'5686	— '42	27553	'3934	+ '19	30046	'8018	+ '01
43189	'1827	+ '26	45683	'5913	— '29	27691	'4160	— '01	30184	'8244	+ '14
43328	'2055	+ '29	45821	'6139	— '40	27830	'4388	— '08	30323	'8472	+ '14
43466	'2281	+ '34	45960	'6367	— '28	27968	'4614	— '23	30461	'8698	+ '12
43605	'2509	+ '31	46098	'6593	— '27	28107	'4841	— '30	30600	'8926	+ '15
43743	'2735	+ '26	46237	'6821	— '20	28245	'5067	— '54	30738	'9152	+ '24
43882	'2963	+ '26	46375	'7047	— '10	28384	'5295	— '57	30877	'9379	+ '18
44020	'3189	+ '27	46514	'7275	+ '04	28522	'5521	— '56	31015	'9606	+ '23
44159	'3417	+ '30	46652	'7501	— '05	28661	'5749	— '49			

Photographic measures of double stars made on plates taken with the 40-inch refractor of the Yerkes Observatory, by *A. J. Wesselink*.

During my stay at the Yerkes Observatory from July 1938 to March 1939 I was, by kind permission of Dr. O. STRUVE, enabled to use the 40-inch telescope for the photography of some double stars.

Eastman Kodak I G, II G and III G Spectroscopic plates have been used in connection with a yellow filter. According to HERTZSPRUNG ¹⁾, the effective wavelength of these combinations of emulsions and filter is 5575 Å on the average. This value is practically independent of the colour of the star, so that a differential refraction due to a difference in colour between the components is negligible ²⁾.

The effective wavelength varies somewhat with the kind of plate used, but this does not affect our results.

The exposure times were only a few seconds. The observations were made very much in the way described by HERTZSPRUNG ³⁾.

The differences in magnitude between the components of the double stars which have been photographed are small so that no gratings were used for the elimination of a magnitude equation.

The properties of the 40-inch objective have been investigated by PHILIP FOX ¹⁾.

A least squares solution yields the following formula for the focal reading as a function of the wavelength:

$$r^{\text{mm}} = 643.31 - 139.708 l + 24.7234 l^2,$$

where $l = \frac{1}{\lambda - .2}$, λ expressed in μ , or

$$r^{\text{mm}} = 445.96 + 24.7234 \left(2.825 - \frac{1}{\lambda - .2} \right)^2.$$

The wavelength at which the focal length is minimum as found from the constant 2.825, is $\mu.554$.

We write the formula in the form

$$\frac{f - f_{\text{min}}}{f_{\text{min}}} = .0012 \left(2.825 - \frac{1}{\lambda - .2} \right)^2.$$

The constant .0012 is a measure of the extension of the secondary spectrum and may be compared with that found for other refractors. In fact HERTZSPRUNG ²⁾ finds for the 36-inch refractor of the Lick Observatory .0012, thus the same value. The wavelength of minimum focal length of the Lick refractor is $\mu.566$, so that the secondary spectra of the Lick and Yerkes refractors are very much alike.

¹⁾ B.A.N. No. 330 (1940).

²⁾ Compare E. HERTZSPRUNG, "Über photovisuelle Sterngrößen", *Zeitschrift für Wiss. Phot.* Bd. 30, Heft 3-6 (1931) and A. J. WESSELINK, B.A.N. No. 294 (1937).

³⁾ E. HERTZSPRUNG, *Publ. Ap. Obs. Potsdam*, No. 75 (1920). Compare also K. AA. STRAND, *Leiden Ann.* XVIII, 2.

¹⁾ *Ap. J.* 27, 249 (1908).

²⁾ B.A.N. No. 330 (1940).

The comparison between observation and calculation of the secondary spectrum is as follows:

λ	$\frac{1}{\lambda - .2}$	$r(O)$	$r(C)$	O-C
μ		mm	mm	mm
4340	4.274	496.6	497.8	- 1.2
4383	4.196	491.9	492.4	- .5
4540	3.937	477.8	476.5	+ 1.3
4710	3.690	465.4	464.4	+ 1.0
4862	3.494	457.9	457.0	+ .9
5184	3.141	448.8	448.4	+ .4
5283	3.046	447.3	447.2	+ .1
5490	2.865	445.5	446.0	- .5
5732	2.680	445.3	446.5	- 1.2
5893	2.569	446.4	447.6	- 1.2
6270	2.342	450.7	451.7	- 1.0
6800	2.083	461.6	459.6	+ 2.0

The normal scale value (temperature + 10° C, focal reading 101.0) is 10.6550"/mm on the Toepfer measuring machine used at present at the

Leiden Observatory. In this scale value the factor 1.000027 = 1 + k (refractive index of the air at Williams Bay) for the shortening by refraction in the zenith has been included. The generally unimportant rest of differential refraction in zenith distance has been accounted for by the formulae given by HERTZSPRUNG in *B.A.N.* No. 330, 116.

In units of .0001 "/mm the correction of the scale value for temperature is .42 per degree centigrade. For focal reading the correction is 5.5 per millimetre. The measurements and their reduction have been carried out in the same way as described by HERTZSPRUNG in *B.A.N.* No. 330. In particular the computation of the external weights has been the same.

The total number of settings made is 3674. The total weight of the present photographic measures is found to be 196900 $"^{-2}$ of which 96500 $"^{-2}$ belongs to $\Delta\alpha \cos \delta$ and 100400 $"^{-2}$ to $\Delta\delta$. In the accompanying table mean values are given for each of the fourteen double stars measured.

I am indebted to Mr. EBBIGHAUSEN and Mr. SULLIVAN for assisting me in taking the plates.

ADS	Σ	1938	$\Delta\alpha \cos \delta$	$\Delta\delta$.01/(m.e.) ²		ρ	p epoch	p 2000
					$\Delta\alpha \cos \delta$	$\Delta\delta$			
1723	232	.652	+ 6.053	+ 2.690	55	55	6.624	66.04	66.25
2091	300	.657	- 2.439	+ 1.945	62	87	3.112	308.57	309.24
2984	485	.720	- 14.816	+ 10.069	47	55	17.914	304.20	304.84
3853	666	.720	+ 2.940	+ .842	34	29	3.058	74.02	74.42
11500	2351	.572	- 1.806	+ 4.868	91	129	5.192	339.64	339.19
12145	2481	.572	- 2.399	- 3.697	110	70	4.407	212.98	212.56
13209	2611	.542	+ 2.382	+ 4.724	76	81	5.291	26.76	26.32
13553	2655	.542	+ .274	+ 6.190	47	38	6.196	2.53	2.22
14556	2742	.693	- 1.731	- 2.111	49	37	2.730	219.35	219.10
14878	2789	.616	+ 5.884	- 2.769	22	34	6.503	115.20	114.83
15060	2802	.693	+ .619	+ 3.759	69	132	3.809	9.35	9.10
16008	2917	.693	+ 4.405	+ 1.537	116	116	4.665	70.76	70.54
16291	2947	.726	+ 3.561	+ 1.924	98	81	4.047	61.62	61.33
17054	3042	.611	+ 5.167	+ .244	89	60	5.173	87.30	87.28

ERRATA.

B. A. N. No. 337: p. 177, note 2, for: E. HERTZSPRUNG, read: H. VAN GENT.
p. 182, last line, for: .4 ln 10, read: (.4 ln 10)⁻¹.