

NOTE ON THE CEPHEID VARIABLE SU CASSIOPEIAE¹

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A variation in the radial velocity of Boss 637, SU Cassiopeiae,² was found by Adams in the course of the regular spectroscopic work with the 60-inch reflector. The observations and measures were made without knowledge of the variations in light, as the star is not listed as variable in the *Preliminary General Catalogue*. The spectrograms on hand permit an inquiry into spectroscopic parallax, variation of velocity, and changes in spectral type, and the last may be compared with the analogous variations previously found from objective-prism plates. The material is discussed in the present note, which also includes some remarks on the variation in light.

The variability in brightness was detected in 1906 by Müller and Kempf³ from the discordances in measures for the *Potsdam Photometric Durchmusterung*. A special photometric study indicated a variation between magnitudes 5.93 and 6.26, with a period defined by the formula,

$$\text{Max.} = \text{J.D. } 2417287.30 + 1.9498 \cdot E, \quad \text{G.M.T.}$$

The visual light-curve was found to differ from that of typical Cepheids in its small amplitude and symmetrical form.

In 1906-1908 the star was observed photographically by J. A. Parkhurst,⁴ who also found the variation peculiarly small and nearly symmetrical with respect to maximum light. The elements by Müller and Kempf being unsatisfactory, the period 1^d9490 was substituted for the value above. From the photographic magnitudes at maximum and minimum, 6.52 and 6.99, respectively, Parkhurst derived a variation in color-index from 0.59 to 0.73. An objective-prism plate at phase 1^d28 gave a spectrum of F3, in

¹ *Contribution from the Mount Wilson Solar Observatory*, No. 145.

² $\alpha = 2^{\text{h}}43^{\text{m}}28^{\text{s}}9$, $\delta = +68^{\circ}28'27''$ (1900.0).

³ *Astronomische Nachrichten*, **173**, 307, 1907.

⁴ *Astrophysical Journal*, **28**, 279, 1908.

fair agreement with the color-index. Because of the star's faintness, the attempt to find a variation in radial velocity with the Bruce spectrograph and the 40-inch refractor was considered inconclusive, although the observed range was from -1 km to -16 km.

An examination of the light-curve by Shapley¹ has shown that the variation cannot be interpreted as the result of the rotation of a simple ellipsoidal body. The conclusion that the star is a Cepheid, notwithstanding the form and amplitude of its light-curve, is verified by the spectroscopic work described below.

Variations in spectral type from A8 to F5 were recorded in 1916 on plates made with the 10-inch photographic telescope at Mount Wilson.² The type of spectrum and the brightness of the spectral images (compared with those of neighboring stars) indicated that neither the formula by Müller and Kempf nor its modification by Parkhurst then represented the variation in light; but the epoch given by Müller and Kempf with an intermediate value of the period, 1^d.94935, was found sufficiently accurate for the work on spectral variation.

A new investigation of the period has now been made, employing (1) the observations made at the Potsdam and Yerkes observatories; (2) a redetermination of the magnitudes on the objective-prism plates of 1915 and 1916, and (3) a series of visual estimates on four nights in August 1917. The result has been checked with the observations of spectral type mentioned in the preceding paragraph, as well as those derived from the slit spectrograms, and with the observations of radial velocity given below. The variations in light, velocity, and spectrum are all relatively small and gradual, making high accuracy for the elements impossible. The following formula, however, gives satisfactory phases for all variations:

$$\text{Max.} = \text{J.D. } 2417287.10 + 1.9495 \cdot E, \quad \text{G.M.T.}$$

There is some evidence that the period is not constant.

The spectroscopic observations with the 60-inch telescope are given in Table I. The phases have been computed from the

¹ *Astronomische Nachrichten*, **194**, 357, 1913.

² *Mt. Wilson Contr.*, No. 124; *Astrophysical Journal*, **44**, 273, 1916.

preceding maximum of the light-curve. Describing the velocity-variations in terms of the orbital elements of a spectroscopic binary, the following results are obtained from a graphical solution:

Epoch of Max. Vel. of Approach = J.D. 2420197.65, G.M.T.

Period = 1^d.9495

$e = 0.0$

$K = 11.0$ km/sec.

$V_0 = -7.0$ km/sec.

$a \sin i = 295,000$ km

$\frac{m^3 \sin^3 i}{(m+m_1)^2} = 0.0003.$

The epoch of maximum negative velocity precedes the maximum of light by 0^d.05. The elements are entirely typical of Cepheid

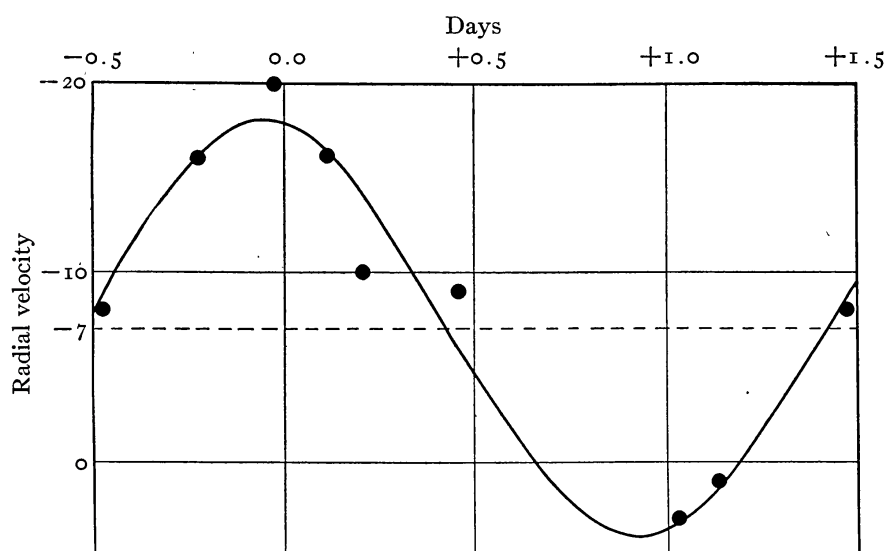


FIG 1.—Velocity-curve of SU Cassiopeiae

variables that have small ranges of velocity and nearly symmetrical velocity-curves. In Fig. 1 the observations are plotted along the computed velocity-curves. The average deviation is ± 1.5 km.

The spectral types determined by Adams from the spectrograms made with the 60-inch reflector are given in the last column of

Table I. The types derived by Shapley from the plates made with the 10-inch refractor are in Table II,¹ with phases based on

TABLE I
OBSERVATIONS WITH 60-INCH REFLECTOR

Plate	Date	J.D. and G.M.T.	Epoch	Phase	Velocity	Spectrum
					km	
7 2897....	1913 Nov. 16	2420088.745	1437	0 ^d 21	-10	F ₂
3072....	1914 Feb. 1	0165.692	1476	1.13	+1	F ₅
3171....	Mar. 5	0197.675	1492	1.93	-20	F ₀
3898....	Nov. 24	0461.915	1628	1.04	+3	F ₆
5116....	1916 Oct. 7	1144.943	1978	1.73	-16	F ₀
5239....	Nov. 9	1177.821	1995	1.47	-8:	F ₃
5311....	Dec. 7	1205.706	2010	0.12	-16	F ₂
6200....	1917 Sept. 6	1478.986	2150	0.47	-9	F ₄

the new elements. The variation of spectrum with magnitude is illustrated in Fig. 2.

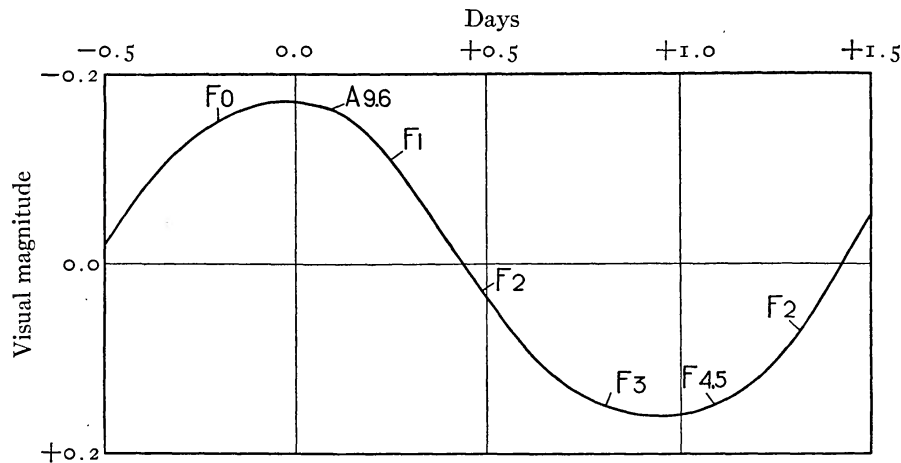


FIG. 2.—Variation of the spectral type of SU Cassiopeiae

The proper motion of SU Cassiopeiae is mainly parallactic, being 0".016 in position-angle 108°. The parallax, according to a

¹ *Mt. Wilson Contr.*, No. 124; *Astrophysical Journal*, 44, 273, 1916. Types marked as uncertain in the earlier paper are now omitted, and a typographical error is corrected. A new classification of all plates yielded but one correction; for the plate on Julian Day 2420841 the spectrum is F₃ instead of F₁.

recent determination by van Maanen,¹ is $+0''.010 \pm 0.003$; the spectroscopic parallax is in exact agreement if the visual magnitude

TABLE II
OBSERVATIONS WITH 10-INCH REFRACTOR

J.D. and G.M.T.	Epoch	Phase	Spectrum	J.D. and G.M.T.	Epoch	Phase	Spectrum
2420841.836...	1823	0 ^d 80	F3	2420900.727...	1853	1 ^d 21	F2
0894.775...	1850	1.11	F3	0900.731...	"	1.21	F1
0894.782...	"	1.11	F4	0901.685...	1854	0.21	A9
0896.711...	1851	1.09	F5	0901.694...	"	0.22	F0
0899.622...	1853	0.10	A9	0901.702...	"	0.23	F2
0899.631...	"	0.11	A8	0901.714...	"	0.24	F1
0899.820...	"	0.30	F2	0901.725...	"	0.25	F0
0899.832...	"	0.31	F0	0901.737...	"	0.27	F0
0900.722...	"	1.20	F2				

is taken to be 6.23, as given in the *Preliminary General Catalogue*. With the corresponding value of the distance, the total velocity in space with respect to the sun is 10 kilometers a second.

MOUNT WILSON SOLAR OBSERVATORY
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¹ *Mt. Wilson Contr.*, No. 136, 1917.