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RAPID VARIATION OF AE AQUARI

1875: R.A. 20^h 32^m7; Decl.: -1° 23'

By KARL G. HENIZE

The variability of AE Aquarii was discovered by A. A. Wachmann¹ and was observed by E. Zinner² who classed the star as a U Geminorum (SS Cygni) type variable. Later Dr. A. N. Vysotsky observed bright lines of calcium (H and K) in its spectrum in addition to bright lines of hydrogen. Dr. A. H. Joy,³ while confirming this occurrence which is characteristic of the SS Cygni type stars, also observed a variable structure of the emission lines as well as a variable radial velocity. Since Dr. Joy had not been able to obtain spectrograms of the star at maximum light, the author undertook to observe the star in order to inform him when a maximum occurred. During the course of these observations it was discovered that AE Aquarii undergoes sudden short-lived outbursts of brightness amounting to about 0.5 of a magnitude.

The observations were made visually with the McCormick 26-inch refractor by the Argelander method. Table I lists data for the comparison stars. The column titled "grades" gives the visual estimates of the relative brightnesses of the com-

parison stars on an arbitrary scale. These are the means of estimates made on several different nights by the two observers, Alden and Henize. The probable error of the interval between any two stars is about 0.2 of a grade. The scales of the two observers agreed sufficiently well to combine their estimates. Herbig's magnitudes⁴ are based on five comparisons with the North Polar Sequence using Schraffierkassette plates and have a mean probable error of ± 0.024 magnitude. The McCormick photovisual magnitudes are based on one indirect comparison with the North Polar Sequence and have a probable error of about ± 0.16 magnitude. The adopted visual magnitudes have been taken from the mean curve obtained by plotting the grade estimates of the comparison stars against the two sets of photovisual magnitudes. Table II lists the daily observations reduced to the scale of the adopted visual magnitudes. The probable error of one observation depends, of course, on many factors, but may be considered to be about ± 0.1 magnitude. Times of observation are given to 0.001 day for the intervals when rapid changes were observed.

The magnitude of AE Aquarii ordinarily fluctuates between magnitudes 11.0 and 11.5 with frequent short-lived outbursts reaching to about magnitude 10.5 which tend to recur at intervals of 7 or 8 days. The range of these outbursts is about 0.5 magnitude and their duration is of the order of three to four hours. The more rapid fluctuations amount to about 0.3 magnitude in 15 minutes. These fluctuations are not to be confused with the broad maxima which are characteristic of SS Cygni stars and persist for several days. In AE Aquarii it appears that the magnitude of these primary maxima reaches 9.7 photo-

TABLE I. COMPARISON STARS

Star	Coordinates		Grades	Magnitudes		
	$\Delta\alpha \cos \delta$	$\Delta\delta$		McC. Ptv.	Adopted Vis.	Herbig Ptv.
A	-9'.35	-0'.15	0	9.8	9.80	9.79
B	+4.74	+9.71	5.0	10.4	10.44	10.49
C	+7.82	+0.95	10.0	10.9	10.87	10.90
D	-4.78	-7.19	15.0	11.2	11.20	11.15
E	-3.96	+4.37	19.8	11.5	11.53	
F	+0.71	-10.02	21.5	11.6	11.64	11.44
G	+0.67	-3.31	27.0	11.9	12.01	12.19
H	+5.40	+4.02	26.0	12.0	11.95	
I	+2.57	-3.48	29.0	12.0	12.15	
J	-1.82	-4.49	30.6	12.1	12.26	
K	+7.04	-6.54	29.6	12.2	12.19	
L	-3.16	-6.29	29.1		12.16	

TABLE II. OBSERVATIONS

J.D. 2,432,000+	Observer	Mag.	J.D. 2,432,000+	Observer	Mag.	J.D. 2,432,000+	Observer	Mag.
395.81	H	11.13	465.489	A	11.41	498.505	H	10.87
396.77	H	11.62	.594	A	11.08	.508	H	10.94
397.65	A	11.39	.608	H	11.00	.513	H	11.09
403.64	H	11.32	.612	A	11.04	.517	H	11.09
	H	11.43	.638	A	11.07	.520	H	11.09
	A	11.20	.646	H	11.07			
404.59	H	11.46	.670	H	11.27	.536	H	11.09
.80	H	11.39	.680	A	11.36	.551	H	11.09
405.74	H	11.13	472.51	H	11.29	499.49	A	11.20
409.63	H	11.07	.55	H	11.07	.49	H	11.20
						502.46	A	11.20
410.65	H	11.20	.56	A	11.20			
411.66	H	11.23	.63	H	11.13	.52	H	11.09
412.63	H	11.29	473.52	H	11.09	.56	H	11.20
	A	11.53	.58	H	11.09	503.46	H	11.20
413.64	H	11.27	477.60	H	11.27	.48	H	11.20
						506.476	H	10.87
417.62	H	11.23	479.47	A	11.09			
421.58	A	10.98	.48	H	11.32			
422.62	A	11.32	.59	H	11.20	.480	H	10.66
423.64	A	10.98	.59	A	11.20	.483	H	10.70
	H	11.13	480.47	H	11.27	.487	H	10.87
						.495	H	10.70
426.70	H	11.27	.47	A	11.20	.498	H	10.87
427.65	H	11.28	481.504	A	11.31			
431.61	H	11.23	.504	H	11.27			
432.61	H	11.31	.562	H	10.74	.504	A	10.70
443.57	A	11.04	.569	H	10.74	.505	A	10.87
						.506	H	10.98
445.69	H	11.16	.576	H	11.07	.507	A	10.77
446.56	H	11.39	.584	H	11.07	.511	H	10.98
.57	A	11.32	.592	H	11.10			
448.55	H	11.20	.603	H	11.10			
	A	11.31	.624	H	11.20			
						.512	A	11.04
455.51	H	11.27	482.47	H	11.04	.513	A	10.98
	A	11.27	.48	H	11.09	.516	A	11.04
456.59	A	10.57	.59	H	11.31	.519	A	11.09
	H	10.52	484.49	A	11.20	.521	A	10.98
.71	H	11.27	.49	H	11.20			
						.523	A	11.09
.74	H	11.20	.502	H	11.20	.525	A	11.12
457.55	H	11.16	.521	H	11.16	.526	A	11.20
458.64	A	11.20	.566	H	11.09	.527	A	11.14
	H	11.20	.587	H	11.20	507.46	H	11.09
459.60	A	11.07	485.53	A	11.09			
						509.46	A	11.12
460.60	H	11.18	486.48	H	11.20	.47	H	11.09
461.55	A	11.44	488.51	H	11.13	510.46	H	11.20
	H	11.32	.51	A	11.31	.48	H	11.20
462.53	H	11.20	495.47	A	11.07	514.47	H	11.20
463.520	A	11.11	496.46	H	11.20			
						516.53	A	11.20
.528	H	10.79	.51	H	11.16	518.50	A	11.12
.531	A	10.80	.52	H	11.20	525.45	H	11.09
.552	A	10.66	498.459	H	10.66	526.46	H	11.31
.562	A	10.58	.460	A	10.75	.47	A	11.31
.564	H	10.61	.463	H	10.66			
						529.45	H	11.20
.566	A	10.79	.467	H	10.66	532.466	H	11.09
.569	H	10.79	.471	H	10.70	.471	H	11.13
.572	A	11.00	.472	H	10.70	.477	A	11.20
.583	A	10.98	.474	H	10.65	533.52	H	11.04
.591	A	11.04	.480	H	10.61			
						.53	H	11.04
.595	H	10.87	.481	A	10.75	536.50	H	11.04
.638	H	11.10	.487	A	10.73	537.49	H	11.20
.650	H	11.16	.496	H	10.70			
464.52	A	11.23	.501	H	10.98			
465.489	H	11.27	.504	H	10.79			

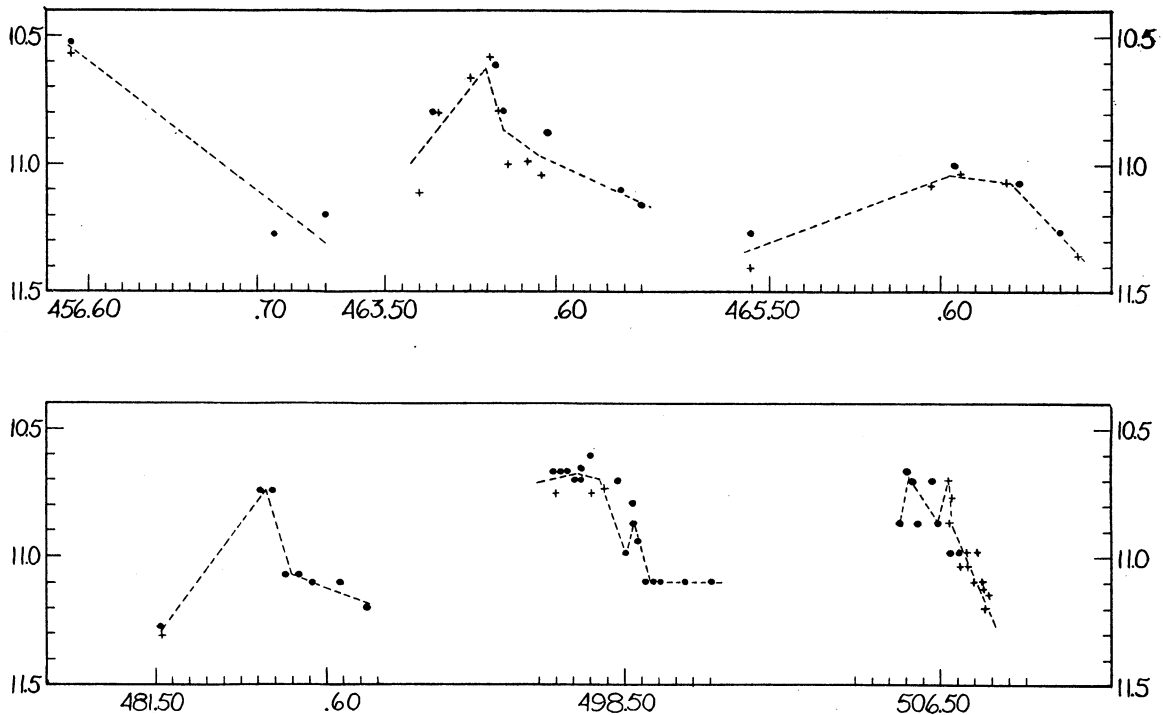


Figure 1. The light curves of six short-lived outbursts of AE Aquarii. Magnitudes are visual. Crosses are observations by Alden; dots are observations by Henize.

graphic.² Zinner observed three of these primary maxima and it seems probable that he also observed a secondary fluctuation, such as is dealt with in this paper, on J.D. 2,426,650.

Figure 1 shows the light curves of the six instances of rapid fluctuation whose ranges exceeded 0.4 magnitude. The mean curves have been drawn through normal points formed by grouping the observations by twos and threes along the time scale except on J.D. 2,432,506, on which day special notes by the observers indicate the slope of the curve.

Although it is recognized that SS Cygni stars are subject to many irregularities, it seems that

such rapid fluctuations in magnitude deserve further investigation, especially with photoelectric photometers.

The author takes pleasure in thanking Dr. H. L. Alden for his many observations and his frequent advice and Dr. A. N. Vyssotsky, who suggested that these observations be undertaken.

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*Leander McCormick Observatory,
University of Virginia,
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THE NEBULAR VARIABLE R MONOCEROTIS

6^h 36^m3, +8° 47': 1950

BY C. O. LAMPLAND AND JOSEPH ASHBROOK

The variable star R Monocerotis, together with its nebulous envelope, constitutes the nucleus of Hubble's variable nebula, NGC 2261. The present discussion is limited to an examination of the light variation of the star, knowledge of which should be useful in the interpretation of the intricate changes¹ in the brightness and appearance of the nebula, and for comparison with the

spectroscopic observations.²⁻⁷ For this purpose, Ashbrook has estimated the magnitude of R Monocerotis on the extensive collection of photographs made since 1916 by Lampland with the 42-inch reflector of the Lowell Observatory.

The star is situated at the tip of the fan-shaped main body of the nebula, with which it is connected by a narrow neck which is sometimes