

## VARIATION IN LIGHT OF THE SPECTRUM VARIABLE 56 ARIETIS\*

SANFORD S. PROVIN

Yerkes Observatory

*Received April 13, 1953*

## ABSTRACT

Observations at three effective wave lengths,  $\lambda\lambda$  5500, 4400, and 3550, show amplitudes of variation of 0.04, 0.06, and 0.06 mag. respectively. The observations give a period of 0.728 day for the light-variation.

The star 56 Arietis (5.65 mag.) is designated as A0p in the *Henry Draper Catalogue*; its noted peculiarity is a feature at  $\lambda$  4129. Deutsch<sup>1</sup> found that lines of *He I* vary in intensity and that the changes are periodic.<sup>2</sup>

The photometric observations reported here were made with the 13-inch reflector of the McDonald Observatory. An RCA 1P21 multiplier was used as the light-sensitive element of the photometer. Observations were made at three effective wave lengths:  $\lambda$  5500, isolated by a Corning 3384 filter;  $\lambda$  4400, isolated by a Corning 5030 and a Schott GG-13 filter; and  $\lambda$  3550, isolated by a Corning 9863 filter.

In this work, two comparison stars were used. They were HR 944 (B9; 5.60 mag.) and HR 945 (A0; 6.38 mag.). The former was used for most of the comparisons with 56 Ari, and HR 945 was observed only occasionally as a check on HR 944.

Scattered observations made in 1951 at Yerkes Observatory indicated that either there were large errors in the observations or the period of 2.563 days given by Deutsch<sup>2</sup> did not apply to the total light. It was found that a period of 0.64 day<sup>3</sup> was in better agreement with the observations than 2.563 days. The possibility of a short period was investigated during the months of November and December, 1952. Observations made in this interval show that the period of light-variation is less than 1 day with the following elements:

$$\text{Light-minimum} = \text{JD } 2434355.806 + 0.728E.^4$$

The observations are compiled in Table 1, where the dates of the observations are in universal time. The phases were calculated according to the period above, with November 6.000 U.T. taken arbitrarily as zero phase. The magnitude difference 56 Ari *minus* HR 944 is given for the yellow, blue, and ultraviolet observations and also for *B—Y* and *U—B*. Only the observations made in the yellow are given for the comparisons of HR 944 with HR 945.<sup>5</sup> The observations are plotted against phase in Figure 1.

\* *Contributions from the McDonald Observatory, University of Texas*, No. 225.

<sup>1</sup> *Ap. J.*, **105**, 296, 1947.

<sup>2</sup> *Ap. J.*, **105**, 503, 1947.

<sup>3</sup> The reciprocal period less than 1 day which can be derived from the period 2.563 days is 0.72 day.

<sup>4</sup> At the December, 1952, meeting of the American Astronomical Society, Deutsch announced a similar period for the spectral variations.

<sup>5</sup> In combining individual comparisons into an observational point, the mean of the comparisons made during intervals of about  $\frac{1}{2}$  hour has been taken. Since HR 944 was observed as frequently as 56 Ari, the number of comparisons (equal to the number of observations of 56 Ari) per interval is 4 or 5. From the comparisons of HR 944 with HR 945 (all single comparisons), the mean error of a single comparison is about  $\pm 0.005$  mag. for the yellow and  $\pm 0.006$  mag. for the blue and ultraviolet. It is estimated, therefore, that the mean error of each observational point is  $\pm 0.0025$  mag. for the yellow and  $\pm 0.003$  mag. for the blue and ultraviolet.

TABLE 1  
PHOTOMETRIC OBSERVATIONS OF 56 ARI

DATE U.T. 1952	PHASE ( $P=0.728$ )	56 ARI <i>minus</i> HR 944					HR 945 <i>minus</i> HR 944
		<i>Y</i>	<i>B</i>	<i>U</i>	<i>B</i> - <i>Y</i>	<i>U</i> - <i>B</i>	
Nov. 6. 218. . . .	0.299	0.044	-0.182	-0.510	-0.226	-0.328	0.182
.290. . . .	.398	.044	-.175	-.515	-.219	-.340	.184
11. 226. . . .	.179	.039	-.194	-.510	-.233	-.316	.182
.358. . . .	.360	.036	-.186	-.515	-.222	-.329	.179
12. 321. . . .	.683	.072	-.149	-.479	-.221	-.330	.182
15. 277. . . .	.743	.071	-.143	-.462	-.214	-.319	.196
19. 277. . . .	.238	.044	-.185	-.506	-.229	-.321	.182
20. 267. . . .	.598	.048	-.178	-.507	-.226	-.329	.182
27. 135. . . .	.032	.034	-.198	-.513	-.232	-.315	.186
Dec. 1. 175. . . .	.581	.049	-.171	-.499	-.220	-.328	.178
.333. . . .	.798	.062	-.151	-.452	-.213	-.301	.188
2. 083. . . .	.828	.069	-.158	-.455	-.227	-.297	.182
.216. . . .	.011	.038	-.190	-.497	-.228	-.307	.182
.350. . . .	.195	.036	-.194	-.510	-.230	-.316	.185
4. 100. . . .	.599	.051	-.174	-.503	-.225	-.329	.183
.179. . . .	.707	.070	-.147	-.459	-.217	-.312	.187
5. 039. . . .	.894	.059	-.161	-.452	-.220	-.291	.....
.065. . . .	.924	.059	-.168	-.454	-.227	-.286	.182
.091. . . .	.960	.047	-.183	-.479	-.230	-.296	.....
.117. . . .	.996	.038	-.188	-.491	-.226	-.303	.185
.142. . . .	.030	.037	-.198	-.504	-.235	-.306	.....
.168. . . .	.066	.027	-.198	-.514	-.225	-.316	.186
.196. . . .	.104	.028	-.208	-.513	-.236	-.305	.....
.219. . . .	.136	.033	-.203	-.517	-.236	-.314	.191
.267. . . .	.202	.036	-.190	-.509	-.226	-.319	.....
.287. . . .	.229	.035	-.197	-.512	-.232	-.315	.181
.314. . . .	.266	.046	-.182	-.505	-.228	-.323	.....
.340. . . .	.302	.046	-.185	-.511	-.231	-.326	.185
.366. . . .	.338	.042	-.183	-.507	-.225	-.324	.....
.398. . . .	.382	.037	-.193	-.502	-.230	-.309	.189
8. 076. . . .	.061	.033	-.200	-.518	-.233	-.318	.186
.104. . . .	.099	.031	-.211	-.513	-.241	-.302	.184
9. 075. . . .	.432	.031	-.196	-.527	-.227	-.331	.180
.194. . . .	.596	.044	-.177	-.509	-.221	-.332	.....
.286. . . .	.722	.072	-.148	-.470	-.220	-.322	.185
.306. . . .	.750	.071	-.149	-.457	-.220	-.308	.....
.325. . . .	.775	.070	-.142	-.454	-.212	-.312	.180
10. 065. . . .	.792	.068	-.142	-.439	-.210	-.297	.....
.150. . . .	.909	.052	-.165	-.469	-.217	-.304	.192
.170. . . .	.936	.054	-.170	-.472	-.224	-.302	.....
.280. . . .	.088	.030	-.198	-.513	-.228	-.315	.181
.297. . . .	.112	.031	-.206	-.508	-.237	-.302	.188
15. 196. . . .	.840	.068	-.147	-.459	-.215	-.312	.187
.289. . . .	.968	.048	-.182	-.483	-.230	-.301	.192
16. 075. . . .	.048	.040	-.199	-.500	-.239	-.301	.195
.120. . . .	.110	.035	-.204	-.516	-.239	-.312	.190
24. 065. . . .	.023	.038	-.194	-.494	-.232	-.300	.192
.106. . . .	.080	.030	-.205	-.510	-.235	-.305	.196
.154. . . .	.146	.032	-.195	-.512	-.227	-.317	.186
.202. . . .	.212	.047	-.189	-.510	-.236	-.321	.187
.244. . . .	0.269	0.040	-0.187	-0.509	-0.227	-0.322	0.175

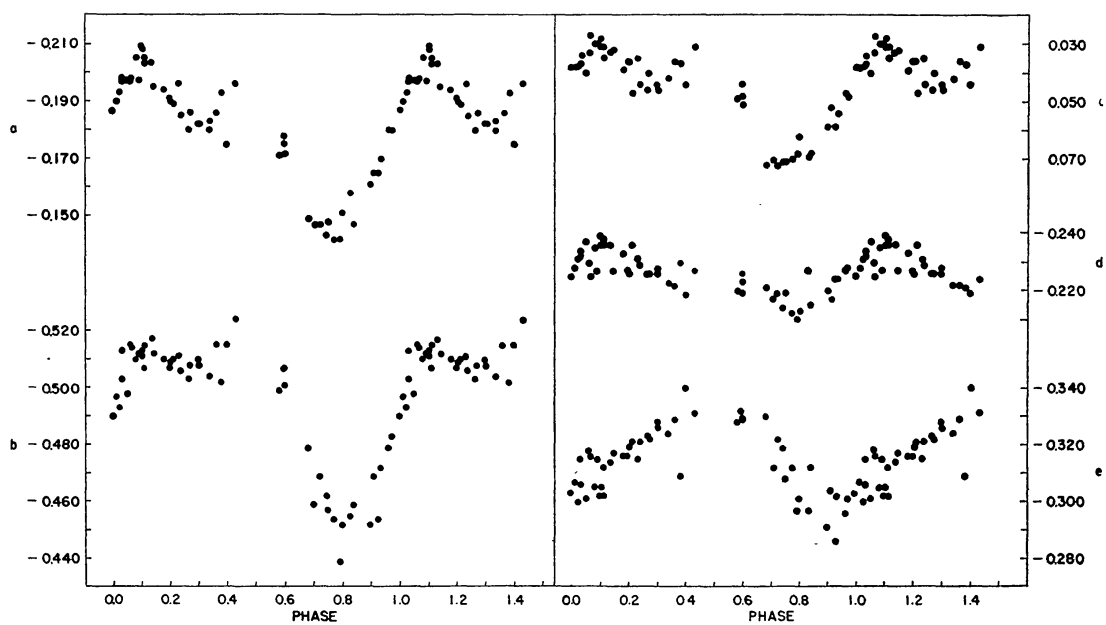


FIG. 1.—56 Ari *minus* HR 944: *a*,  $\lambda_{\text{eff}} = 4400$ ; *b*,  $\lambda_{\text{eff}} = 3550$ ; *c*,  $\lambda_{\text{eff}} = 5500$ ; *d*,  $B - Y$ ; *e*,  $U - B$

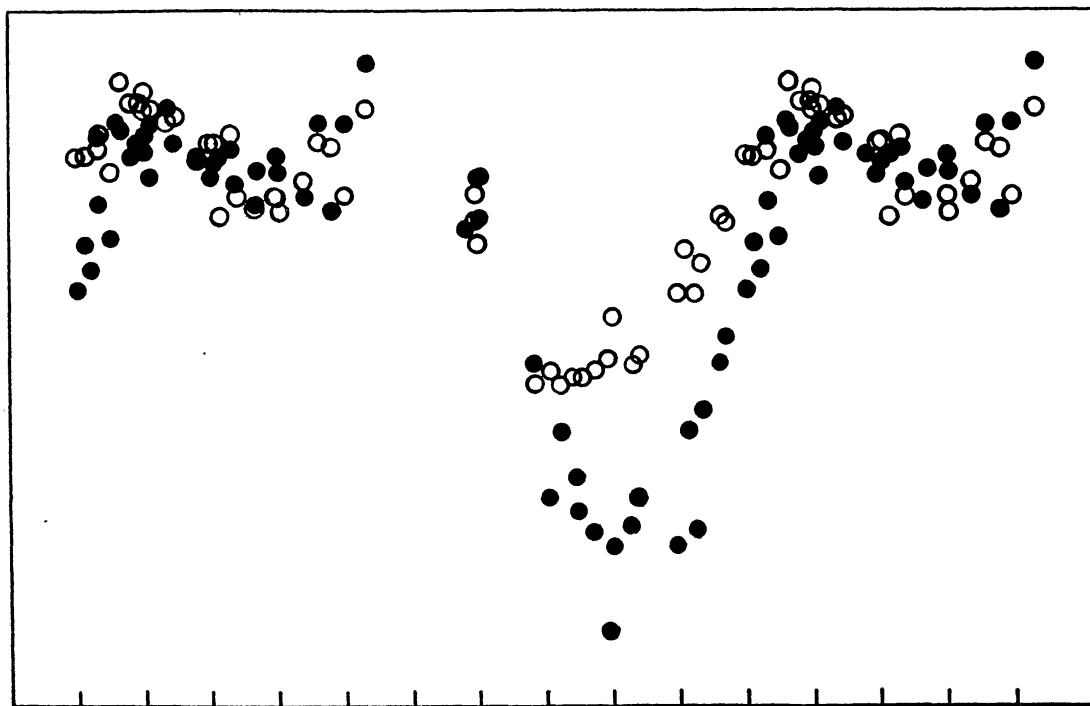


FIG. 2.—The yellow observations are shown by the open circles; the ultraviolet, by the filled circles

The observations show that 56 Arietis varies in light with an amplitude of 0.04 mag. in the visual and 0.06 mag. in the blue and ultraviolet. The depth of the minima in the blue and ultraviolet does not appear to repeat, whereas in the yellow the minima are in good agreement. The observations give evidence for a second minimum near phase 0.3. The color change  $B-Y$  is 0.02 mag., and the change in  $U-B$  is about 0.04 mag. The star is bluest at phase 0.1 and most ultraviolet at phase 0.5.

A feature of the light-curves is a delay in the time at which the ultraviolet reaches minimum as compared to the yellow. The minimum in the ultraviolet occurs about 0.04 later in phase than the minimum in the yellow. In Figure 2 the ultraviolet and the yellow observations are superposed. The shift then becomes quite evident.

The phase shift is such that the star remains relatively faint in the ultraviolet, while the blue and yellow have recovered. This suggests that absorption due to hydrogen may be involved. It is noted that the phase shift found here is in the sense opposite to the shifts found by Stebbins<sup>6</sup> for  $\delta$  Cephei.

In conclusion, I wish to thank Dr. W. A. Hiltner for helpful suggestions in the preparation of this paper.

<sup>6</sup> *Ap. J.*, **101**, 47, 1945.