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scale. Gratifying success has resulted from this effort, inasmuch as two, three, one, and one supernovae have been found in the large clusters of galaxies in Fornax, Cancer, Coma, and the Shane Cloud, respectively.

(i) The spectra of supernovae, especially those of type I still defy interpretation. There is considerable hope, however, that an identification of significant features will be possible on the following lines: within the expanding gas shells from a supernova local explosive events (jets, shock waves, etc.) may be expected to produce sharp emission lines superposed on the luminous bands that defy interpretation because of their width (due to Doppler effects of the integrated shell spectrum and overlaps with other wide bands). Through a succession of spectroscopic recordings within a few hours and even within one hour it has been found that such sharp temporary, but recurring, features in the spectra actually exist. A particular attempt will be made to photograph short-term recurring patterns of sharp features in the expectation that such patterns can be correlated to and identified with patterns known from the study of other light sources.

(j) A study of past supernovae in neighboring galaxies has also been started, since they betray themselves by luminous, often circular, gas clouds whose expansion velocities may be determined through a spectroscopic analysis of their emission lines. Objects like the local galaxy IC 10 appear to be particularly suitable subjects for this study.

[1] F. Zwicky in *Handbuch der Physik,* Vol. 51, S. Flügge, ed. (Berlin, Göttingen, Heidelberg: Springer, 1958), pp. 766–85.

## VARIABILITY IN WOLF-RAYET STARS

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Slight variability of the order of $0^m.1$ has been reported in some Wolf-Rayet stars. Three-color photoelectric observations were made with the 20-inch telescope of the Leuschner Observa-

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tory to determine what proportion of Wolf-Rayet stars are variable, and whether variability is related to the variable emission bands known to exist in some of them. The stars observed were the accessible bright Wolf-Rayet stars not known to be components of close binary systems. The results are summarized in Table I.

TABLE I

WOLF-RAYET STARS INVESTIGATED FOR VARIATION IN LIGHT

| Star | Spectral Type | Reported Variability | Variable Emission Bands | No. of Nights Observed | Observed Variability |
|---|---|---|---|---|---|
| HD 50896 CD −23°4553 | WN6 | None | Abrupt changes[7] | 32 | Slow drop of $0^m.08$; irregular, $\pm 0^m.05$ |
| HD 165763 BD −21°4864 | WC6 | None | No | 13 | None |
| HD 191765 BD +35°4001 | WN6 | Small, irregular[4] | Yes[2] | 25 | Irregular, $< \pm 0^m.05$ |
| HD 192103 BD +35°4013 | WC7 | $0^m.2$;[2] small, irregular[4] | No | 26 | Irregular, $\pm 0^m.05$ |
| HD 192163 BD +37°3821 | WN6 | None | Yes[2] | 23 | Possibly irregular, $\leqslant \pm 0^m.03$ |
| HD 192641 BD +36°3956 | WC7 | Small[3,4] | No | 26 | None |
| HD 193077 BD +36°3987 | WN5 | Small,[3] slow[4] | No (?) | 23 | Irregular, $\leqslant \pm 0^m.05$ |
| HD 45166 BD +8°1332 | W7 + B (?) | $0^m.4$[1] | Yes[1] | 24 | None |
| HD 193793 BD +43°3571 | WC6 + 05 | No | No | 19 | None |

NOTE: Superscript numbers refer to references at end of article.

HD 50896 was definitely variable, falling irregularly by $0^m.08$ in five months. The drop was slightly greater in the ultraviolet than in the yellow and blue. The observations are plotted in Figure 1. Since the star was so far south ($\delta = -24°$), no attempt

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was made to convert to the *U,B,V* system. The observations indicate that the variation is slow, with a range greater than $0^m.1$. To determine whether or not the variation is periodic will require further observations.

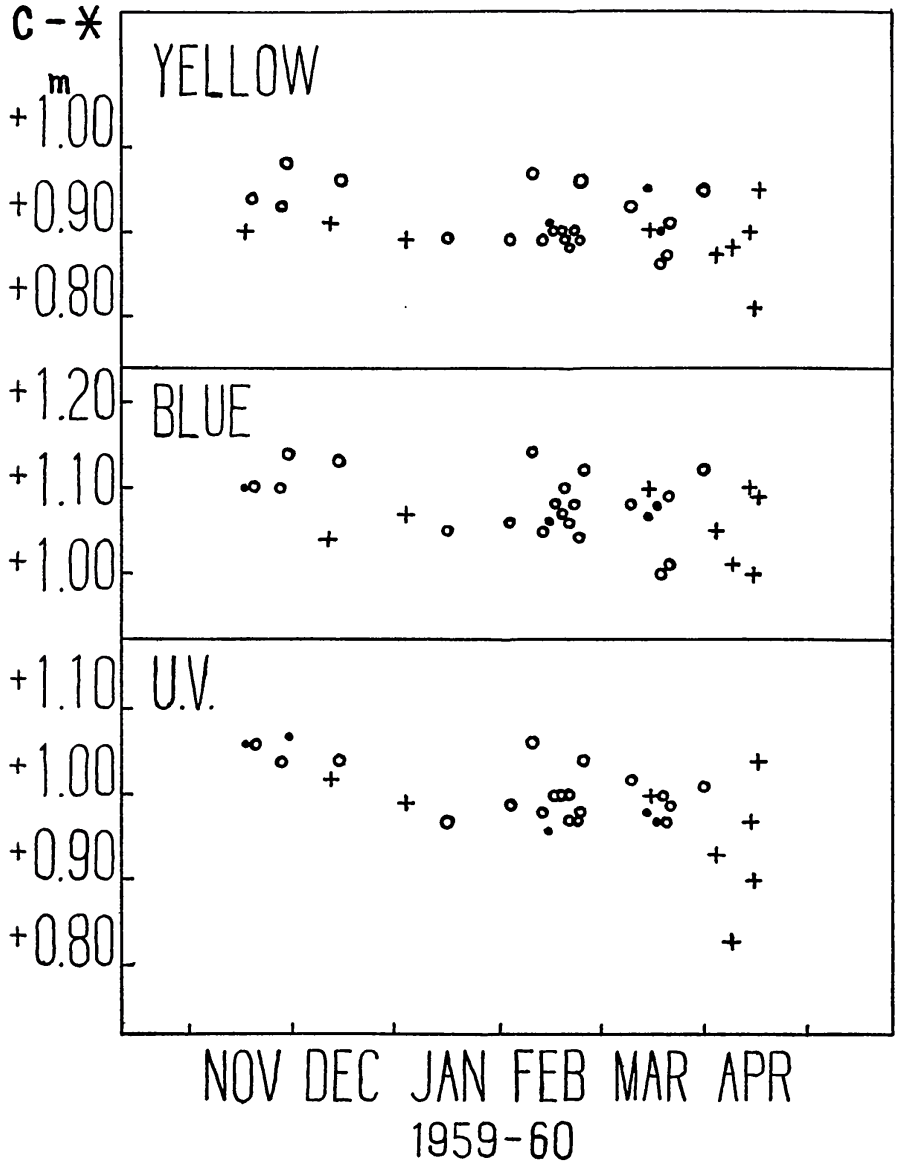


FIG 1.—Observations of HD 50896. Circles are of weight $\geqslant 3$, dots of weight 2, and plus marks of weight 1.

The stars HD 50896, HD 191765, HD 192103, HD 193077, and perhaps HD 192163 show irregular variation in all three colors of $\pm 0^m.05$ or less in a few days. Of these five stars, three

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are WN stars with variable emission bands, and one is a WN star that has not been thoroughly investigated. The observations of the WC star HD 192103 show that variability is not confined to WN stars or always associated with variable emission bands, (which do not seem to occur in WC stars).

No abrupt jumps in brightness, as reported by Martin and Plummer in some of these stars,[4] were observed, possibly because none of the stars was followed for more than eight months. The variability reported for HD 192641 and for the Wolf-Rayet binary or Wolf-Rayet-like composite object HD 45166 was not observed. They may vary with extreme slowness, or exhibit occasional abrupt changes in brightness, possibly related to outburst phenomena such as have occurred in $\gamma_2$ Velorum.[5,6]

No extremely rapid variation, of the order of a few hours or less, was observed.

These results suggest that Wolf-Rayet stars, in particular the WN stars, are somewhat unstable objects, as might be expected on evolutionary grounds.

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[1] C. J. Anger, *Harvard Bull.* No. 891, 1933.
[2] M. K. V. Bappu, *A.J.*, **56**, 120, 1951.
[3] S. Gaposchkin, *Pub. A.A.S.*, **10**, 250, 1942.
[4] C. Martin and H. C. Plummer, *M.N.R.A.S.*, **79**, 196, 1919.
[5] C. D. Perrine, *Ap. J.*, **47**, 52, 1918.
[6] C. D. Perrine, *Ap. J.*, **52**, 39, 1920.
[7] O. C. Wilson, *Pub. A.S.P.*, **60**, 383, 1948.

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## THE VISUAL BINARY ROSS 79

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The duplicity of Ross 79[1] was first noted on plates taken with the Sproul 24-inch refractor in 1945.[2] The separation has increased appreciably since, as shown by plates obtained under good conditions in 1956 and 1960, on which the images are well separated and should not be seriously affected by systematic error.

A summary of the Sproul photographic observations follows:

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