Observations of the Polarized Light From Stars

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PHOTOELECTRIC OBSERVATIONS of the polarization of starlight made during the period November 1948 to January 1949 with the 40-inch reflector at Washington substantiate the hypothesis of W. A. Hiltner (*2*) that this effect is produced by interstellar matter. Furthermore, the percentage of polarization appears to be independent of wavelength; and the plane of polarization (plane containing the magnetic vector and the line of sight) appears to have no one preferential orientation.

The observations were obtained with a photoelectric polarizing photometer (*1*) built at Amherst College

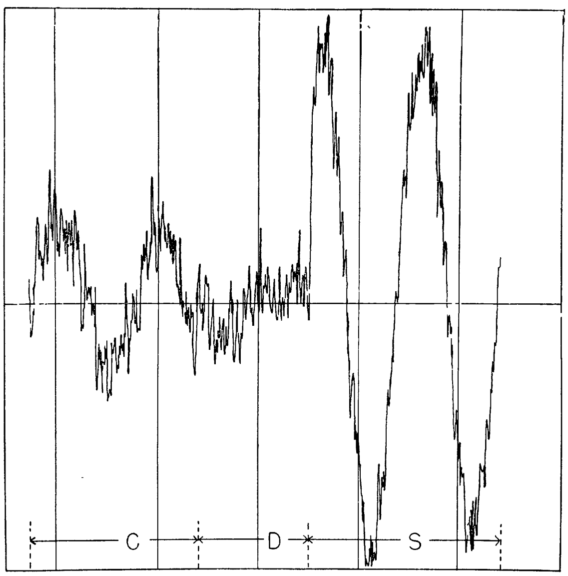

FIG. 1. Star HD 19820, a reddened star of spectral type O8. Polarization, 5.0% ; position angle of the plane of polarization, + 30°.

in 1946 with the aid of a grant from the Research Corporation of New York. The light from a star is collimated and directed through a cover glass, which serves as a calibrating device, and then through a Glan-Thompson prism rotated at 15 cycles per second to a 1P21 photomultiplier. The 30-cycle voltage developed by the polarized component of the light is selectively amplified and mixed with a phasing voltage in such a way that the d-c output can be impressed as a sine wave on a Brown recorder. The amplitude of this wave is proportional to the intensity of the polarized light, and the phase of maximum defines the plane of polarization. Records of two stars showing large and small percentages of polarized light are shown in Figs. 1 and 2. The vertical lines represent two-minute intervals. The trace during interval *S* is produced by polarized light from the star. During interval *D* a quartz depolarizer is placed in the light path, and *C* is the result when the cover glass is tilted 20° about an axis whose position angle is arbitrarily set at 94°. The starlight was already depolarized during the interval *C*. The plane of polarization is defined by the direction of the light and the axis about which the glass is tilted. A 20° tilt corresponds to 1.4% polarization.

The percentages of polarization of the light from 27 early-type stars are shown in Fig. 3 as a function of the color excesses determined by Stebbins and Huffer (*3*). A strong correlation is obvious; the

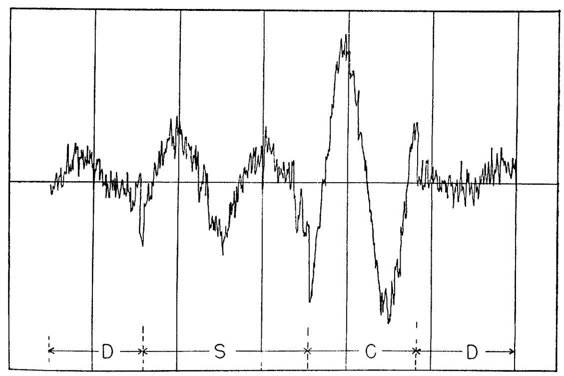

FIG. 2. Star HD 24760, ε Persei. This bright star is not generally considered to be a reddened B-type star. Polarization, 0.5% ; position angle, − 68°.

scatter, however, is much greater than the accidental errors of the observations.

The dependence of polarization on color was determined on three nights from observations of ζ Persei using Schott filters UG1 and BG14 for the ultraviolet region and RG1 or a Wratten yellow filter for the red region. The effective wavelengths of the two spectral regions were near 3,700 A and 6,200 A. The observed percentages with the ultraviolet filter were 2.0, 1.6, and 1.8; and with the red filter, 1.6, 1.0, and 2.2. The average value obtained when no filter was used is 1.8 percent. A second star, HD 33,203, was observed on one night, the result being 1.8 in the ultraviolet, 2.2 in the red, and 1.8 with no filter. No definite variation of the orientation of the plane of polarization with color is indicated by these observations.

Fig. 4 shows the observed planes of polarization for 28 early-type stars. The amount of polarization and the orientation of the plane of each is indicated by the length and direction of the line, whose midpoint represents the position of a star. The group of seven stars near the middle of the diagram exhibit a remarkable similarity in percentages of polarization and orientations of the planes, which may be a consequence of the relative homogeneity of the obscuring material in the direction from which their light comes.

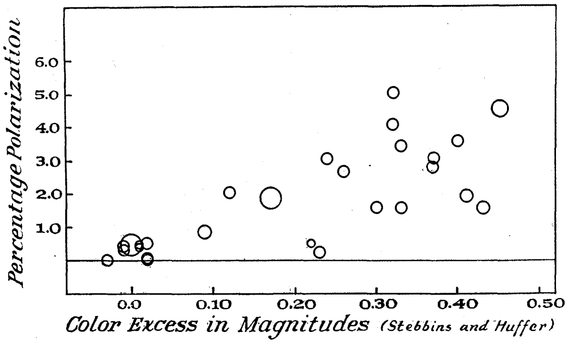

FIG. 3. Observational evidence of a correlation between color excess and percentage of polarization for early-type stars. The size of the circle indicates the weight of the observations.

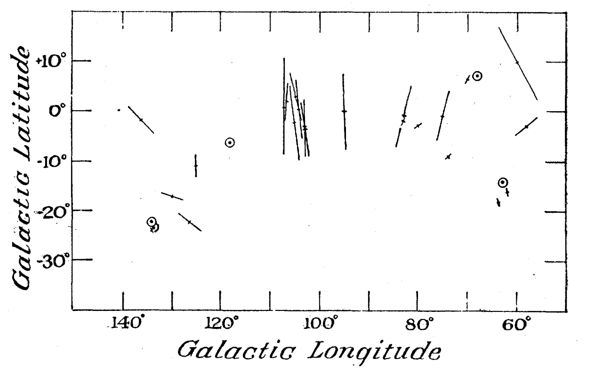

FIG. 4. Observational evidence that there is no one preferential orientation of the plane of polarization. Stars showing no polarization are represented by circles.

I have obtained these preliminary results from a project initiated in collaboration with W. A. Hiltner. My grateful appreciation is expressed to Dr. Hiltner and to the Yerkes and McDonald Observatories for the use of the 82-inch reflector for a period of two weeks during the summer of 1947. Despite very unfavorable weather conditions and some difficulty with a new type of photometer, we obtained some evidence of polarization in the light from one star, CQ Cephei. Accordingly it was planned to make a second trial at McDonald during the summer of 1948 with improved equipment, but a second trial could not be made because of other obligations incurred by my transfer from Amherst to Washington on September 1, 1948. With the improved photometer, however, it was easily possible to detect polarization in the light from CQ Cephei with the 18-inch refractor at the Amherst College Observatory. Furthermore, these observations, made during the summer of 1948, showed little if any change in the amount of polarization with the phase of this eclipsing binary star. Meanwhile, Dr. Hiltner's independent work presumably had progressed so far that he did not feel justified in accepting my proposal, made in November 1948, to prepare a joint paper on our work.

References

1. HALL, JOHN S. *Astronom. J.*, 1948, **54**, 39.
2. HILTNER, W. A. *Science*, 1949, **109**, 165.
3. STEBBINS, J., and HUFFER, C. M. *Publ. Washburn Observ.*, 1934, **15**, 5.