THE V-STOKES PARAMETER AS A MANIFESTATION OF ENVELOPE ACTIVITY FOR COOL, BRIGHT, EVOLVED STARS

B. D. Holenstein and R. H. Koch
Department of Astronomy and Astrophysics
University of Pennsylvania

R. J. Pfeiffer
Department of Physics
Trenton State College

At Pennsylvania's Flower and Cook Observatory, instrumentation has been developed to measure simultaneously the four Stokes parameters of the filtered radiation field from a celestial source. The instrumental Q/U/V-parameters have been found to be very small and well-behaved. Thus far, the program has concentrated on cool bright giants and supergiants and on hot, evolving close binaries. A single season's investigation of Alp Ori has already been reported (Holenstein 1987) and the present paper is a summary of current results for the cool, evolved program stars.

For Psi^1 Aur, V CVn, 6 Gem, 72 Leo and 119 Tau no V-signal at the level of 3σ has been detected from data from the 1986-1987 season. At the level of 0.0n%, unambiguous and variable V-signals have been detected for VV Cep, Mu Cep, Alp Her, Alp Ori, Bet Peg, and Alp Sco. For these, we make a number of recognitions: (1) for no star has there been an enduring correlation among Q or U and V, (2) for all stars as a group the absolute value of V is not correlated with the value of p, (3) no star has remained at V = 0.00% for an extended (>50 days) interval although an interstellar component of V could be present in the data, (4) for red through blue, polarity changes of V have been common and both senses of change appear equally common, and (5) time scales for significant changes of V range from about 2 days to about 100 days. Information from the p- and V-polarization spectra for the same six stars may be summarized: (6) for a given star the linear spectrum is variable changing from monotonic to non-monotonic and back again and with a continuous range of gradient, (7) for a given star the V-spectrum is variable, and (8) the most conspicuous detail of the V-spectrum is the negative ultraviolet circular polarization for five of the stars.

Items (1) and (2) may be interpreted to indicate that the linear and circular signals arise in different locales or that conversion efficiencies vary with time because the scatterers themselves vary with

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time. Item (3) signifies that the concentrations of scatterers may diffuse to an insignificant density but that some other mechanism concentrates them again quickly or that other scattering centers form quickly. It may also be that an asymmetric distribution of secondary scatterers becomes symmetrical for a brief time. It also follows that all linear surveys have underestimated the polarization of cool supergiants by the neglect of the V-component. Item (4) may indicate that more than one type of birefringent scatterer exists in a stellar envelope or that there are twisted alignments of them which can change with time. The time scale range in Item (5) is shorter than the fundamental pulsational time scales for these stars, but light time effects in the binary stars and mass motions in the M-star envelopes are permitted. Item (6) is familiar from older linear surveys and has been ascribed to a time-variable assortment of scatterers as modelled by Shawl (1975). It may be considered that Item (7) is a necessary consequence of Items (1), (2), and (6). Item (8) may be a consequence of observational selection from a small number of stars or may reveal something of the birefringence of the scattering medium.

The most evident understanding of most of these results would rest upon the explanation developed by Angel and Martin (1973) for the near-IR V-signal seen from a few, very cool objects: multiple scattering in an asymmetric, dusty envelope. For the five stars other than VV Cep, the electric vector rotates significantly. Therefore, by the criterion of Angel and Martin, elongated grain alignment is unnecessary to cause their circular signals.

IRAS data indicate that for most of the stars there does not appear to be an emission peak near 10μm. On the other hand, merged, low resolution IUE spectra clearly show the 0.22μm dip for VV Cep and Alp Sco and show it weakly for Mu Cep and Alp Ori. The spectra for VV Cep and Alp Sco have been fitted successfully using Seaton's (1979) reddening law, when the hot companions are taken into account. Therefore, it appears their circumstellar dust envelopes do not inflect the 0.22μm feature.

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Reference List

Angel, J. R. P., and Martin, P. G. 1973, Ap. J. 180, L39.
Holenstein, B. D. 1987, Bull. A. A. S. 19, 754.
Seaton, M. J. 1979, M. N. R. A. S. 187, 73P.
Shawl, S. J. 1975, A. J. 80, 595.