PHOTOMETRY OF AM HER STARS - LINE AND CONTINUUM EMISSION

Paula Szkody*

Department of Astronomy
University of Washington

The 4 known AM Her stars or polars (AM Her, ANUMa, VV Pup, and 2A0311-227) are characterized by large circular polarizations of 10-35%, (Tapia 1977a, b, Krzeminski and Serkowski 1977), an emission line spectrum with strong H and He lines (Crampton and Cowley 1977, Greenstein et al. 1977), complex photometric variations (Szkody 1978, Priedhorsky and Krzeminski 1978, Warner & Nather 1972), long term high and low states and short orbital periods (80-180 min.). Models of these systems envision a close binary containing a magnetic white dwarf primary ($B \sim 10^8$G) and late type main sequence secondary transferring material into an accretion funnel over one or both poles of the white dwarf (Stockman et al. 1977, Lamb & Masters 1979, Liebert et al. 1978).

The available data on AM Her points to several regions of emission. Due to the large circular polarization, most of the visual and red light probably results from cyclotron emission in different regions of the accretion funnel, while the lack of polarization and different times of minima argue for different locations for the U and B light. Lack of Zeeman splitting in the He emission line (Greenstein et al. 1977) also points to a location farther from the white dwarf for a broad component of the line emission while the radial velocity curve of a sharp component argues for an origin on the heated secondary. Spectrophotometry of VV Pup (Liebert et al. 1978) has shown that flares can occur independently in the continuum or the lines, while simultaneous U, V, 4686 photometry of AM Her (Szkody & Margon 1979) gives a strong correlation between the broad band U & V and 4686 flickering.

To further study the position and interaction of the visual continuum and line emission regions in the polars, broad band UBV and narrowband (40Å) HeII 4686 photometry was obtained for AM Her, ANUMa and VV Pup throughout their orbital cycles (plus narrowband Hα for ANUMa). The data on ANUMa and VV Pup was obtained at KPNO with the 3 channel photometer on the 1.3m-telescope so that either (U,B,V) or (U, 4686, Hα) data was obtained simultaneously. Standards were used to convert the UBV magnitudes to the Johnson system and to calibrate the fluxes of the narrow band filters. Mean values of the continuum fluxes obtained with narrow-band filters at 4605 and 6498 near the times of the line emission

*Guest observer at Kitt Peak National Observatory, which is operated by AURA, Inc., under contract with the National Science Foundation.

https://doi.org/10.1017/S0252921100076132 Published online by Cambridge University Press

measurements were used to subtract the continuum flux. Data on AM Her was obtained at the U of W 0.8m telescope with 10 second sequential integrations between 4605, 4686, and V and random measurements of UBV. The resulting light curves are shown in Figures 1-3, and some basic properties are summarized in the following table:

Object	Deepest Min(mag)	Max B-V	Max U-B	Min B-V	Min U-B	Sec. Min. (Mag.)	Mean log Fλ4686	Mean log F Hα
AM Her	V(0.7)	.2	-1.1	.0	-1.1	V(0.4)	-13.78	
ANUMa	U(1)	0	-.7	.4	-.6	V(0.3)	-15.16	-15.40
VV Pup	V(2)	.3	-.4	-.1	-.5	none	-15.24	

The broad band UBV light curves show differences: in VV Pup the max is red and the minimum starts and ends at the same time in all colors implying a similar source (accretion column) but in ANUMa, the max is blue and while the primary min starts at the same time the U light minima lasts 0.3 phase longer than V implying different regions. Like VV Pup, the max in AM Her is red but primary min usually starts and ends later in U & B than in V.

Although all 3 show flickering in He4686, the large scale variations in VV Pup appear independent of the continuum U (which goes along with independent variations in Hα seen by Liebert et al. 1978) while in ANUMa there is some evidence for a decrease in 4686 and Hα flux near secondary minimum (which argues for association with the accretion column rather than the heated region of the secondary.) In AM Her, the flux decreases near the time of U minimum which may or may not be near the accretion column.

The mean 4686 flux of AM Her is about 30x higher than the others. At least for VV Pup, the lower value must be due to differences in the actual physical parameters rather than distance if d(AM Her) ∿ 72 pc (Young and Schneider 1979) and 80 < d(VV Pup) < 150 (Liebert et al. 1978).

References

Crampton, D. and Cowley, A. 1977, PASP 89, 374.
Greenstein, J., Sargent, W., Borenson, T., Boksenberg, A., 1977, Ap.J. 218, L121.
Herbig, G.H., 1960, Ap.J., 132, p. 76.
Krzeminski, W. and Serkowski, K. 1977, Ap.J. 216, L45.
Lamb, D.Q. and Masters, 1979, preprint.
Liebert, J., Stockman, H., Angel, J., Woolf, N., Hege, K., Margon, B. 1978, Ap.J. 225, 201
Priedhorsky, W.C. and Krzeminski, W. 1978, Ap.J., 219, 597.
Stockman, H.S., Schmidt, G.D. Angel, J.R.P., Liebert, J., Tapia, A. and Beaver, E.A. 1977, Ap.J. 217, 815.
Szkody, P. 1978, PASP, 90, 61.
Szkody, P. and Margon, B. 1979, preprint.
Tapia, S. 1977a, Ap.J. 212, L125.
Tapia, S. 1977b, IAU Circ #3054 and #3327.
Warner, B. and Nather, R.E. 1972, MNRAS, 156, 305.
Young, P.J. and Schneider, D. 1979, preprint.

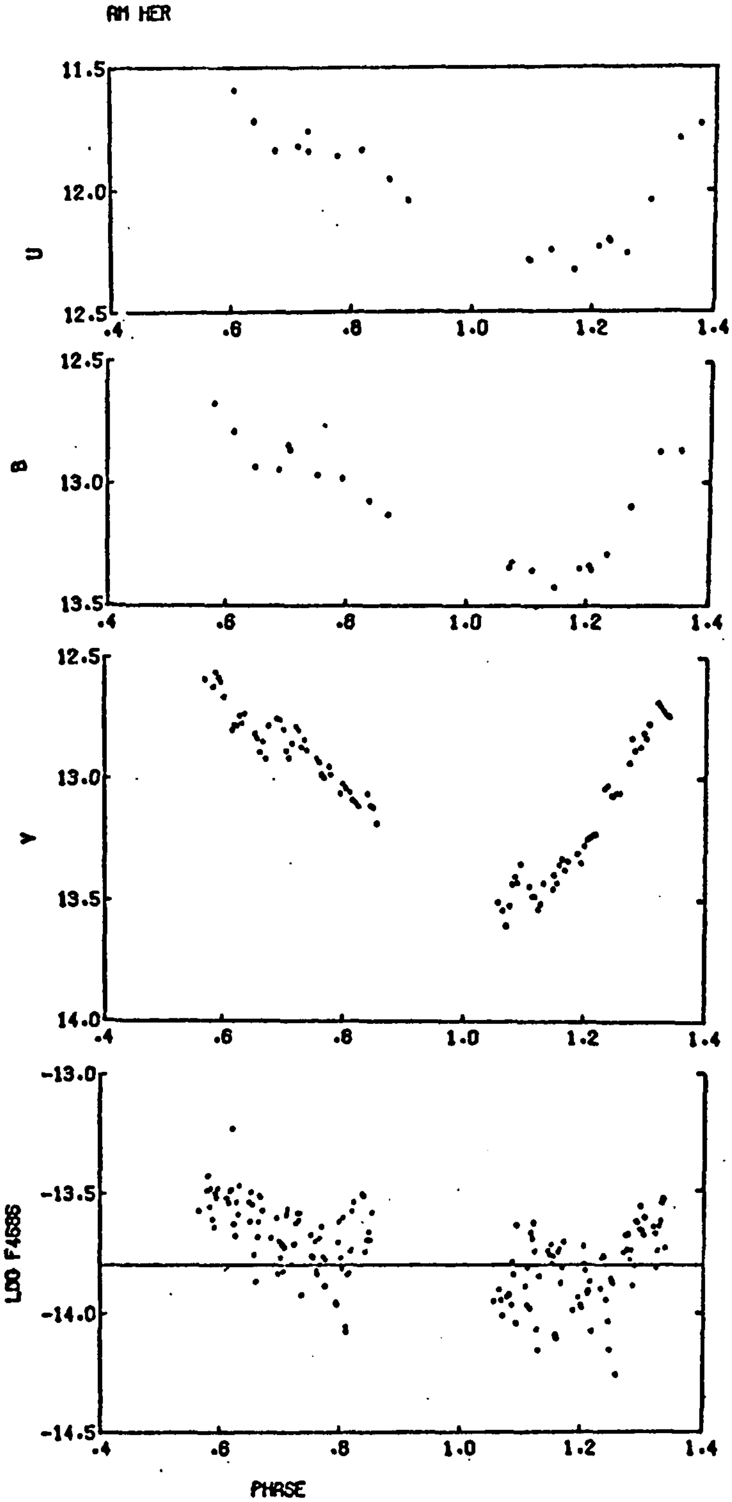
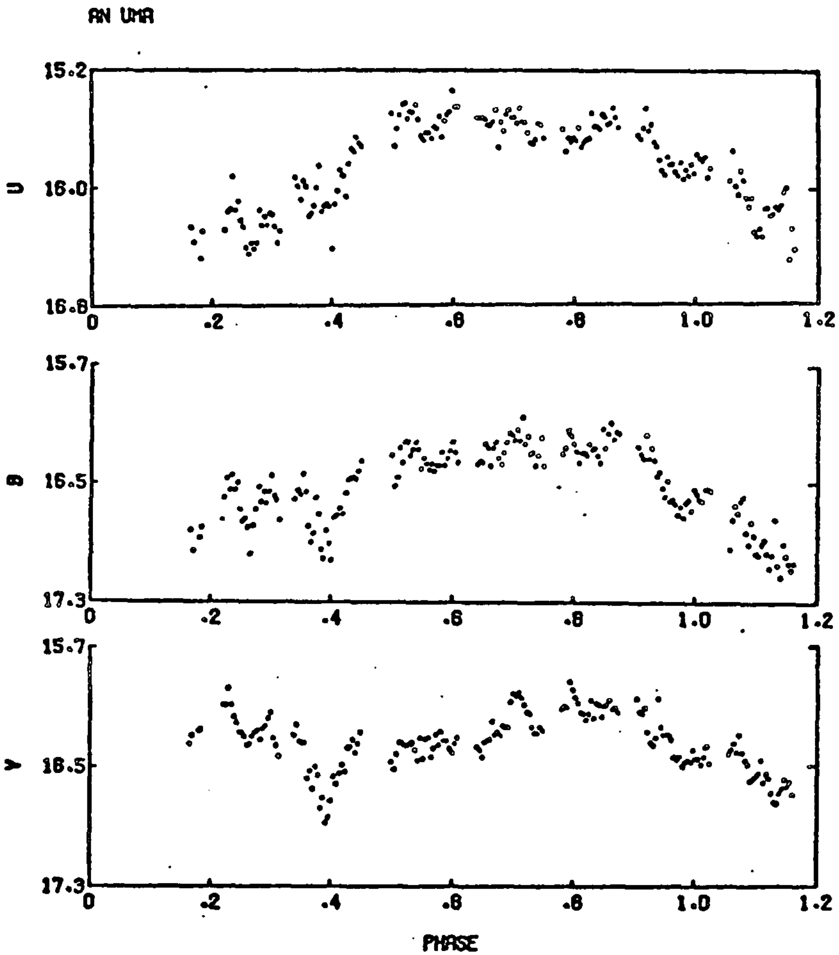


Fig. 1 The light curve of AM Her on May 15, 1979 with broad band UBV and narrow band 4686. Each point represents a 10 sec. integration with uncertainties ± .02 mag. The log F4686 has the continuum flux subtracted and is in units of ergs/cm^2/sec/Å. Phasing used is: Tmin = 2443014.712660 HJD + .12892774E (period from Young & Schneider 1979).



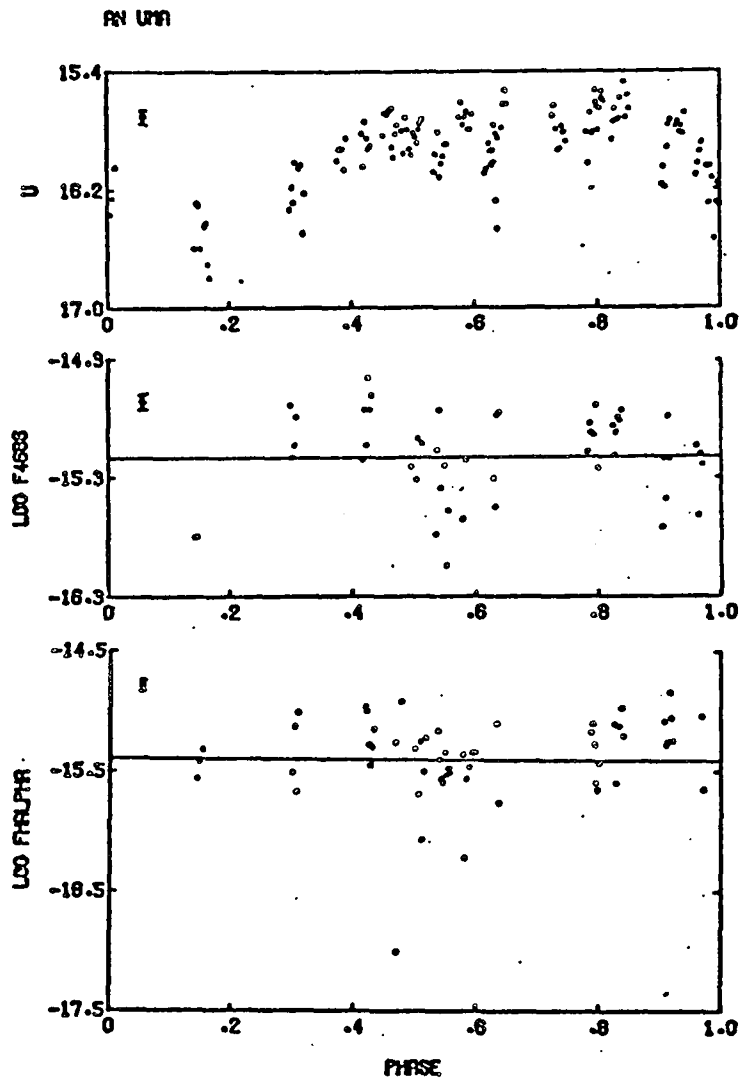
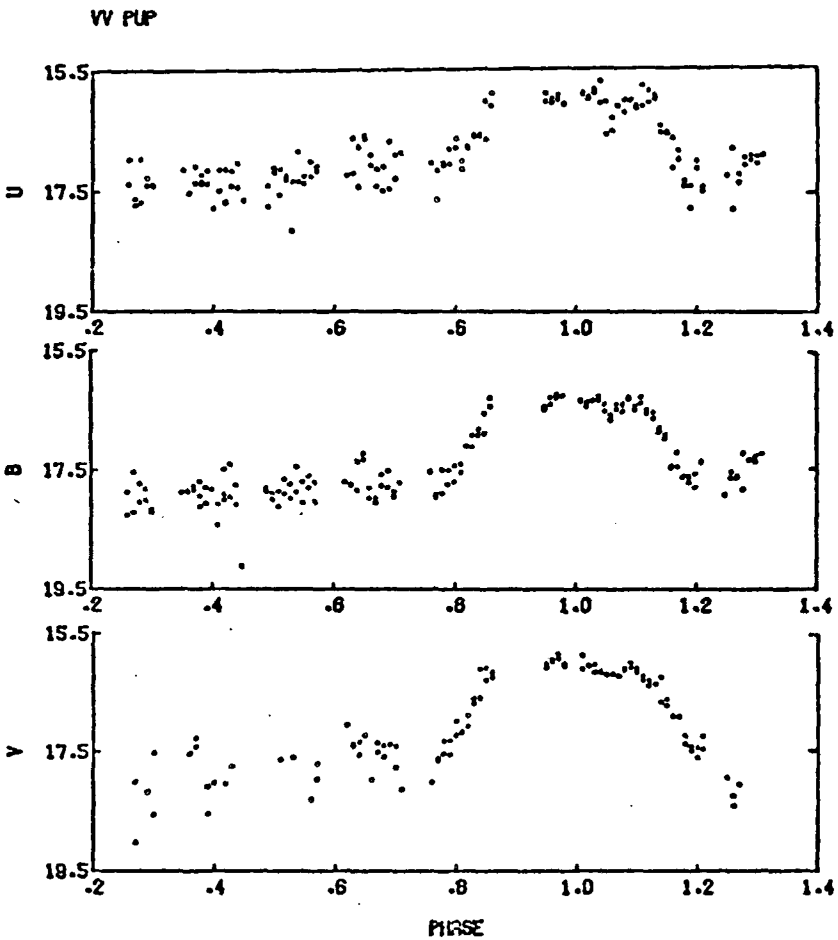


Fig. 2 UBV light curves of ANUMa obtained Jan. 30, 1979. Each point is a 30 sec. int. with uncertainties U ± .04; B ± .03; V ± .02. The U, 4686, and Hα data are 20 sec. int. obtained May 18, 19, & 21, 1979 with ± 1σ error bars as shown. Phasing is Tmin = 2442502.285 HJD + .0797520E (Krzeminski & Serkowski 1977).



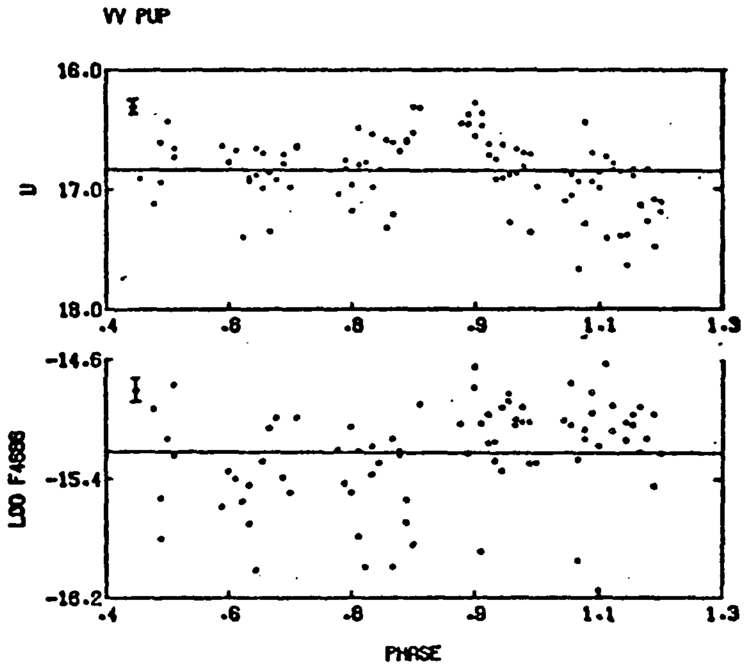


Fig. 3 The broad band UBV light curves of VV Pup obtained Jan. 30, 1979 and the U, narrowband 4686 light curves obtained one cycle later. Integration times were 30 sec. with uncertainties U ± .07 B ± .05, V ± .02 and error bars as shown for log 4686. Phasing used is Tmax = 2427889.6474 HJD + .0697468256 E (Herbig 1960).