A PHOTOMETRIC AND SPECTROSCOPIC COMPARISON OF THE CATACLYSMIC VARIABLES ON THE 2 SIDES OF THE PERIOD GAP AND AT A SPECIFIC ORBITAL PERIOD

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ABSTRACT. New and previously existing photometric colors and spectroscopic H and He line strengths are used to compare CV disk systems below the period gap (P=80-130 min) with those directly above (P=190-240 min). Significant differences are found in the mean U-B,V-J colors and in the Hβ equivalent widths on the 2 sides of the gap. A detailed comparison from UV-IR of 3 high inclination novalike systems with periods near 3.3 hr (PG1012-029,PG1030+590 and V1315 Aql) shows similar continuum distributions (and implied mass accretion rates) but large differences in high excitation lines (HeII1640,4686;CIV1550).

1. INTRODUCTION

Using all available data on cataclysmic variables (CV's) as of 1983, Patterson (1984) found a linear correlation of mass transfer rate with orbital period. Within this relationship, the objects with orbital period less than about 2 hrs showed less scatter than the spread of 3 orders of magnitude evident for objects with orbital periods above the 2-3 hr gap. Shafter, Wheeler and Cannizzo (1986) recently postulated that there may be a jump in accretion rate across the gap instead of a linear trend through the period range.

In order to further investigate the properties of accretion disk systems on both sides of the gap, the quiescent photometric colors and spectroscopic line strengths were compiled for all disk systems (the magnetic AM Her systems were excluded) just below (P=80-130 min) and just above (P=190-240 min) the period gap. The data set consisted of recent UBVJ measurements on previously unmeasured systems (described in detail in Szkody, 1986) combined with past compilations (Williams, 1983; Bruch, 1984; Patterson, 1984) and individual measurements from the current literature. The 25 objects below the gap are comprised of 19 known SU UMa stars and 6 other dwarf novae and novalikes which are highly likely to be members of this group. Of the 25, 16 have measured

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UBV magnitudes, 10 have J magnitudes, 18 have measured H equivalent widths and 11 have HeII4686 e.w's. The 28 known CV's in the 3-4 hr range are made up of 7 dwarf novae, 10 novalikes, 3 old novae and 8 VY Scl objects (systems which enter very low states while the mass transfer almost turns off). Of the 28, 20 have UBVJ measurements available, 25 have Hβ e.w.'s and 18 have HeII4686 e.w.'s.

2. RESULTS

The U-B,B-V and V-J colors and the Hβ and HeII4684 equivalent widths (in Angstroms) are plotted as a function of orbital period for the two sides of the gap in Figures 1 and 2. Table 1 gives the means and standard deviations for each group.

Table 1 Mean Colors and Equivalent Widths

	P=80-130min	P=190-240min
U-B	-1.03±0.17	-0.88±0.16
B-V	0.06±0.08	0.09±0.17
V-J	1.07±0.23	1.13±0.94
E.W.Hβ	76±45	32±30
E.W.4686	9±10	12±8

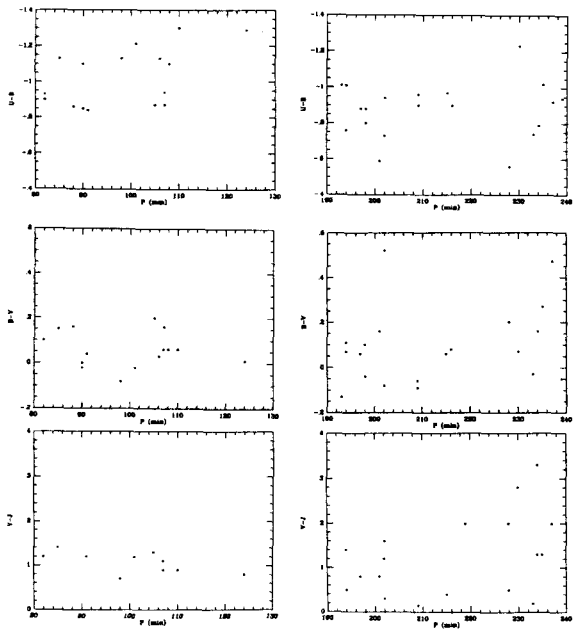

Figure 1. The colors as a function of orbital period.

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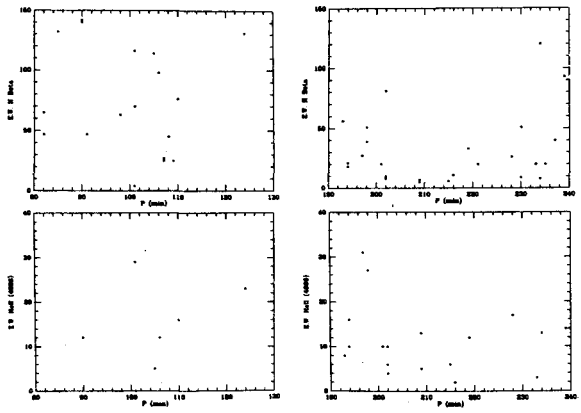

Figure 2. The Hβ and HeII4686 E.W.s(Å) as a function of orbital period.

2.1. Colors

The largest difference in colors across the gap occurs for the U-B and V-J colors. Half of the SU UMa type stars have U-B colors bluer than -1.0 while only 20% of the 3-4 hr group are this blue. As the U-B color spans the Balmer jump, the bluer colors are indicative of the greater strength of the Balmer continuum in the shortest period systems which have the lowest mass transfer and the lowest density disks. The V-J colors of the SU UMa group have much less scatter than the 3-4 hr group and there is a significant linear correlation in opposite directions within each group, with the SU UMa stars becoming bluer and the 3-4 hr systems becoming redder at longer periods. These trends are explicable in terms of the contributions of the convective (below the gap) vs radiative (above the gap) secondaries in contrast to the accretion disk contribution as the orbital period increases.

2.2. Line Strengths

There is a large difference in the Hβ line strengths on the 2 sides of the gap, with no significant linear trends within each group. While 30% of the SU UMa systems have Hβ e.w. > 100A, only 1 dwarf nova (YY Dra) has this large a strength among the 3-4 hr group. This is again in keeping with the expectation of extensive low density areas in the shortest period disks. There is no apparent difference in excitation on the 2 sides of the gap.

2.3. Three Similar Systems

In an attempt to determine the extent of variation in mass transfer rate and observable disk properties at a given period within the 3-4 hr group,

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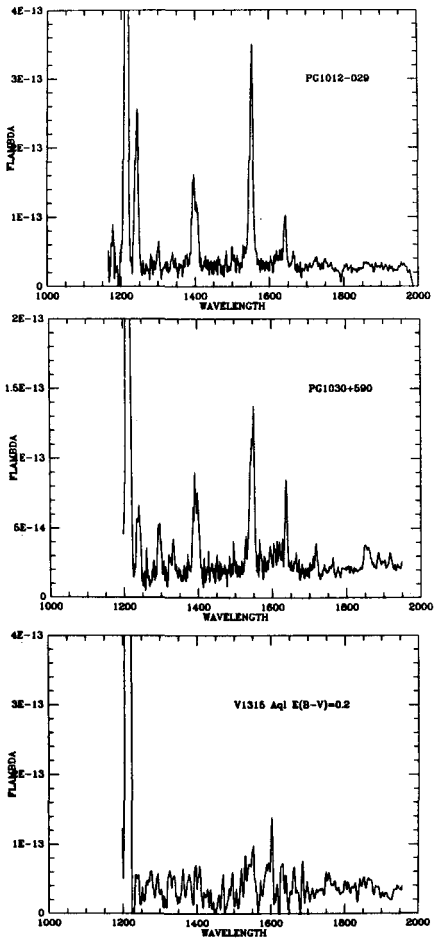

Figure 3. The IUE SWP spectra of the 3 novalikes.

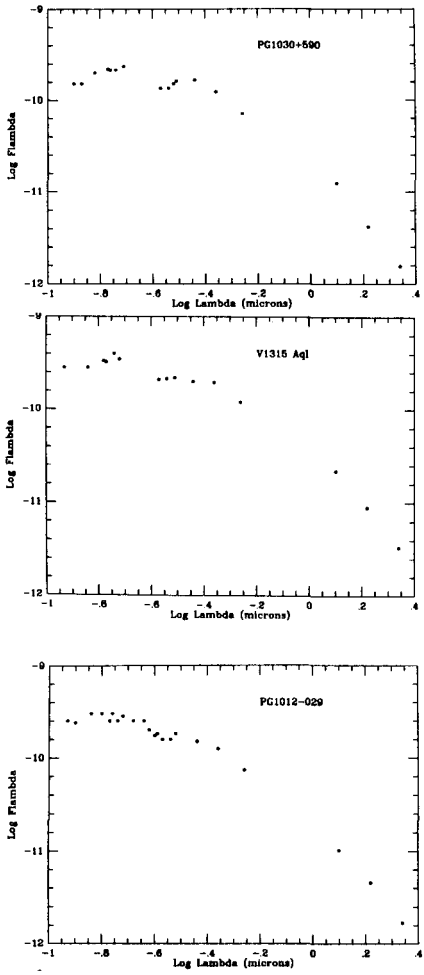

Figure 4. The continuum distributions from IUE to IR wavelengths.

a detailed comparison was made of 3 eclipsing novalike systems. An unusual trait evident in all 3 is the appearance of central absorption in the H and HeI lines only near phase 0.5, which is possibly related to mass loss through the outer Lagrangian point (Downes et al., 1986; Honeycutt, Schlegal and Kaitchuck, 1986). Table 2 lists the known properties while Figures 3 and 4 show the IUE SWP spectra and the continuum distributions from 1200A to 2.2 microns (SWP21536 for PG1012-029 was extracted from the IUE data bank; the other 2 spectra were obtained in Nov. 1985).

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Table 2 A Comparison of 3 Novalikes of Similar Period

	PG1012-029	PG1030+590	V1315 Aql
Orbital P(min)	194 a	197 b	201 c
Eclipse depth	1.5mag (B)	1.4mag (V)	1.7mag (V)
Inclination	79°	---	78°
Primary mass	0.6M	---	0.9M
Sec mass	0.3M	---	0.4M
E(B-V) d	0	0	0.2
V e	14.3	14.4	13.8
B-V e	0.11	0.06	0.16
U-B e	-0.76	-0.88	-0.59
V-J e	0.5	0.8	0.8
E.W. Hβ	21	27	20
E.W. HeII4686	16	31	10
E.W. CIV1550	125	81-208	26
E.W. HeII1640	15	17-45	12
IUE slope f	-0.6	-0.3	-0.5

a Ref for P, i and masses is Penning et al., 1984
b Ref for P, optical e.w.'s is Hessman and Shafter, private comm.
c Ref for P, colors, masses is Downes et al., 1986
d Reddening determined from 2200A feature in IUE spectra
e Corrected for above reddening
f Best fit power law to Log F vs Log Lambda

All 3 systems have similar continuum distributions, implying similar $\dot{M}$ ($\sim 10^{-10}$ $M_\odot$/yr from a Williams and Ferguson, 1982, model fit) which is right in the middle of Patterson's log P vs Log $\dot{M}$ relation. The H line equivalent widths are also very similar, implying similar outer disk conditions. The major difference in the 3 lies in the excitation, with PG1030+590 exhibiting much stronger (3-4 times) CIV1550,HeII1640,4686 line strengths than V1315 Aql. This increasing excitation is apparently uncorrelated with increased $\dot{M}$ as the slope of the flux distribution is flattest for PG1030+590 and it has the smallest phase 0.5 absorption of the three. The implications are that under similar inclinations, the UV slope, the optical colors and the H line strengths can be indicators of $\dot{M}$ but the high excitation phenomena are not simply related.

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