

INTERNATIONAL OBSERVING CAMPAIGN: PHOTOMETRY AND SPECTROSCOPY OF P CYGNI

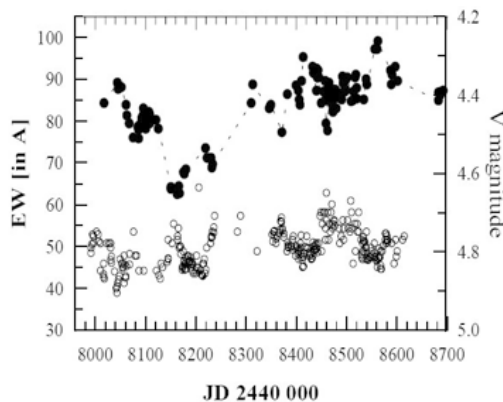
ERNST POLLMANN AND THILO BAUER, ASPA-SPECTROSCOPY GROUP

The international observing campaign, Photometry and Spectroscopy of P Cyg, is a common project of the AAVSO, Active Spectroscopy in Astronomy (ASPA), and the BAV. Launched in November 2008 (see *AAVSO Special Notice No. 131*), the project yielded very encouraging results. Markova (2001) and Markova *et al.* (2001) suggested an anti-correlation between the variations of the equivalent width (EW) of the H α line profile and the variations of the photometric V magnitude of the star P Cyg. The variability of the equivalent width of the H α line was up to 10Å. In this investigation the time scale of the variability is found to be between 40 and 60 days. Participating observers are given in Table 1.

The primary goal of the project is to continue observations to confirm the anti-correlation between the photometric variability and the spectroscopic variations suggested by Markova. In addition, further information about the flux of the spectroscopic lines will be obtained.

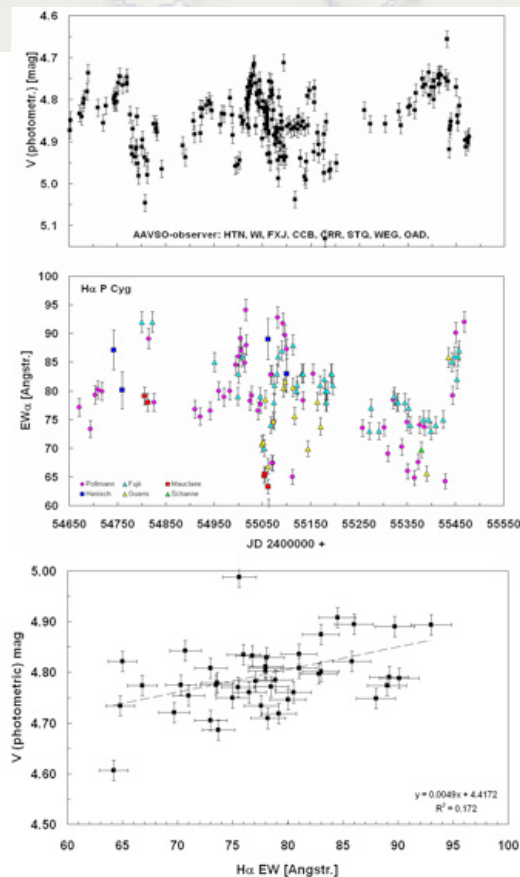
The proposed anti-correlation is based on a direct comparison of earlier photometric and spectroscopic observations (Markova 2001). If the equivalent width of the H α line decreases, the stellar brightness increases and vice versa (Figure 1). It is assumed that the variability of the width of the line profiles is more likely caused by variations of the continuum flux and not by variations of the density of the stellar winds. Therefore, the influence of the variability of the continuum flux will be our primary concern, if the properties of the stellar winds and rate of mass loss are studied.

Figure 1. Plot of the photometric V magnitude versus H α -equivalent width (from Markova *et al.* 2001). An anti-correlation is found from the graph.



So far, our own results (Figure 2) well represent the anti-correlation results of Markova. Strict anti-correlation is expected if the variation of the continuum flux is independent from spectroscopic variations. If the photometric flux of the spectral line is constant over time, an increase of the continuum flux will yield a smaller flux from the evaluation of the equivalent width found in the line profiles. A simplistic normalization of the continuum is a typical source of the problem. The lower plot of Figure 2 shows this anti-correlation as V versus H α EW. The small coefficient of correlation of only 0.17 has at least two causes:

Figure 2. In analogy to the results in the investigations of Markova *et al.* (2001, in Figure 1) the comparison of the behavior of EW and V during our campaign.



- differences in the continuum fluxes. Strictly applied, the continuum flux at 6563Å should be used. But here ΔV is a good approximation since the color indices of P Cygni do not vary greatly.
- further intrinsic components (temperature, density, velocity).

To find out if and how the flux obtained from the spectral line profiles varies, the equivalent width measurement is corrected for the effect mentioned in the previous section.

From the definitions of equivalent width $EW = \sum \frac{F_c - F_\lambda}{F_c} d\lambda$ and the photometric stellar magnitude $J2/J1 = 10^{-0.4(m2-m1)}$ the relation yields: $F = EW / 10^{(0.4 V_{phot})}$.

In practice, EW is corrected with a simple division by $10^{(0.4 V_{phot})}$. It is important to consider the absolute flux of the line because its variations are caused by the effects of mass loss, stellar wind density, and changes of the ionization of the chemical elements in the outer gas shell. In the current campaign we have already obtained 46 nearly simultaneous measurements of the equivalent width EW and the photometric flux in the visual (V) spectral range.

Figure 3 attempts to display if and to what extent the intrinsic line flux (a continuum-corrected EW) depends on V_{phot} . From a statistical point of view one can say that the low 0.12 correlation coefficient (which should be zero after the continuum correction), with consideration of the measurement uncertainties, suggests the conclusion that the H α line flux is independent of V_{phot} .

This would confirm that the uncorrected EW variations with (almost) constant line flux predominantly result from changes in V, and (if so) confirms the anti-correlation of EW to V_{phot} shown in Figures 1 and 2.

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P CYGNI CAMPAIGN
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Figure 3. The relationship between line flux and V magnitude; correlation coefficient is only 0.12, thus showing anti-correlation.

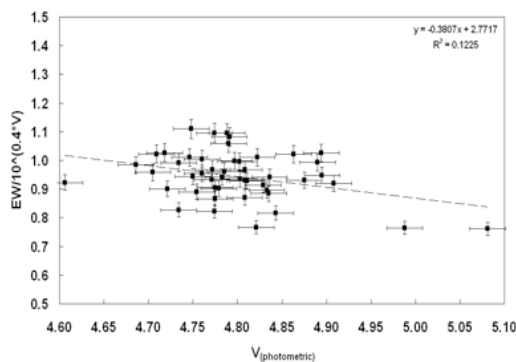
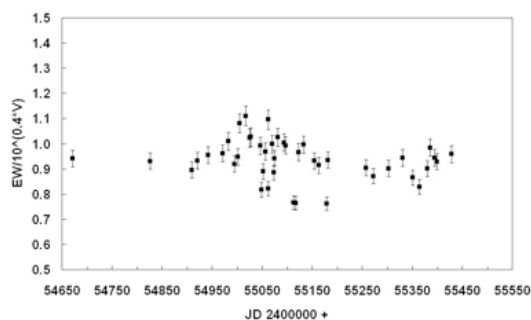


Figure 4. Intrinsic flux of the H α line since 2008/11 to 2010/11.



The temporal variation of the absolute line flux of H α is found to be at a nearly constant level with a certain deviation (Figure 4). This kind of plot represents changes of the mass loss, stellar wind density, and changes of the ionization. The 46 EW and V-measurements of the current campaign are, of course, from a statistical point of view, still not sufficient to make firm statements regarding the simultaneous temporal behavior of V and the intrinsic line flux. In order to achieve this aim further, multiyear, simultaneous spectroscopic and photometric measurements are needed. Please keep observing P Cygni!

Table 1. Participating observers in the P Cygni project.

AAVSO (V_{phot})		Spectroscopy (H α -EW)
Adrian Ormsby	David Williams	Mitsugu Fuji (Japan)
Robert E. Crumrine	E. G. Williams	Benjamin Mauclaire (France)
Jim Fox	Charles L. Calia	Joan Guarro (Spain)
Kate Hutton	Thomas L. Peairs	Lothar Schanne (Germany)
Nick Stoikidis	Jeffery G. Horne	Bernd Hanisch (Germany)
		Ernst Pollmann (Germany)

Acknowledgements

We are grateful to Dr. Dietrich Baade (ESO-München), Dr. Otmar Stahl (Landes-Sternwarte Heidelberg), and Prof. Dr. Edward Geyer (formerly Director Observatorium Hoher List, University-Bonn) for their critical comments which led to essential improvements of this work.

References

- Markova, N. 2001, *P Cygni 2000, 400 Years of Progress*, ASP Conference Series, Vol. 233.
 Markova, N., Morrison, N., Kolka, I., and Markov, H. 2001, *Astron. Astrophys.*, **376**, 898.

Z CAMPAIGN REPORT

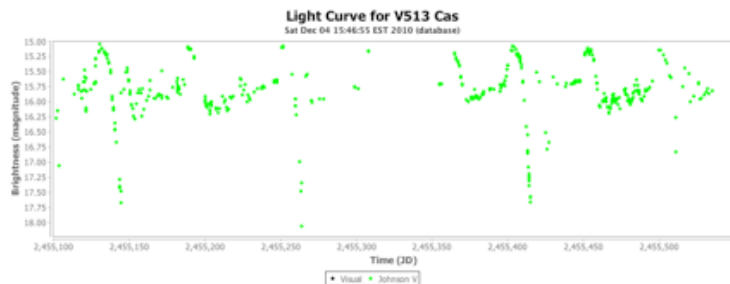
MIKE SIMONSEN (SXXN), AAVSO

At the first quarter point of the second year of this campaign we have some interesting results and publications in print and in preparation. I'd like to take this opportunity to thank all the observers reporting their data on Z CamPaign stars. Your data is driving this project, and I appreciate the time and effort you have invested in it.

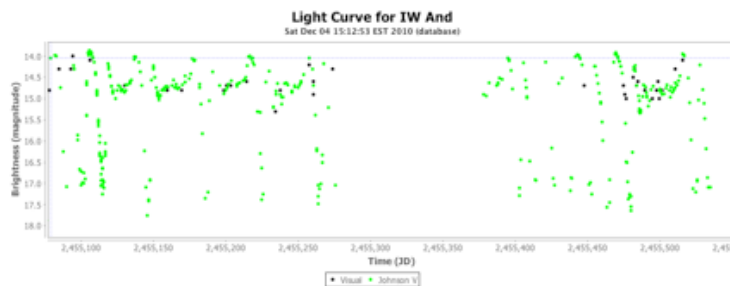
Most of the following light curves are roughly January 2009 to the present. They were all plotted using VStar.

WW Cet WW Ceti is in standstill as of this writing. This is the first historical standstill of this CV, and as such has given us the chance to classify this dwarf nova unambiguously as a Z Cam. Our paper on this standstill and WW Ceti's new classification has been accepted by *AAVSO* and is available on the AAVSO website (<http://www.aavso.org/ejaavso132>) and on the arXiv pre-print server (<http://arxiv.org/abs/1012.1545>). Special thanks go to John Bortle and Rod Stubbings for their invaluable data.

V513 Cas This IW And star continues to exhibit quasi-periodic fades that resemble eclipses every 3–4 months, as well as brief maxima that have gone from ~60 days apart to ~45 days on average lately.



IW And The cousin to V513 Cas, IW And exhibits a similar behavior, with eclipse-like features every 39 days or so and short outbursts every 40 days apart on average.



The pattern for this season changed to deep fades 11–16 days apart and outbursts every 20–30 days, but it looks like the star is transitioning into the prior behavior pattern in the last few weeks.

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