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Magnetic activity in the atmospheres of F-type binaries: V963 Cyg, XZ CMi, V965 Cyg

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Abstract. We have found photometric indications that Interacting Eclipsing Binaries of early to mid F spectral type (and possibly A) have strong magnetic activity which would arise from convective atmospheres. Light curve solutions and periodicity studies revealing spots, magnetic breaking and magnetic cycles are presented in XZ CMi, V965 Cyg and V963 Cyg.

Keywords. Stars: activity, stars: binaries: eclipsing, convection

1. V963 Cygni

Our analysis of UBVR$_c$I$_c$ observations of V963 Cygni taken 19-25 July 2004 indicates that it is a detached F6.5 ± 1 binary. The light curves show strong distortions in the out-of-eclipse portions, which we assumed are due to several large spot regions. If this assumption is correct, V963 Cyg has strong magnetic activity. In addition, the out-of-eclipse portions of the light curves have somewhat different shapes in each effective wavelength. Particularly, the R curve is very different from the B curve in the shoulder of the secondary eclipse.

As with the other systems included with this paper, we premodeled the light curves with Binary Maker 3.0 (Bradstreet 2002) and then used the resulting parameters as starting values for a simultaneous light curve solution with the updated 2004 Wilson Code (Wilson & Devinney 1971, Wilson 1990, 1994, Van Hamme & Wilson 1998). This code includes full stellar atmospheres based on Kurucz atmospheres, rather than those of a black body, and a detailed reflection treatment along with 2-D limb darkening coefficients. In addition to spot modeling for this binary, we tried adjusting the F parameter (non-synchronous rotation) and third-light. Both of these gave negligible values. Our best solution indicates that the binary is a detached system with a mass ratio $= 0.85 \pm 0.01$. The component temperature difference was only about 280 K. This solution used 4 spots: 1 cool spot on component 1, and 3 hotspots on the second component. We note here that the eclipses are partial, so our model is preliminary in nature, but a mass ratio near one is strongly suggested. Radial velocity curves are needed for a complete solution.

2. XZ Canis Minoris

XZ Canis Minoris is an F3 binary, with a history of published light curves displaying asymmetries in and out of eclipse portions of its light curve. Our present period study

covering 67 years gives a long term negative quadratic fit to the O-C residuals, as well as a sinusoidal 23 year oscillation. The negative quadratic term may indicate the occurrence of magnetic breaking due to solar activity. Indeed, the sinusoidal term suggests a magnetic cycle. We should point out that the periodic fit is based largely on high precision, more recent data. We believe that high precision timings afforded by today's CCD detectors should be regularly analyzed for the effect of magnetic cycles. High energy observations from spacecraft should be undertaken to verify these purely photometric results.

3. V965 Cygni

Our UBV$R_c I_c$ observations of V965 Cyg were taken during June 2004. They show the binary is a 14th magnitude W UMa System. The dereddened $(B\text{-}V)_0$ $\sim$0.07 indicates an A3V-type. In addition, it has a critically high fill-out contact binary ($> 95\%$) and a large polar cool spot region (colatitude $5 \pm 2^\circ$). Also, this system appears to be very close to coalescing into an FK Comae-type star. This is the ultimate destiny of solar type contact binaries due to magnetic breaking. Both the high altitude spot and the contact configuration point to strong and continuous magnetic activity.

References

Bradstreet, D.H. 2002, *BAAS* 34, 1224
Van Hamme, W.V. & Wilson, R.E. 1998, *BAAS* 30, 1402
Wachmann, A.A. 1961, *Bergd Abh7* #8
Van Hamme, W.V. & Wilson, R.E. 1998, *BAAS* 30, 1402
Wilson, R.E. & Devinney, E.J. 1971, *ApJ* 166, 605
Wilson, R.E. 1990, *ApJ* 356, 613
Wilson, R.E. 1994, *PASP* 106, 921

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