The 2009 July Superoutburst of IL Vulpeculae

David Boyd
5 Silver Lane, West Challow, Wantage, OX12 9TX, UK; drsboyd@dsl.pipex.com

Tut Campbell
7021 Whispering Pine, Harrison, AR 72601; jmontecamp@yahoo.com

George Roberts
2007 Cedarmont Drive, Franklin, TN 37067; georgeroberts@comcast.net

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Abstract IL Vulpeculae experienced its first recognized superoutburst in 2009 July, thereby identifying itself as a UGSU-type dwarf nova. We measured the superhump period and amplitude as 0.071(1) day and 0.12 magnitude, respectively, and estimate its orbital period to be 0.069(1) day.

1. Background

The first reported outburst of IL Vul was in *IBVS* No. 80 by Hoffmeister (1965) using the name S9068 Vul. He observed it on 1964 August 14.98 UT at magnitude 15 on plates taken at the Karl-Schwarzschild Observatory. He reported its normal magnitude as being in the range 19–20. In the same paper he also reports two "rather certain" observations, on 1930 August 20 at magnitude 15.5 and 1955 September 22 at magnitude 15.0, found during a search of plate archives from 1928 to 1964. No outburst brighter than magnitude 15 was found.

Bruch *et al.* (1987) listed IL Vul as an identified dwarf nova, noting it is extremely faint on POSS blue prints. They reported five observations of it during 1981 with one outburst detected on 1981 September 5.91 but they did not give a magnitude. Liu *et al.* (1999) reported a spectroscopic observation on 1997 August 8.71 UT with *V* magnitude 17.8, and they related its spectrum as that of a dwarf nova after outburst. On the available evidence, the *General Catalogue of Variable Stars* (GCVS; Kholopov *et al.* 1985) classified IL Vul as a UG-type dwarf nova with unknown orbital period. At the time of writing, its classification in VSX (Watson *et al.* 2007) is the same.

A further outburst was reported on 2005 July 3.388 at magnitude 15.5CR by Schmeer (2005). Observing the following day, Krajci (2005) saw the star fading steadily at magnitude 16.8 with no sign of superhumps. This was probably a normal outburst. A search of the AAVSO International Database revealed several positive observations between 2005 July and 2008 July in the magnitude range 16.7 to 18.4, which may be normal outbursts, but nothing brighter until the present outburst.

2. Observations

The 2009 outburst of IL Vul was first reported to several variable star newsgroups by Muyllaert (2009). He observed it unfiltered with the Bradford Robotic Telescope and measured its magnitude on July 09.144 UT as 15.69 using a preliminary USNO-derived sequence.

DB obtained unfiltered time-series observations on July 9.931–10.080 UT while TC and GR obtained further unfiltered data on July 10.282–10.406 UT. Both sites were operating under poor conditions. Bad weather persisted, with DB being able to obtain only short runs on July 14.922–14.979 UT and July 19.947–19.951 UT.

Astrometry using images taken on July 9 gives a mean position for IL Vul of R.A. $20^h\ 38^m\ 32.72(1)^s$, Dec. +22° 42' 17.0(1)" (J2000). Figure 1 shows an image of the field taken on July 9.984 UT.

V magnitudes of possible comparison stars around IL Vul were derived from r' magnitudes in the CMC14 catalogue (Univ. of Cambridge 2005) and *J* and *K* magnitudes in the 2MASS catalogue (Skrutskie *et al.* 2006) using the formula in Dymock and Miles (2009). Comparison stars were selected which were as blue as possible to minimize their color difference from the dwarf nova.

3. Analysis

All images were dark-subtracted and flat-fielded and instrumental magnitudes obtained by aperture photometry. Absolute magnitudes were then calculated by reference to the comparison stars. Heliocentric corrections were applied to the times of observation. The resulting light curve is shown in Figure 2. The downward slope indicates we observed the outburst during its later stages. Figure 3 expands the data from July 9 and 10. These show the first recorded superhumps in IL Vul and confirm that this is a UGSU-type dwarf nova.

A Discrete Fourier Transform (DFT; Vanmunster 2007) power spectrum of the data from July 9 and 10 is shown in Figure 4 and reveals two prominent signals at periods of 0.071(1) day and 0.088(2) day with more power at the shorter period. The distribution of alias signals is as expected from a spectral window analysis of the data and there are harmonic repeats of this pattern with decreasing power.

To decide which of these is the superhump period, we measured the times of maximum of the four superhumps recorded on July 9 and 10 by fitting a quadratic to the light curve around each maximum. We then fitted a linear ephemeris to these times of maximum to determine the superhump period. Depending on the assignment of cycle number to each maximum, we find the superhump period to be either 0.0712(3) day with χ^2 of 3.0 or 0.0890(4) day with χ^2 of 85.2. We therefore adopt the shorter period as the correct superhump period. Taking the more conservative estimate of its uncertainty, we report the superhump period

as 0.071(1) day. The phase diagram obtained by folding the data on this period is shown in Figure 5. The superhump amplitude is 0.12 magnitude.

As we observed the later stages of the outburst, during what Kato *et al.* (2009) refer to as stage C, we use their relationship between the superhump period and the orbital period in this regime to estimate an orbital period for IL Vul of 0.069(1) day (1.65 hours).

4. Conclusions

We have detected superhumps during the outburst of IL Vul in 2009 July, confirming this is a UGSU-type dwarf nova. Although our observations were limited, we were able to measure its superhump period and amplitude to be 0.071(1) day and magnitude 0.12, respectively. We estimate empirically that its orbital period is 0.069(1) day.

5. Acknowledgements

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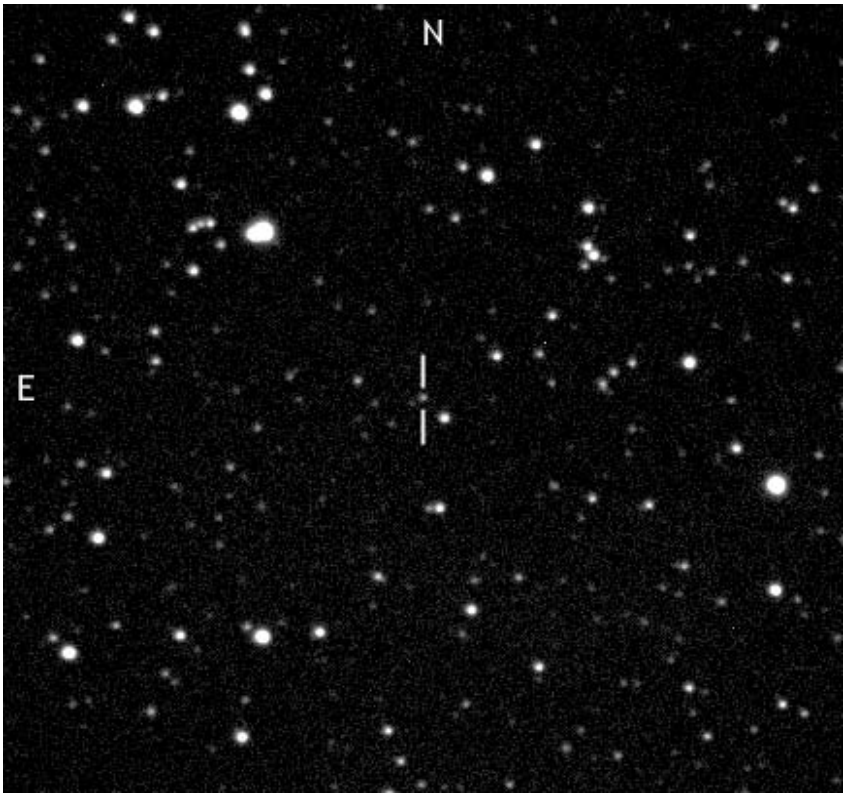

Figure 1. Image of the field around IL Vul taken on 2009 July 9.984 UT—10 × 10 arcmin.

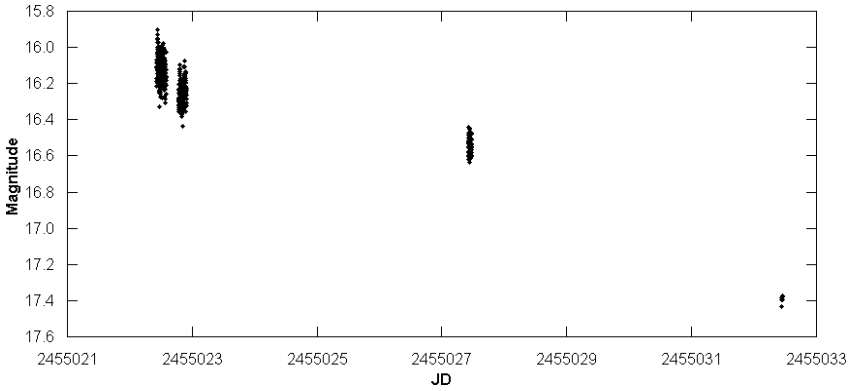

Figure 2. Light curve of the 2009 July superoutburst of IL Vul.

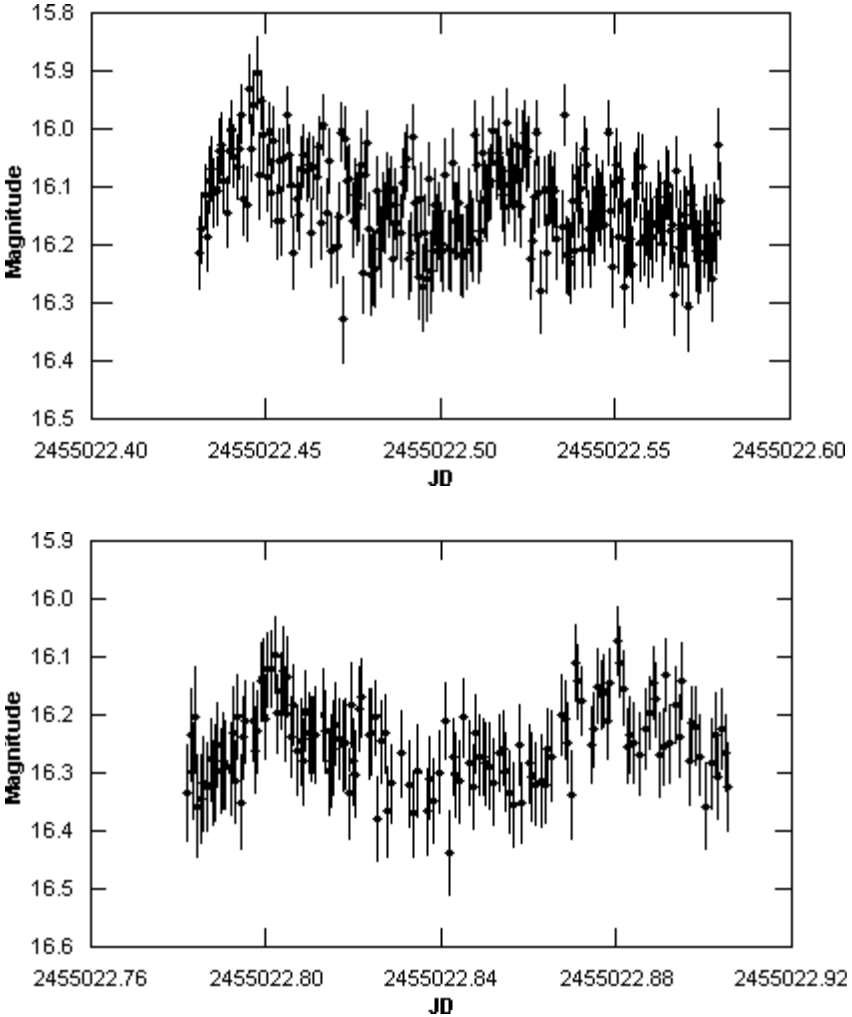

Figure 3. Superhumps recorded on 2009 July 9 (top) and 10 (bottom).

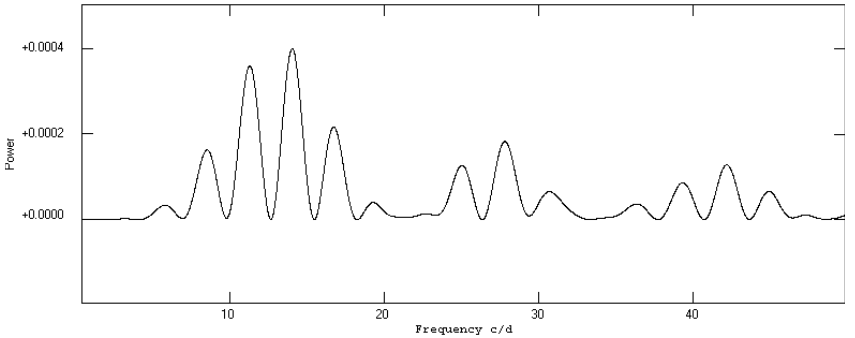

Figure 4. Discrete Fourier Transform power spectrum of data from 2009 July 9 and 10.

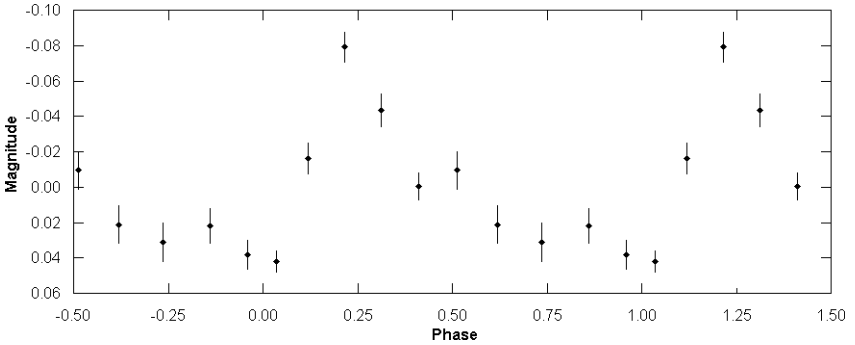

Figure 5. Phase plot for a period of 0.071 day.