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SS URSAE MINORIS: A NORMAL U Gem TYPE DWARF NOVA

SS Ursae Minoris was discovered as an X-ray source E1551+718 and identified then with an uncataloged dwarf nova by Mason et al. (1982). In quiescence, the star is usually around 17 magnitude, in outbursts it reaches 13 magnitude. The spectra of the star taken in quiescence (Mason *et al.* 1982) show Balmer and helium emission lines which are common for dwarf novae. The HeII 4686 emission is weak which suggests that the star does not have strong magnetic field and is typical unmagnetized dwarf nova.

All emission lines in the SS UMi spectrum are very broad (FWHM $\approx$ 2000 km/s emission superposed on FWHM $\approx$ 7000 km/s feature). Moreover, they reveal a clear, double peaked structure. Therefore, inclination of the system is probably high and one can expect presence of optical variability caused by changing visibility of the "hot spot" on accretion disk around primary component, or even eclipses.

The possibility of light variation has been strengthened to some extent by Andronov (1986). He observed SS UMi photographically and found variability in the range of 1 magnitude. Moreover, he claimed that the orbital period of the star is slightly longer than 2 hours. If so, SS UMi would be an ultra-short period dwarf nova – presumably of the SU UMa type. The suggested period would fall almost exactly at the short period boundary of the 2 – 3 hours "period gap" in the orbital period distribution of cataclysmic variables. Therefore, if this period is indeed the correct one, the star could be a very important object for study evolution of the cataclysmic binaries. The CCD photometry of SS UMi which is reported here has been performed to resolve these issues.

The CCD photometric observations of SS UMi were carried out on two nights (June 2/3 and 3/4, 1989) at the Dominion Astrophysical Observatory, Victoria. The 122-cm telescope equipped with the CCD camera and RCA CCD chip was used. The observations consisted of series consecutive, V-filter images of the SS UMi field. At least one B frame per night was also obtained to check colour of the variable and comparison stars. The exposure times were equal to 120 sec. in V and 180 sec. in B filters.

TABLE 1. Positions of the Comparison Stars.

Star	R.A.	Dec.
l	60"E	55"N
r	25"W	15"N
s	25"W	30"S

The images were de-biased and flat-fielded using the standard procedures within the IRAF package. All measurements were carried out with the DAOPHOT photometry package (Stetson 1987). Differential magnitudes of the variable were determined relative to star *l* on Andronov (1986) finding chart. Stars *r* and *s* served as secondary comparison stars. Positions of the comparison stars relatively to SS UMi are given in Table 1. The accuracy of individual, differential magnitude is of the order of 0.02 magnitude based on measurements of two comparison stars.

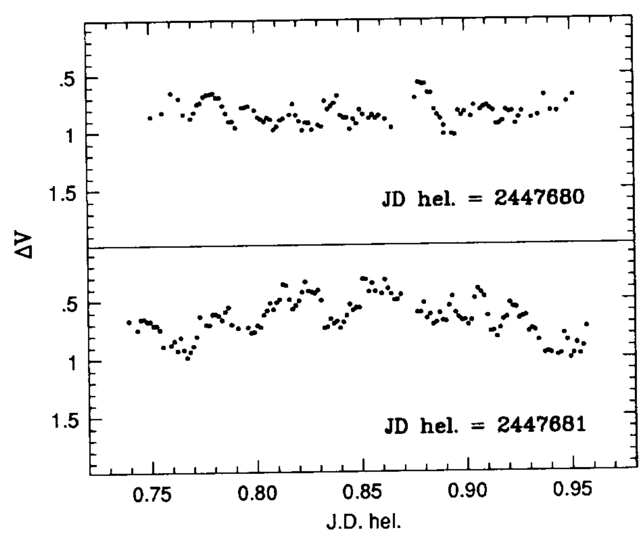

Figure 1.

Figure 1 shows the differential light curves from both runs. SS UMi was apparently at quiescence during observations at a mean brightness level of 16.6 magnitude (estimated accuracy of the zero point is about 0.2 mag). The variability has two obvious components:

a minute time-scale flickering and an hour-scale variability. The flickering activity of SS UMi seems to be very strong. Brightness increases amounting up to 0.4 magnitude and lasting several minutes are often present. The relatively large scatter of observations in some parts of the light curves is evidently caused by the short time-scale variability, smeared by the longer integration time.

The more interesting, orbital variability seems to be present as well. The hump observed during the second night looks like a typical orbital hump in dwarf novae (e.g. U Gem, Warner and Nather 1971). The large amplitude of this hump, 0.6 mag, suggests that the inclination of the system is indeed high. However, it is not high enough to cause eclipses; no evidence of eclipses can be found in our data. It is clear from Figure 1 that the orbital period must be much longer than 2 hours suggested by Andronov (1986). Unfortunately, because of short duration of the night we were not able to obtain runs longer than 5 hours. We did not catch two evident maxima or minima on any single night to establish the orbital period more precisely. We can only give its lowest limit at 5 hours.

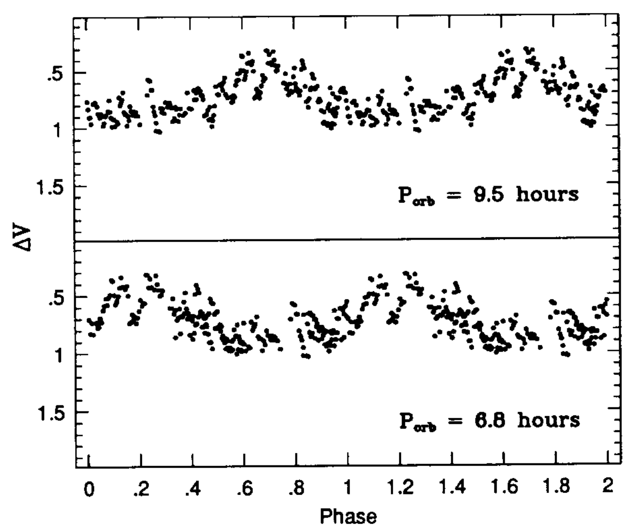

Figure 2.

However, having data from two nights, we can speculate about the value of the period. The first run evidently covered the minimum, whereas the second one the maximum of light. Assuming that the mean level of light did not change between the runs, we tried to fold the data from both nights together to get the smoothest combined light curve i.e. we applied the phase dispersion minimization method of Stellingwerf (1978). The searched periods were limited to be shorter than 12 hours, as is typical for cataclysmic variables. The periods giving best results are 9.5 hours and its 1-day alias, 6.8 hours. We prefer the second value because if the period were 9.5 hours, one could expect clear evidences of secondary in the spectrum of SS UMi. This results from the strict relation between the size and mass of secondaries and the orbital period in cataclysmic variables (Warner 1976). Examination of the red part of the spectrum (Mason *et al.* 1982) indicates that the shape of the spectrum is more consistent with the shorter 6.8 hours period. Figure 2 presents observational data folded with the periods 9.5 and 6.8 hours and repeated twice for clarity. The zero-phase moments have been chosen arbitrarily on this figure.

Summing up, SS UMi is a normal dwarf nova, probably of the U Gem type. It has a relatively high orbital inclination which is, however, insufficient for eclipses. It is not an ultra-short period system, as it was suggested by Andronov (1986). The orbital period of SS UMi is apparently longer than 5 hours, most probably equals 6.8 hours.

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