Parameters of the Dwarf Nova SS Cygni Obtained From *UBV* Photoelectric Light Curve Analysis

Irina Voloshina
Tatiana Khruzina
Sternberg Astronomical Institute, Universitetskij pr.13, Moscow, Russia

Abstract We present the results of analysis of *UBV*-photoelectric mean light curves of SS Cygni at quiescence.

1. Discussion

Light curves of the dwarf nova SS Cyg were constructed on the basis of night-long photoelectric observations during the period 1982–1995. All observations were carried out at quiescence, with a *UBV* photometer on the 60-cm telescope of the Sternberg Astronomical Institute in Crimea. The whole sample consists of more than 2,000 measurements in three colors. The individual measurements are accurate to 1% in *V* and *B* bands, and to 2–3% in *U*. Observations on different nights were reduced to the same brightness by subtracting the mean for the night from the individual measurements. Mean light curves of SS Cyg were derived by the method of moving averages. The orbital phases were calculated using the elements of Voloshina and Luytyj (1993).

A new version of computer code using the Nelder-Mid method together with the genetic algorithm (Charbonneau 1995) was applied to determine light curve fitting parameters. To estimate fit quality, a χ^2 criterion was used.

The system is assumed to consist of a late-type optical star filling its Roche lobe, and a white dwarf, which is surrounded by an optically thick accretion disk lying in the orbital plane. The disk is geometrically thin near the white dwarf surface and becomes geometrically thick at the outer edge. It can be heated by optical radiation from both the white and the red dwarfs. The hot spot is at the site of collision of the gaseous stream with the accretion disk and contributes to the optical luminosity of the system at the orbital phases out of eclipse. The draft view of the SS Cyg system at the orbital phase $\varphi = 0.7$ is shown in Figure 1 ($\varphi = 0.0$ corresponds to superior conjunction of the white dwarf).

Planckian spectrum is assumed for both components and the different parts of the accretion disk. The model also implies asynchronous rotation of the components (Khruzina 1998). The results of our fitting are shown in Figure 2.

2. Results

The following parameters of the dwarf nova SS Cyg were obtained from analysis of the *UBV* light curves:

- The mass ratio $q = M_{wd} / M_{rd} = 1.6 \pm 0.4$
- The inclination of the system $i = 57° \pm 2°$
- The effective temperature of the red dwarf ≈ 4,300° (K 5–6V)
- The accretion disk radius $R_d = 0.26 - 0.40a$
- The thickness of the outer edge of the accretion disk $0.04a$
- The temperature of the outer edge of the accretion disk ≈ 3,000–3,500 K
- The temperature of the white dwarf $T_{wd} = 23{,}000–24{,}000$ K
- The radius of the white dwarf $R_{wd} \approx (0.007–0.011)a$ K
- The mass of the red dwarf $M_{rd} = (0.22–0.32) M_{\odot}$
- The mass of the white dwarf $M_{wd} = (0.37–0.41) M_{\odot}$
- The hot spot radius $0.015a$, its azimuth 65°, and temperature ≈ 10,000 K

3. Acknowledgements

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References

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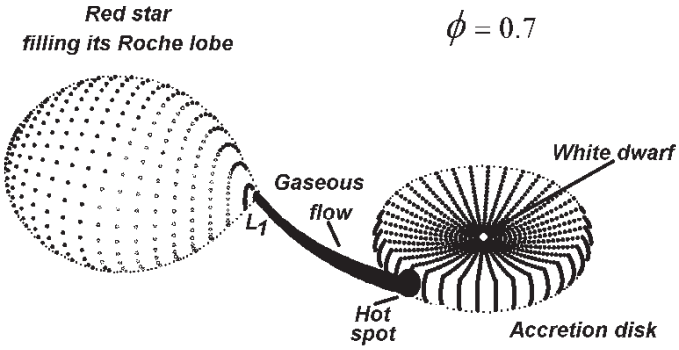

Figure 1. The dwarf nova SS Cyg.

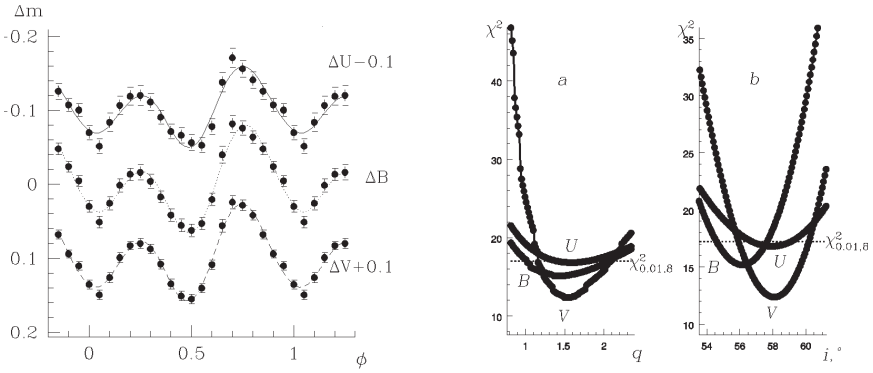

Figure 2. Left panel: the fitting of the mean observational light curves of SS Cyg (points with bars) by the model ones (shown by lines) for parameters: $i = 57°$, $q = 1.6$, $T_{rd} = 4{,}300$ K, $T_{wd} = 23{,}000$ K, $R_{wd} = 0.009a$, $\varphi_{sp} = 65°$, $T_{sp} = 10{,}000$ K, $r_{sp} = 0.06R_d$, and $R_d = 0.3a$. The vertical bars represent rms errors of each point. Right panel: χ^2 deviation as a function of q (a) and i (b) for the optimal parameters. The dotted line marks the confidence level 1% by χ^2 criterion.