COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3610

Konkoly Observatory
Budapest
23 May 1991

HU ISSN 0374 - 0676

THE UNUSUAL ECLIPSING VARIABLE SS LACERTAE

The star SS Lac is a probable member of the open cluster NGC 7209. On the basis of visual and photographic observations it has been classified as an eclipsing variable. The star is listed in the GCVS with a period of about 14.4 days and an amplitude of 0.4 mag in both primary and eccentric secondary minima.

In a strong contrast Zakirov et al. [7] have published photoelectric observations, showing that the brightness variation was at a standstill during the years 1984 - 89. An attempt has been made to shed light on the situation by examining sky patrol plates of the Sonneberg Observatory and making reduction procedures for all available original observations.

There is a total of about 6000 photometric data. The material dates from the years 1890 - 1989 (see ref. [1] to [7]). The individual sequences of comparison stars of different authors are reduced to the photoelectric sequence of NGC 7209 measured by Hoag et al. [8]. For a detailed analysis of all original data and the reduction procedures see also ref. [3].

The amplitude of the eclipses of each data sample plotted against the time of observation yields a well defined relation which describes the continuous change of the amplitude.

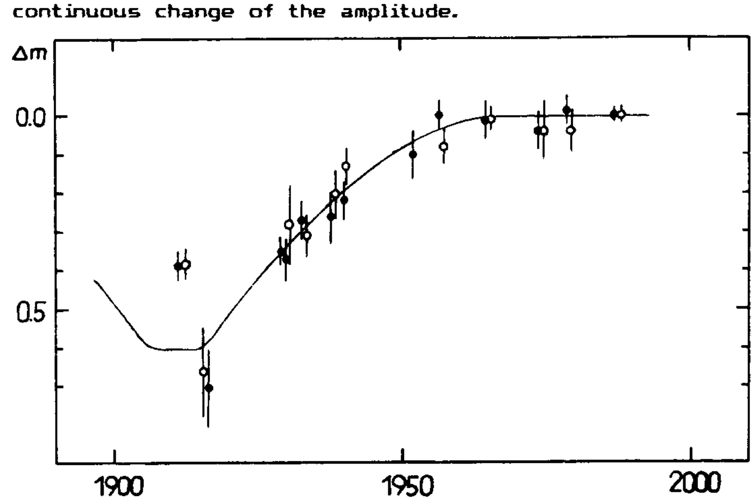

Figure 1: The disappearance of the eclipsing amplitude of SS Lac. Filled (open) circles represent primary (secondary) minima. The solid line is calculated (see text).

On the assumption that the observed variable amplitude is due to a continuous change of the inclination i of the orbital plane of the eclipsing binary, the greatest amplitude corresponds with $i=90°$. In particular a constant di/dt leads to an "eclipsing light-curve" with a much longer time-scale than the real one in the case of central occultation ($t=\tau$), but the shape of these curves is identical. So the best fit in figure 1 (the solid line) gives

$di/dt = 0.18 \pm 0.02$ °/year

$\tau = 1911 \pm 3$ years.

A possible explanation of the changing inclination is the existence of a distant third body, and the eclipsing binary's orbital plane inclines from the plane of motion around the centre of gravity of the three-body-system (the "big plane") by the angle ϵ. In such cases a precession of the binary's orbital angular momentum axis can take place like in the Sun-Earth-Moon-system.

With Θ being the inclination of the "big plane" to the plane of the sky and Ω being the position angle of the line of nodes in the "big plane" we receive:

$$\frac{di}{dt} = \frac{-\sin\Theta \sin\epsilon \cos\Omega}{\sin i} \frac{d\Omega}{dt} .$$

Central occultations can happen only if

$$|\tan\Theta \tan\epsilon| \le 1 .$$

If we favour a small angle ϵ, the inclination of the "big plane" must be $\Theta \approx 90°$ resulting in

$$\frac{di}{dt} = \sin\epsilon \frac{d\Omega}{dt} .$$

So the upper limit of the period of the rotation of the line of nodes equals 2000 ±200 years.

Furthermore it will be noted that there is a small deviation from the elements derived by Dugan et al. [1], but there is no reliable evidence of apsidal motion. The improved elements using all data are

$$\text{Min. (I)} = 2415900.694 + 14.416262\,E , \qquad \Phi\,(II) = 0.575\,E$$
$$\pm 0.002 \qquad \pm 0.000025 \qquad\qquad \pm 0.001 .$$

T. LEHMANN

Sternwarte Sonneberg
O - 6400 Sonneberg
Germany

References:

[1] Dugan et al. (1935), AJ 44, p150.
[2] Hoffmeister (1921), AN 214, p1.
[3] Lehmann (1991), MVS 12, 6, in press.
[4] Szafraniec (1961), Acta Astr. Suppl. 4, p487.
[5] Tashpulatov (1965), VS 15, p424.
[6] Wachmann (1936), AN 258, p361.
[7] Zakirov et al. (1990), IBVS 3487.
[8] Hoag et al. (1961), US Naval Obs. Publ. Vol.XVII, p349.