THE STAR SPOT MODEL AND THE OBSERVATIONS OF SZ PISCIUM

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Details of photometric observations during the totalities of the primary and secondary minima of SZ Psc are analysed in the light of the "star spot model" for RS CVn type binaries. Presence of scatter during the totality of primary minimum and its absence during the totality of secondary minimum of SZ Psc provide evidence towards one of the assumptions of the model,i.e. the spot activity confines to one of the hemispheres of the cooler star.

1. INTRODUCTION

The eclipsing binary system SZ Piscium is a member of RS CVn stars. Extensive photometric observations and radial velocities of SZ Psc are published by Jakate et al(1976, Paper I). SZ Psc was observed photomet-rically by the author during October and November 1978 season from the David Dunlap Observatory using its 61cm telescope. The present paper discusses the photometric observations of minima of SZ Psc in the light of the proposed "star spot model" for the RS CVn stars(Hall 1972).

2. DISCUSSION

Following are two basic assumptions, among others, of the "star spot model" proposed by Hall(1972) to explain various characteristics of RS CVn:

i) The surface brightness of the cooler star is non-uniform due the presence of star spots on it. ii) Furthermore, this star spot activity confines to only one of the hemispheres of the cooler star.

If the first assumption is right then one would expect some scatter during the totality of the secondary minimum, reflecting the non-uniform surface brightness as the hotter star scans the surface of the cooler star. Figure 1 shows the details of the secondary minimum of SZ Psc obtained in the year 1978. Outside as well as during the totality the

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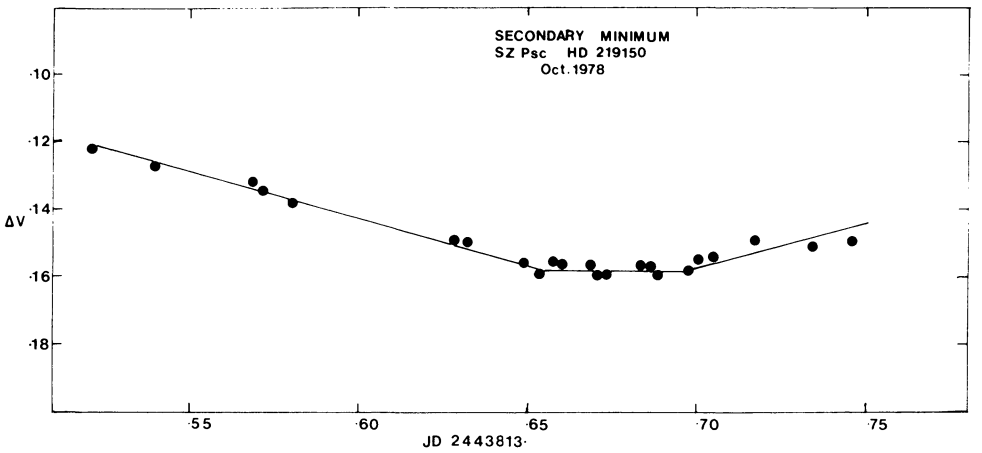

Figure 1: 1978 (JD 2443813.) secondary minimum of SZ Psc.

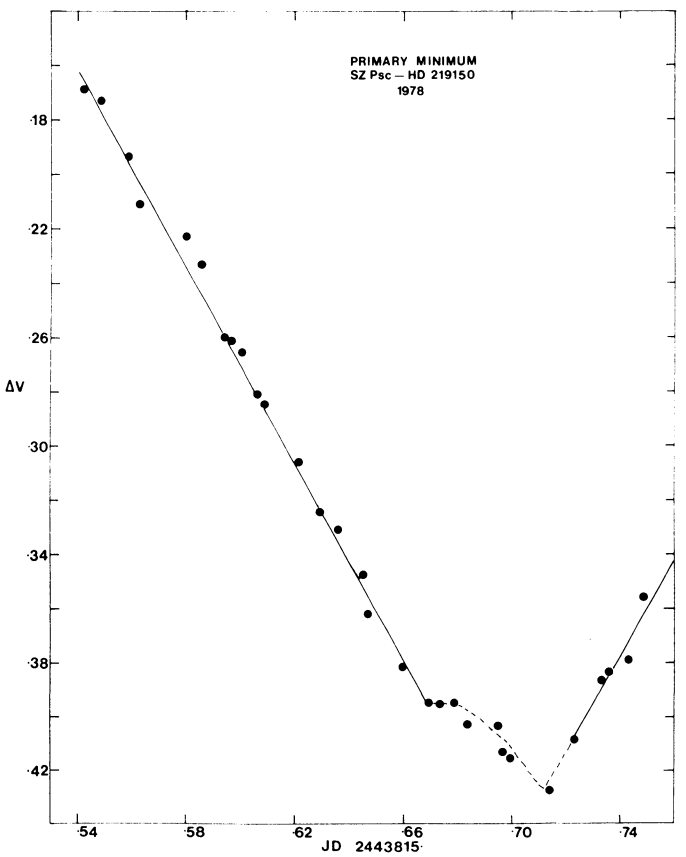

Figure 2: 1978 (JD 2443815.) primary minimum of SZ Psc.

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scatter is not more than expected from the observational uncertainty (.003 mag.). The reason for the absence of the scatter could be that the star spot activity is not confined to this hemisphere of the cooler star facing the hotter star.

Figure 2 shows details of the primary minimum obtained two days later (JD 2443815). This time the scatter during the totality is significantly large (0.01 mag.). The scatter outside this totality is within the observational uncertainty. During the totality of the primary minimum of SZ Psc, we are looking at the opposite hemisphere of the cooler star. This could, perhaps, be the first direct evidence of the presence of non-uniform surface brightness preferentially on one of the hemisph--eres (in this case it is the opposite hemisphere) of the cooler star.

Durations of the totalities of the primary and the secondary minima of 1978 are equal, as expected. The ratios of the depths are in agreement with the spectral types and colours of these two stars.

Furthermore, the scatter seen during the totality of primary minimum has a definite pattern which is as suggested by the dotted line in Figure 2. This pattern seems to suggest that the crowding of the spots have taken place on the left side of the opposite hemisphere in 1978.

The primary minimum of SZ Psc observed in 1957 (Paper I), also shows scatter during the totality. The scatter has an equal amplitude but exactly opposite shape compared to what has been found in the case of the 1978 primary minimum. This suggests, that the situation of spots in 1957 on the opposite hemisphere of the cooler star was exactly opposite of 1978. Therefore, if this is a periodic phenomenon then this duration of 21 years(1978-1957) represents roughly, either a half cycle (P=42 years) or one and half cycle(P=14 years) or more number of cycles (P<5 years).

The scatter during the totality of the primary minimum of SZ Psc obtained in 1974 (Paper I) is small and represents a situation, some what intermediate compared to the extreme cases of 1957 and 1978, supporting 14 years period.

The picture would have been a lot more clear if we had complete light curves of SZ Psc for all these years. Nevertheless, the data presented here provides direct evidence for the major assumption of the "star spot model", i.e. the spot activity confines to one of the hemi--spheres of the cooler star.

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DISCUSSION FOLLOWING JAKATE

Geyer: Do you have an investigation of the behavior of the color index?

Jakate: For the 1978 observing program the aim was limited, just to obtain times of minimum. However, in our previous paper we did publish color curves.

Rajamohan: Isn't it articifial to assume starspots migrate periodically only on one hemisphere of the star?

Jakate: I did not say that star spot migration takes place only on one of the hemispheres. The assumption of the "star spot model" is that at a given time, the spot activity is confined to only one of the hemispheres.

Chambliss: Did you observe any variation in the depth of the primary minimum in SZ Piscium, and what is the duration of the total phase of the primary, i.e. how much time is there between second and third contacts?

Jakate: I cannot make definite comments on the depths of primary minima for the following reasons: 1) I do not have observations outside eclipses for 1978; 2) the comparison star used in 1978 is different. My observations suggest that the comparison star used during the 1957 and 1974 observations is probably a slow variable (IVBS 1578). The duration between second and third contacts is about 5½ hours.

van't Veer: What is the mass ratio of SZ Psc?

Jakate: About 1 as for most RS CVn stars.

Popper: The masses of the components of SZ Psc are 1.3 solar masses for the smaller, F star, and 1.6 solar masses for the cooler subgiant. They differ in mass more than in most typical systems of the group.

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