TWO-SPOT MODELING OF SYNOPTIC LIGHT CURVES OF II PEG

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The light curve (LC) of the single-line spectroscopic binary system II Peg (K2-3, IV-III) generally shows an asymmetrical and highly variable shape (Fig.1, left). Therefore, single circular spot models can be successfully applied only to symmetric LCs, as the 1977 one by Vogt (1981). When asymmetrical or almost flat LCs develop, as appears to be the rule for II Peg, at leasts two-spot modeling is required (Bopp and Noah 1980, Dorren and Guinan 1982).

From classical single-spot models (Torres and Ferraz Mello 1973, Friedman and Gurtler 1975, Bopp and Evans 1973) we have developed a computer code including two separate circular spots of different size which are allowed to assume any relative location on the stellar surface. The model is symmetric with respect to the equator. The spots are assumed to radiate as back bodies with temperature ranging from 100 to 2000 degree lower than the temperature of the unspotted photosphere (4500°K).

Of course the problem of the solution uniqueness still remains a serious one and makes any attempt to study one single LC quite hazardous. However, if several successive LCs are studied with the same method and the obtained results are carefully and critically analyzed, valuable information on the migration and evolution of spotted areas can be drawn. Moreover, if consistent values of the spot temperature, size and location are obtained from the solutions of very different LCs of the same star, the inherent disavantage of not being able to achieve unique solutions might sometime be overcomed.

Our computer code generates a dense grid of synthetic LCs covering a wide range of the location and dimension of two unequal circular spots and of their temperature difference with respect to the unspotted photosphere. Also the inclination of the rotation axis is initially assumed as a free parameter. Successive iterations guided by the goodness of fit between synthetic and observed LCs, allow us to restrict progressively the range of the most probable parameters and

P. B. Byrne and M. Rodonò (eds.), Activity in Red-Dwarf Stars, 185–188.

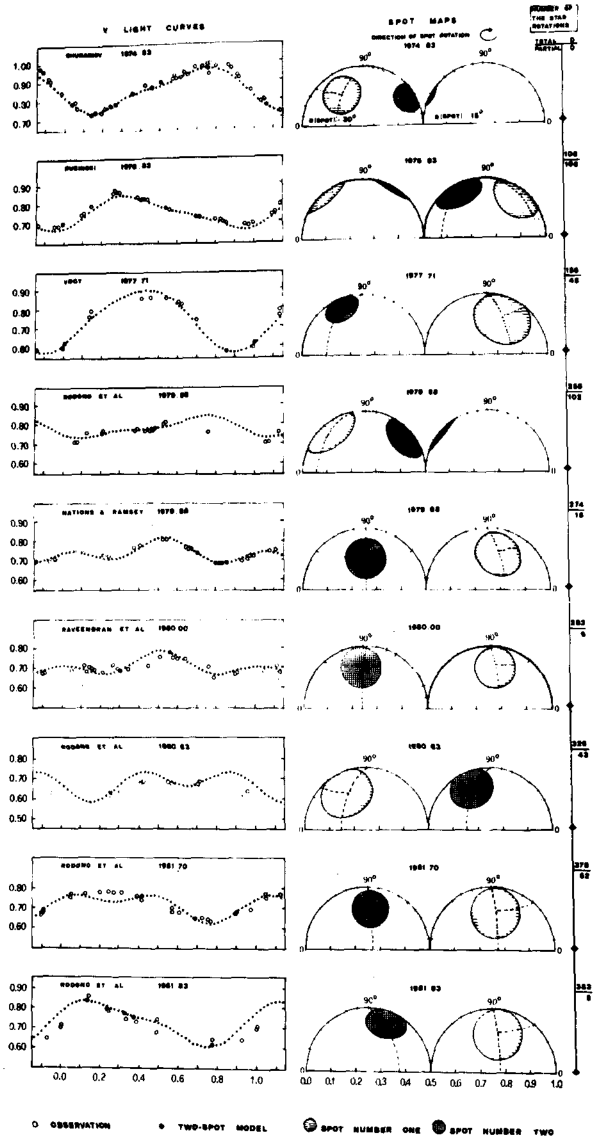

Figure 1 . Observed (open circles) and synthetic (dotted curve) light curves of II Peg from 1976 to 1982 and corresponding spot maps of the northern hemisphere from two-spot model solutions. The two numbers on the left give the number of star rotations from an arbitrary epoch and from the preceeding solution, respectively.

https://doi.org/10.1017/S025292110009607X Published online by Cambridge University Press

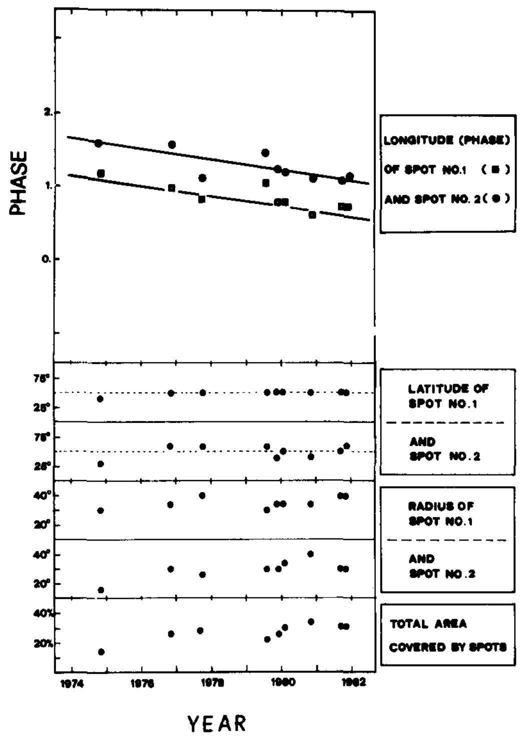

Figure 2. Spot migration, location, dimension and total fractional area from two-spot modeling of light curves in Fig. 1.

eventually to select the best solution. The numerical integration of the resulting flux from the spotted star at a given phase is obtained following the Simpson discrete integration method. A detailed description of our computer code will be published elsewhere. Here we present some results from the analysis of nine LCs of II Peg obtained by various authors from 1947 to 1982 (cf. Rodonò et al 1983).

Since the solutions obtained are symmetric with respect to the equator, only the spot maps of the northern hemisphere are shown in Fig. 1 (right). These maps readily show the large extension of the spotted areas, their relative dimension and location. The best solutions always led to the same values of the inclination of the rotation axis and the spot temperature: 35 degrees and 3300 ± 200°K, respectively. Numerical values of other parameters are plotted in Fig. 2. The upper inset clearly shows that both spots migrate linearly toward decreasing orbital phases, i.e. either the spotted star rotation is not synchronized with the orbital motion, as in several other BY Dra and RS CVn spotted systems, or the spectroscopic period needs to be revised.

Both spots are located near latitude 50° N, the larger spot occasionally extending up the polar region. The dimension of both spots appears to increase in the period covered by the observations, the smaller spot being the most fast-growing one. It appears that the total spotted area has been increasing almost monotonically from 1974 to 1982. This result is consistent with the increase of the median magnitude of II Peg in the same period (Rodonò et al 1983). By using the Harvard archival plate collection, Hartmann et al (1979) have found that, after a fairly long period of inactivity from 1900 to 1940, II Peg is presently exhibiting appreciable light changes. The present systematic decrease of luminosity, i.e. the increase of spottedness, might be part of a regular cycle of variability and therefore be worth of being closely scrutinized both observationally and theoretically.

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