

PERIOD CHANGES OF W URSAE MAJORIS STARS

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About 6000 times of minima for 120 W Ursae Majoris stars were collected by Mrs. Z. Frasińska and the writer in the Cracow Astronomical Observatory. From this material 15 O - C diagrams (fig. 1) with large number of minima were taken into consideration. Each of them covered more than 30,000 epochs. The analysis of O - C curves leads to the following conclusions:

1. The periods of all well-observed W Uma stars are variable.
2. There are no "pure" parabolae in well-observed O - C curves.
3. The periods change in a rather short time and then remain constant for 5,000 - 25,000 E (fig. 2).
4. The number of increases and decreases of periods is approximately the same. The mean absolute change of period of 15 investigated stars amounts to  $0.^d00000365 = 0.^P0000105$ .  
(The mean increase of period =  $0.^d00000386 = 0.^P0000109$ , the mean decrease of period =  $0.^d00000349 = 0.^P0000102$ ).
5. The mean absolute change of period for 15 investigated stars was plotted versus parameter  $q$  (mass ratio =  $m_2/m_1$ ) (fig. 3). Systems with almost equal masses of stars have a tendency to show violent changes of period.

The whole observational material will be published in *Acta Astronomica*.

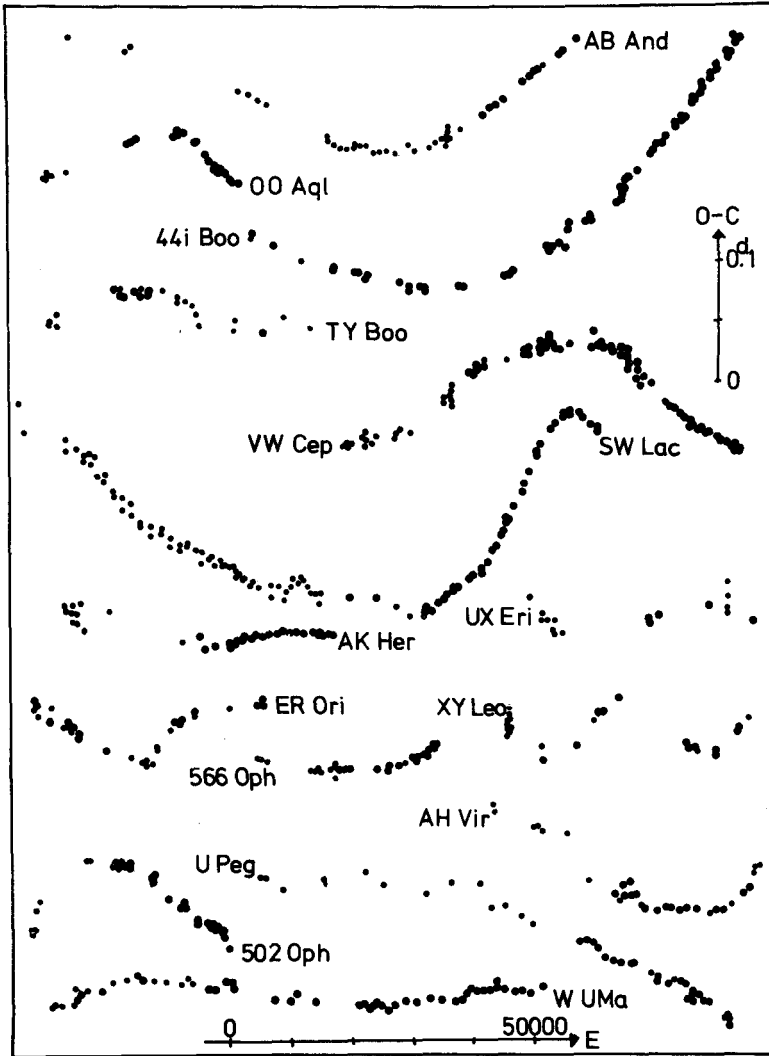


Fig. 1. O-C diagrams for W UMa stars.

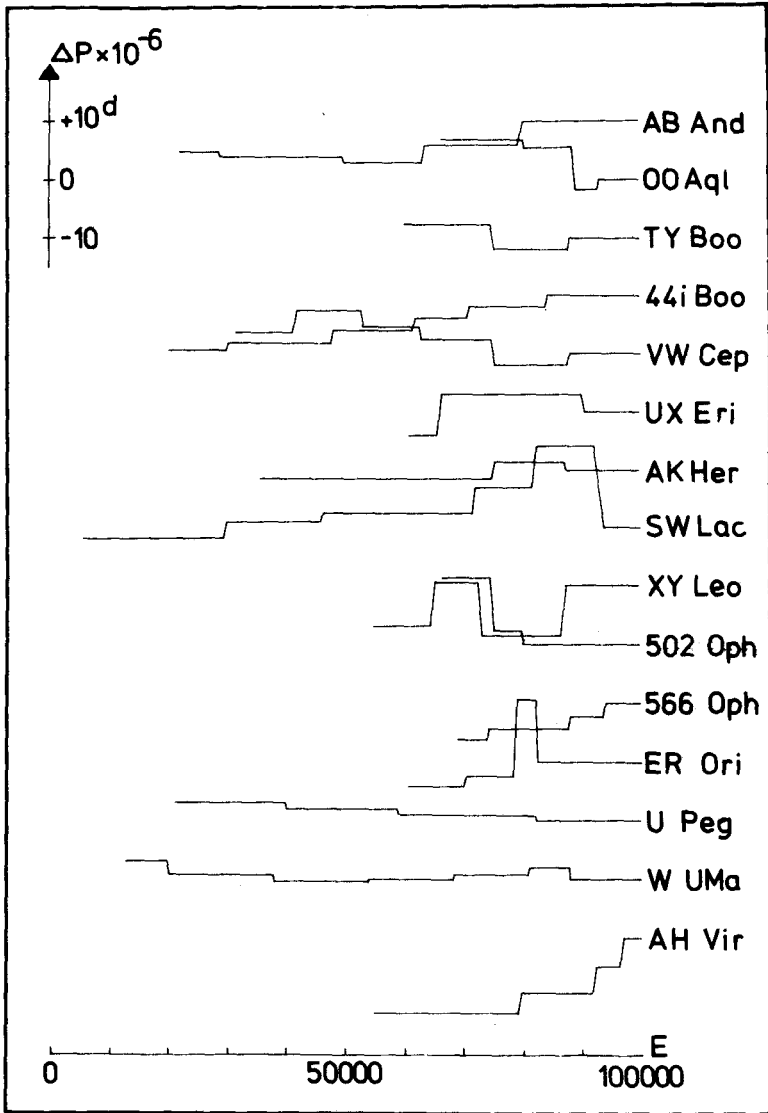


Fig. 2. Period changes for W UMa stars.

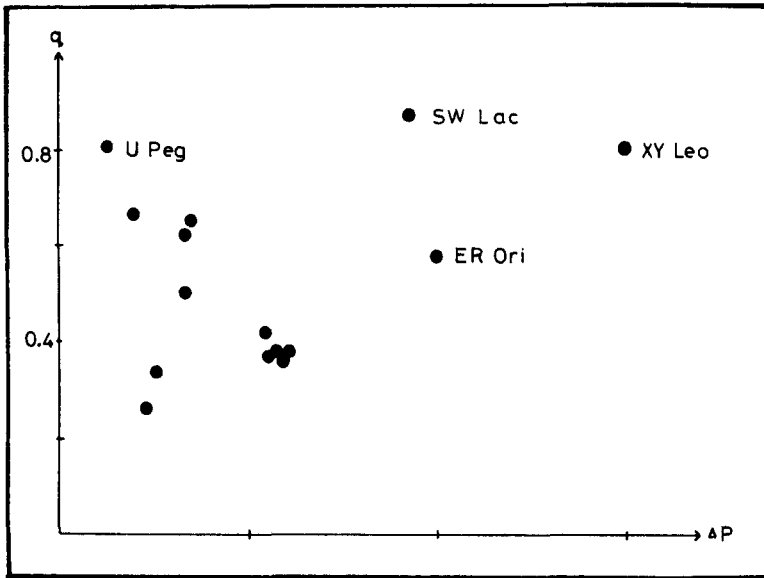


Fig. 3. Mean absolute change of period versus mass ratio  $q$ .

DISCUSSION of papers by VAN 'T VEER AND KREINER:

- RUCINSKI: 1. I would like to warn that there might be a systematic error in the photometric determinations of mass-ratios, therefore, the systematic behaviour that  $q_{ph} < q_{sp}$  might not be true.
2. As a comment to Dr. Kreiner's paper, I would like to stress that the mass-exchange events are very short, relative to periods of relative constancy of orbital periods; this might have important consequences for understanding of the mass, versus energy, exchange processes in the W UMA-type systems.
- WILSON: Spectroscopic mass ratios for W UMA stars are too often based on spectra taken at inadequate dispersion, and suffer from systematic errors, as pointed out by Popper. In one case I found that a spectroscopic  $q$  value (which had been used without question) was based on only 7 data points which had very bad scatter. I take the opposite view from Dr. Rucinski and would say that the spectroscopic values are, in most cases, considerable inferior to photometric ones, and that the photometric values are essentially free of large systematic errors.
- VAN 'T VEER: I agree.
- GEYER: I agree with you concerning the spots on W UMA systems. A large variable system of this type is YZ Boo. According to the thesis of M. Hoffmann not only the maxima change within a time scale of a few years, but also the minima, which interchange in depth.
- Concerning the erratic period changes, I would like to mention my recent paper in *Astrophys. and Space Science* 48, 137 (1977) where I showed that such erratic changes in the (O-C)-diagram cannot be considered as real if the light-curve shows variations by itself. In this respect I am very pleased with Dr. Kreiner's results.
- HERCZEG: I think a word of caution is perhaps necessary, concerning the reality of the observed mass exchange and mass loss. I do not know of a shred of direct evidence for copious circumstellar matter around these systems, although occasional weak emission lines, Kuhi's flare (in W UMA) and last but not least, the period changes are certainly indicating that some exchange of mass may well be going on. The indirect cases of evidence based on the "spots" and on analogies with the sun (prominences, flares) are, at least for me personally, interesting hypotheses but far from being convincing. Thus it is my opinion that evidence is still lacking for such a strong mass loss which could make all W UMA stars young, in the sense of the paper presented.
- VAN 'T VEER: My arguments will not convince everybody and for the moment it must only be considered as a working hypothesis. However, I should like to stress that especially the changes in the maxima of the light curves will be very difficult to explain by phenomena not involving mass loss.