

It is also obvious from Figure 3 that the one very red star, designated No. D in Plate I and Table I, falls in the color-magnitude diagram quite close to where it should in order for it to be a high-luminosity member of the cluster. The star is designated by the open circle in Figure 3 which falls underneath the red branch of η and χ Per. Unfortunately Gratton and Hernandez state that this star is "probably not a member of the cluster according to the radial velocity." They add, however, that they wish to confirm this result. Because of the place of this star in the cluster, and in the color-magnitude diagram of the cluster, it would seem important to check carefully its luminosity characteristics. If it turns out that this star is in the same region of space as the cluster it may still be analogous to η and χ Per whose late-type giants occur far to the outside of the cluster.

Finally it may be noted that in Figure 2, it becomes very difficult to trace the main sequence below $V = 13$ mag. One possible interpretation of this is that as we go fainter than $V = 13$ mag. the field stars become so numerous that they overwhelm the cluster members. It is also quite clear, however, that if stars are born from an interstellar medium, the less massive ones will contract more slowly. Therefore going down the main sequence of a young cluster such as NGC 4755 we would expect to eventually reach stars which lie to the red side of the main sequence because they have not yet contracted onto the main sequence. Calculations by Salpeter (1953, 1954), Henyey and Le Vieur (1955) and Sandage (1958) show that roughly 7 magnitudes should separate the brightest stars in a cluster, which have evolved less than the Schönberg-Chandrasekhar limit, and the faintest stars which have just contracted onto the main sequence. Walker (1956, 1957) has made observa-

tions in two galactic clusters which show these predictions to be approximately correct.

Since the brightest stars in NGC 4755 are just about $V = 6$ mag. we would expect stars fainter than $V = 13$ mag. to begin deviating from the main sequence because of incomplete contraction. Obviously the measures in Figure 2 should be carried fainter in order to confirm this suggestion. The fitting procedure used to obtain the modulus would be made more accurate and the modulus might be increased by several tenths of a magnitude if less weight were given to faint stars falling off the red side of the main sequence.

It should be emphasized that we are very close to the interesting point where stars not yet on the main sequence should be encountered in large numbers. The present cluster, being so nearby, is a favorable case in which to study such stars. Also it should be emphasized that, unlike Walker's clusters which show conspicuous dust and obscuration, NGC 4755 appears fairly free of such internal nebulosity. It would be of great interest to determine whether this difference is in any way reflected in the color-magnitude diagrams of the cluster.

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NOTES AND OBSERVATIONS

EVOLUTIONARY CHANGES IN SPECTROSCOPIC BINARIES OF EARLY TYPE

By OTTO STRUVE

This paper is concerned with a comparative study of two groups of spectroscopic binaries of very early spectral type, which have been

recently observed with the coude spectrograph at Mount Wilson.

Star	M_{vis}	Spectrum	Light curve	$H\alpha$
Group I				
AO Cas	-4.5	O9 + O9	E, a	em. $\Delta v = \pm 400$ km/sec
HD 47129	-4	O8 + O8	Irreg.	em. $\Delta v = \pm 800$ km/sec
29 UW CMa	-4	O7f + O	E, a	em. $\Delta v = \pm 600$ km/sec
V448 Cyg	-4	B1 + O9	E	em. v weak
Group II				
Y Cyg	-4	Bo + Bo	Algol	None
α Vir	-2	B2 + B3	—	None
β Sco	-3.5	Bo + Bo	—	None
π Sco	-2.5	B3 + B3	—	None
HD 159176	-3.5	O9 + O9	—	None

The principal differences between these two groups are:

1. Strong $H\alpha$ emission in Group I; no emission in Group II.
2. Ellipticity effect in the light curves of Group I, but not in those of Group II.
3. $K_2 < K_1$ in the velocity curves of Group I, but not in those of Group II.
4. The spectral types of Group I are systematically earlier than those of Group II, and the absolute magnitudes of Group I are brighter than those of Group II.
5. The masses of Group I are larger than those of Group II.

Although these results do not indicate that the two groups represent different evolutionary stages of stars of similar mass, it is reasonably certain that the members of Group I are losing mass more rapidly by the ejection of hydrogen than are the members of Group II. Within Group I the difference between V 448 with very weak emission on one side and HD 47129 and 29 UW CMa with strong emission on the other is especially striking. The periods of these three stars are 6.5, 14.4 and 4.4 days, respectively. They are rather similar with respect to their orbits, and yet the emission phenomena are drastically different. We must conclude that these phenomena represent a transient stage in the evolution of close binaries.

Even more remarkable is the absence of emission in binaries of Group II and the frequent occurrence of hydrogen emission lines in those Algol-type binaries whose primaries are late B's and whose secondaries are G or K subgiants. We conclude:

- a) When the two components produce double absorption lines of nearly the same intensity the formation of gas streams is impeded (Y Cyg, π Sco).
- b) When the two components produce absorp-

tion lines of unequal intensity we rarely catch them in the stage when one star is on the main sequence and the other has expanded to subgiant or giant stage. Perhaps the duration of this stage is short in the O and early B binaries, and is much longer in the typical Algol-type binaries like Algol itself, or RW Tau.

c) We must of course remember that the emission rings in Algol-type binaries are usually observed during the partial phases of deep primary eclipses. No such deep eclipses occur in any of our representatives of Group II. This may again be due to the fact that when the primary is a main-sequence star of type O or early B, its companion is never found to be in the state of a large, cool subgiant or giant.

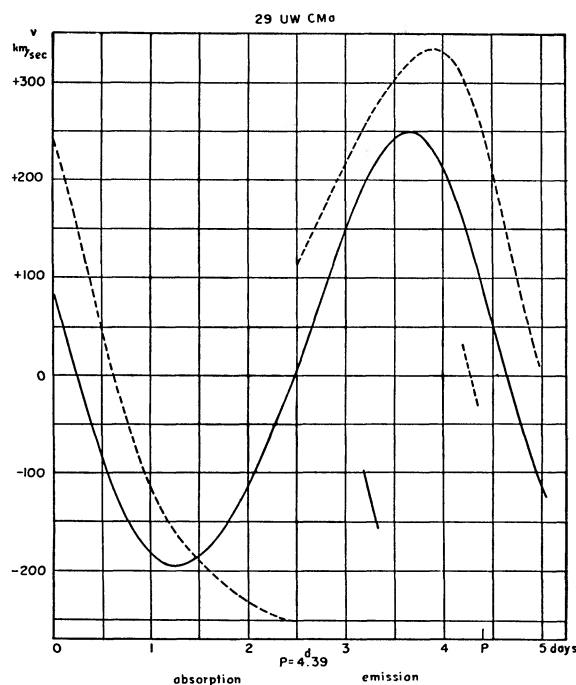


Figure 1. Velocity curves of 29 UW Canis Majoris.

Among the stars we have observed the most remarkable is 29 UW Canis Majoris. Figure 1 shows our velocity curve derived from the absorption lines, and a re-interpretation of the velocity curve obtained from the $HeII$ 4686 and $NIII$ 4634, 4641 emission lines. The latter is clearly discontinuous near secondary light minimum. Although no discontinuity is observed at primary light minimum, the emission lines become double just preceding zero phase. These emission lines arise in a gaseous stream which is not very far from the principal star and contains a condensation that follows this star in its orbital motion.

A possible model of the system envisages a stream originating near the inner Lagrangian point on the surface of the principal star. At phases 0.4 to 0.7 day this stream produces strong violet-displaced absorption lines of H , HeI , etc. The same stream produces weak violet-displaced emission lines at phases 4.0 to 4.4 days, as it circles around the secondary star. The stream broadens in cross-section and gives rise to strong red-displaced emission lines, observed at phases near 4.0 days. The undisplaced, broad emission line of $H\alpha$ comes from the large gaseous envelope produced by the spiralling stream after it has circled once around the system. Figure 2 shows the main features of the model.

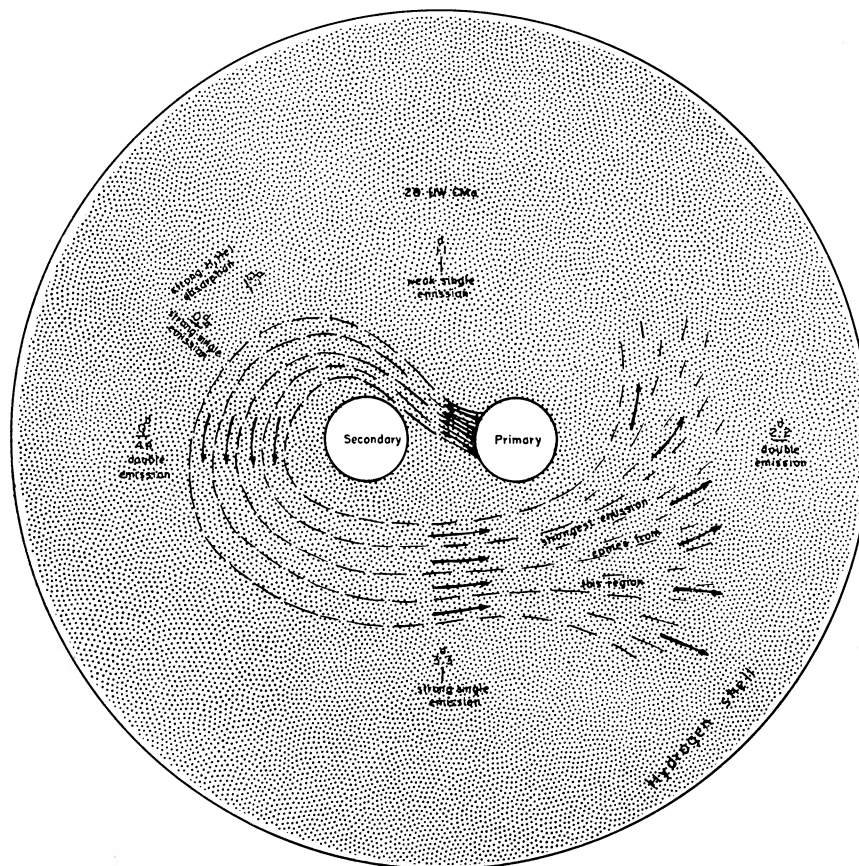


Figure 2. 29 UW Canis Majoris.

This model has many common properties with models previously discussed for β Lyrae, UX Mon, Algol, HD 47129, etc. But it must be admitted that the interpretation of the observations is now about in the same state in which the theory of the solar system was in the days of

Ptolemy. An exhaustive computational study is needed of the hydrodynamical problem of the motions of the gaseous streams in binary systems.

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