ASTRONOMICAL NEWS.

Volume 236. No. 5653. 13.

About the interpretation of the behavior of Algol and about the variability of the speed of light. By *M. La Rosa*.

In this communication I intend to make one last point to investigate in my & "*ballistic theory* of the variable stars" had remained dark namely divergence which Messrs *Salet*[1]) and *Bemheimer*[2]) between the premises of the theory and the data of observation in relation to the Algol-type stars believed to notice, and which they considered sufficient, about the applicability of the *ballistic principle* to the to combat and reject propagation of the light.

By going over from the reservations made earlier the reliability of the parallax measurements that I still uphold, refrain from kicking, not to do it to let lack of security, gladly on those of my opponents given ground and discuss the behavior of Algol (and hence the analog stars) due to the present recognized astronomical data.

Among the eclipse mutables, Algol is the one which was the subject of study with preference, so that we have extensive and precise knowledge about it.

The basic elements that characterize its behavior, are:

a) the light curve, which is meticulously defined by means of the selenium cell was determined;

b) the curve of the also precisely determined radial speeds;

c) the small anomalies affecting these curves, viz namely the first to exhibit over time.

It is very important to keep in mind that light curve and speed curve not on one and the same body alone can be obtained as they have extremely different periods, namely from 2,867 days for the light curve and 1.88 years for the speed curve.

The latter is almost a regular sinusoid of 10 km/sec amplitude, while the former is the characteristic reproduced here shape (see figure).

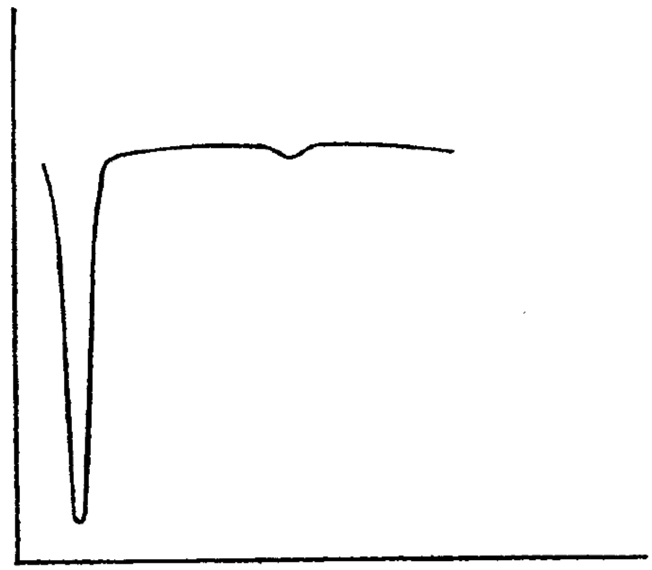
Analysis of these curves and those indicated above anomalies and among these especially that in the times of light minima found led to the various rashes researchers concluded that Algol consists of at least three bodies: a first one with the period of 2.867 days moving body (the eclipsing in the main minimum body), a second body around which the first in a nearly line of sight containment orbit moved as well, and which is the darkened body, and a third body around which the mass overflows center

[1]) C.R. de l'Acad. des Sciences T. 180, p. 647, 1925; T. 183, p. 1263, 1926; T. 188, p. 387, 1929 Jan.

[2]) Z. f. Phys. **36**.302, 1926.

of the first two, with a period (given by the velocity curve) of 1.88 years.

The elements of these two orbits are known, and from them the essential constants of the first two bodies have also been derived.



Over the speed curve we don't have much to notice. Maybe like the use stronger ability to separate will make it possible in the future that -- at least at certain moments -- a complex composition of the lines demonstrated and those of the various components to be assigned to bodies are separated become; but since it is not in the current state has been possible to do so, one must take into account the good agreement of the measurements conclude that of the three bodies the second, that is the on which the periodic shift of the lines is demonstrated and has been unequivocally determined, a respect on the other two significantly predominant brightness must have.

On the other hand, the light curve contains more important peculiarities, which are examined with much greater care need, since they are on the simultaneous game of the three bodies based.

The presence of two minima reveals one to us double eclipse, that is it tells us that the first body is luminous, in other words that it when it is not hidden behind the second (secondary minimum), an appreciable contribution to the luminous intensity of the whole delivers.

Moreover, comparing the amplitudes of the both minima say something more precise about the relative brightness of the three bodies.

If the eclipse were complete, so would have the conclusions that derive from this comparison let, certainty value; but the character of the first minimums, which lacks a horizontal section, forces us to assume that at least the first eclipse, the large, partial.

However, considering the very long duration of this minimums (nearly 10 hours from the approx. 65 of the period) one thinks that the occlusion of the second body by the first to a very sizable fraction of his surface extends[1]), giving us the amplitude of the first minimum occurring light change a sufficiently approximated idea of the brightness of the second body in relation to the other two bodies.

Because the apparent size of the whole during the apparent constant phase in the stellar size scale 2.3 is evaluated while at the moment of minimum is rated at 3.5, one concludes that this incomplete covering of the second body by the first the brightness derived from *Pogson*'s equation of the whole at the moment of the minimum, when one considers the immediately before or immediately after the minimum itself observed equals 1, given by the fraction 0.19.

This tells us that as a result of the eclipse more than 4/6 of the total light accounted for, and thus that of given to the second body to the normal brightness of the whole contribution is greater than or at least equal to this fraction.

In a corresponding way one finds in the comparison the ordinate of the 2nd minimum and that of ours for comparison used (those carefully taken from the figure are) among themselves that the occurring in this phase changes in brightness, as usually estimated in stellar magnitudes, is 0.036. From this number one calculates that the luminosity at the moment of this minimum hardly 0.965 that in that moment is observed in which the transition phase begins (or ends) through the first minimum.

This result tells us that the brightness of the first body compared to the overall brightness of the system and is small with that of the second body. Could one assume that this secondary eclipse is a complete one would be, it could be deduced that this brightness is hardly 0.035 of the overall brightness achieved.

But even assuming that this is not the case, are we entitled to believe that the brightness of this body is only a few hundredths of the total brightness (0.05 or 0.06 would certainly be too high).

Hence, we can conclude that the brightness of the remaining body, the third, no larger than 0.19 - 0.05 = 0.14 will be.

So, if you want to theoretically reconstruct which on the basis of my hypothesis about the cause of the variability phenomena predictable light curve of the system would have to, one must have the presence of all three bodies, their relative brightnesses and the influence of their movements take into account.

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[1]) This hypothesis, as we shall see, carries very little weight in our conclusions, and so they will unaffected by this uncertainty.

Although not yet periodic from the third body movement has been detected, one must reasonably assume that he takes part in the movement with which this center of mass of the other two appears equipped, namely, that it makes an orbit around the center of mass of the complete system in 1.88 years[2]).

In an attempt to deduce which is the light curve of the system, one has to consider the variable contributions know the power of the *ballistic hypothesis* of a can be given to each of the three bodies. And to determining the value of these contributions and their laws of dependency of the time must for each of the three bodies the fundamental constant that I use in my working with *Kb*, namely the quantity:

$$Kb = \frac{d}{c\,\tau} \cdot \frac{v_0}{c},$$

where d is the distance between observer and star (or better center of mass of the three bodies), τ the period of rotation, v_0 is the amplitude of the radial velocity, c is the normal propagation speed of light.

Replacing d by the parallax π (in arc seconds), so our constant is given by the formula

$$Kb = 343.33\,\frac{1}{\pi} \cdot \frac{v_0}{\tau},$$

where v_0 is expressed in km/sec and τ in seconds. In Algol's case, let π be 0".05 (i.e., the same one that Mr. *Salet* uses) and for v_0 and τ the values due to the first body, namely v_0 =40 km/sec and $\tau = 2^d.867$ = 247,708 sec, we find for *Kb* the value K_1b_1 = 1.85. This result tells us that in reality this first body, as my opponents want, must lead to variability effects in the light curve based on the application of the *ballistic principle*; probably but it should be noted that they only do this through this body contribution delivered to the overall brightness, which is based on 0.05 for the latter can be estimated.

In a corresponding way, we find for the other, namely the second, since v_0=10 km/s and $\tau = 1^a.88$ that is = 59,329,24 sec, $K_2b_2 = 1.46 \times 10^{-3}$. Because this value around so much lower than the 0.02 limit that is necessary is, so that an effect dependent on the movement can be perceived can be, we must conclude that the movement of the second body to no light variability can lead, in other words that it can, if it does not lead the first is obscured, with its constant contribution of 0.81 to the normal brightness of the whole (from the value 1) contributes.

In the case of the third body, as I said, we have none direct knowledge of its movement. Let's take it as dormant, so we could not depend on it expect phenomena of variability. But there the view is quite plausible that he too with a path movement is equipped, whose period is also the same $1^a.88$, *Kb* must also be calculated for it.

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[2]) It is also natural to think that since this body is so much less luminous than the second, it is smaller than the latter and thus describes a larger orbit and moves with greater speed than the second.

For this purpose, we had to know the *v*, about the we failing delivered by the observation elements can set up some hypotheses. Taking into account which in relation to the second low brightness, after which we must consider it smaller, we can assume that this speed is greater (but not much) than that observed for the center of mass of both. In order not to let it fail at security and us in the most unfavorable situation, we could assume that the *v* of the same is 10 times greater than that of the second (i.e., 100 km/sec), and were used for *Kb* the (undoubtedly exaggerated) value of 10 times find K_2b_2, but always behind that limit would remain behind, which is necessary for an on the orbital motion based variability effect can begin, to become observed.

So of the three bodies only the first can do one external influence on the light curve; and you look up reason of the value found for K_1b_1 with ease assumes that it has two maxima that are a little apart must have the same intensity, between which either the main minimum of the effective light curve (or more precisely the passage position of the first body in front of the second) or the other must be included, as the case may be the direction of the rotations.

The amplitude of the fluctuation between maxima and minima on the light curve supporting the *ballistic hypothesis* for this case[1]) alone (i.e., for *Kb* between 1 and 2), roughly calculated, appears larger than the 5:1 ratio and less than the 10:1 ratio.

An important property worth highlighting to become lies in the behavior that comes after the *ballistic theory* the light when rising to the two must have maxima and during descent, namely must one at one (first or second depending on the direction of rotation) a more gradual climb and a steeper one descent and the opposite behavior in the other receive.

So, if we want to anticipate what the change of the total light of the system as a function of the changeability to be attributed to the first body, so, we find that it contained between the following limits must be: 0.05 x 5 = 0.25 and 0.05 x 10 = 0.5.

[1]) I reserve the right to come back to this point in order to give in a more precise way the light curve predictable for Algol, applying to the calculation the method that I presented in my paper A.N. **234**.233.

If one adds to these values the through the second and third field given invariant contribution (0.95), so one finds that the total brightness through the movement of the first body can undergo a change between 1.20 and 1.45 must be included.

Well, thanks to the extremely careful measurements von *Stebbins* it is now certain that Algol's[2]) light curve shows slight changes in the intervals between the two minima, namely two maxima which closely enclose the secondary minimum. Of them, the one that follows the main minimum shows a gradual rise and a sudden fall, while the other shows the opposite behavior: a sudden rise and a gradual fall. The value of these maxima, derived from the light curves given by *Stebbins* and expressed directly in terms of magnitude, is 1.30.

Everyone sees how this behavior agrees wonderfully with the conclusions of the *ballistic theory*, how it manages with extreme simplicity to give us an account of everything, even that incidental fact of opposite character with which the two slight changes in the phase of ascent and in that of descent take place [3]).

The attentive investigation of the phenomena offered by Algol thus provides a new and brilliant confirmation of my theory, a new and exceedingly strong proof of its essential premise: the influence of the motion of the source of light on the speed of light.

Whether this influence is felt from the total value of v, or [4]) from a fraction thereof according to a coefficient $q < 1$, I am not yet in a position to determine; I think, however, that it is now time, without any prejudice, to subject to more exact controls this very essential point of our knowledge of light, which is of the greatest interest for astronomy.

Palermo, Physical Institute of the Royal University, March 1929.

M. La Rosa.

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[2]) Other analogous stars show these important secondary changes more clearly.

[3]) Needless to say, if the *ballistic hypothesis* were to be accepted as proven, by a more detailed comparison with the phenomena presented, make certain peculiarities of the system in question even better precise could.

[4]) The hypothesis $q < 1$, which has been examined by several, has recently been published by Mr. *Kunitskij* (Russ. Astr. Journal I, H. **2**.43 [1924] and **4**.247 [1927]) and with success to explain the unequal distribution of the periastron lengths in spectroscopic double stars have been used.