

AROUND SOME OBJECTIONS
AGAINST BALLISTIC THEORY
OF VARIABLE STARS

Note of M. La. Rosa

In the No. 21, vol. 179 of the "*Comptes Rendus*" of "Ac. Des Sciences" Messrs Ch. Nordmann and C. Le Morvan recalled attention to the following fact, that in their opinion, would be incompatible - or at least inexplicable - with the, my theory of variable stars deduced from the Ritz postulate.

Changes in light intensity, i.e., the magnitude apparent, they are, for certain stars, dependent on color of the light chosen to make the observations, i.e., more exactly: the amplitude of the intensity change results, function the average frequency of the spectral region to which it belongs the light taken to make observations. For example, for β the change in apparent magnitude goes sharply growing from red to bleu; is equal to 0.66 (of the step of magnitude) in red; 0.94 in green; 1.34 in bleu.

The reason why this fact seems incompatible with my theory it is so expressed by the cited A. A.: "If the light fluctuation of continuously varying stars was due to the mechanism invoked by Mr. M. La Rosa, the amplitude of the variation would necessarily be the same in all regions of the light spectrum".

The fact recalled, it is certainly incontestable, and it is worthy all the attention of those involved in the study and the interpretation of the phenomena of "variables". For truth I do not know, if and how it can be explained in the theory of the eclissi and in the others so far given for these mysterious phenomena, but what is certain is that my theory, *also in this case*, offers a clear reason for the fact in the way clearer, more

direct and more *spontaneous* (i.e., without artificiality adaptation). And we immediately explain how.

For this purpose, these stars on which the phenomenon in question has been observed present changes *small light amplitude* (of the order of a step of the magnitude scale), and remember that fundamental hypothesis the theory is *that all variables must be double or more complex stars*.

Given this, we observe that the light comes to us from a "variable" is only partly due to the revolving companion (or more exactly to the star that satisfying the relative limitation to the constant Kb , gives rise to changes in light), hence in determining the law of intensity changes due account must be taken of the light emitted by the other (of from other bodies); which only in particular, the circumstances can be negligible (for long-period variables, with orbits very eccentric and close to the maximum ¹).

But this is certainly not the case with "variables" of small amplitude, for which account must be taken - what the Messrs. Nordmann and Le Morvan did not - and some light of the variable components and that of the invariable components.

Assumed for simplicity that the star in question is one "double", of which only one component satisfies the condition necessary for it to be able to cause changes in light small size ²) (while the other is invariable), we find that the luminous intensity of this component must present changes of equal magnitude in all regions of the spectrum

¹) Recall that the condition of "variability" is $1/50 < Kb < 5$ and that the amplitude of the change is large when Kb is very close to $1/2\pi$.

²) In a very recent writing Messrs. Nordmann and Le Morvan consider as a *new* hypothesis this presence of (at least) another luminous body, invoked by me to explain the fact discovered by one of them, and to remove the objection made to me. But it is more than evident that the presence of two bodies is *necessary* imposed by the hypothesis of the revolving star above, a closed orbit; and for that matter in all my theory I have always assumed *explicitly* that all variables are "double" stars, or, more generally, "complex" stars.

(as Nordmann and Le Morvan think) but this constancy of amplitude cannot be presented in the total light, because the light of one is superimposed on that of the other component.

Indicating with i_r , i_v , i_b the luminous intensities that it would manifest to us the variable component in red, green, and in blue respectively at the moment of minimum, the corresponding intensities at the moment of maximum would be mi_r , mi_v , mi_b , where m is a constant factor; but the reports of luminous intensities predicted by the set of the two stars in the moment of maximum and minimum, for said regions are:

$$(1) \quad \frac{I_r + mi_r}{I_r + i_r} \quad ; \quad \frac{I_v + mi_v}{I_v + i_v} \quad ; \quad \frac{I_b + mi_b}{I_b + i_b}$$

being I_r ; I_v ; I_b the corresponding intensities of the component invariable.

And it is clear that the three ratios (1) will be in general different, since their equality (being $m \neq 1$) can occur only when:

$$\frac{I_r}{i_r} = \frac{I_v}{i_v} = \frac{I_b}{i_b}$$

that is, when in the spectra of the two luminous bodies the distribution of the intensities is done according to the identical law, that is, when the two bodies *have the same temperature* and also the same emissive behavior.

In other words, *the ratio of the maximum to the minimum of light*, presented by our variable, *must*, in general, *depend on the color of the light used in the measurement*, photometric; and only in the particular case (very unlikely) in which the two emitting bodies have *the same temperature*, that ratio can be constant throughout the extension of the spectrum.

So, in general *our relationship will be a function of frequency*; so that the exact measure of the values it presents in the different spectral regions, for each given star, coupled with a good understanding of the law of distribution of radiant energy in the spectrum (at temperature

high) will be able to give us a new way to determine of the temperatures of the two emitting bodies ¹⁾).

For this reason, the fact was observed for the first time from Mr. Nordmann it acquires, in the light of my theory, an importance singular, not only for the remarkable confirmation that it the door, but for the new basis which it promises to give to investigations on the temperatures of celestial bodies.

Another objection, made by Mr. Salet ²⁾ concerns a contradiction that this *A* would have detected among the phenomena observed and a deduction – in truth imperfect – that he derives from a summary examination of the "ballistic principle".

The deduction is this: ... "the epochs of maximum and of minimum intensity (bright of the star) must correspond to times when the radial velocity increases "or decreases".

The contradictory facts enumerated by Mr. Salet, are:

a) "For stars of the Algol type, the intensity is absolutely

¹⁾ As an example, I wanted to calculate the values that take the ratios (1) for the wavelengths 6500; 5200; 3900; attributing to the two bodies emitting temperatures abs. of 6000° and 8000° respectively ed assuming that the second only satisfies the necessary condition (relative per *Kb*) for a limited variability.

To calculate the amount of energy emitted at the individual wavelengths, I used the well-known Planck formula, and I have again supposed that the hotter star possesses a surface double of the other (because of its greater mass) and that the ratio *m* was equal to 3.2. The values found are: 2.37 in red; 2.32 in the green; 3.12 in the violet; these ratios correspond to the changes of magnitude 0.93; 1.12; 1.25.

A more exact verification cannot be hoped for until they have been made appropriate measures of our relationship, and until it is better known the law of distribution of energy in the spectrum, at temperatures very high which probably dominate in the stars.

Planck's law (the best that for this purpose the science of possesses today) is validly applicable only for temperatures rather low than the source, and in the region of great lengths wave of the ghost.

²⁾ Bulletin de l'Observ. de Lyon, vol. VII, no. 3, March 1925.

" constant and the same before and after the abrupt minimum
" that we attributed until now to an eclipse. The radial speed
" should therefore (in my theory) be constant during these
" two-time intervals and suddenly start at,
" vary at the time of the minimum, which seems quite impossible
" possible ".

b) " For the Cepheids, the maximum brightness should have
" takes place at the moment when *the increase* of the radial
velocity is
" maxima ... lies, the maximum intensity takes place, at the con
" milking, usually *around the time the radial velocity*
" is maximum. So, there is a difference of a quarter of a period
" between the data of the new theory and reality".

c) (This is a reserve here)

" For the variables to
" long period, it would remain to show that the variations
" intensity are accompanied, in the sense provided by the
" theory, of variation of the radial velocity".

If Mr. Salet could have read my original work¹⁾ instead of the vulgarization article, he would have noted that precisely for the "long-term variables" the theory has demonstrated all its fecundity and its value. Examine, from the spectral point of view, the consequences to which the theory leads in the field of radial velocities, we arrive at give full reason for the existence of stars (invariable, or almost) with strongly expanded line spectra; of the existence of stars (variables) with multiple rows, floating and number components periodically variable; of the existence of stars (variables or not) with simple and mobile lines etc.; all this in accordance of observed, but hitherto unexplained facts²⁾.

¹⁾ *Memoirs of the Italian Astronomical Society*, vol. II, no. ser. 1923, and *Nuovo Cimento* vol. I (new series) January 1924.

²⁾ This topic is more fully developed in one of mine recent note entitled "Radial velocities and ballistic theory of variables" - *Rend. Acc. Lincei* - vol. XXXIII, p. 446, Dec. 1924.

And precisely in this field of long-term variables the my theory can boast a fortune that very few others have had, that of having received, a few months after the its appearance, the brightest and *spontaneous*, confirms. I allude *discovering the periodic changes of radial velocity* of "Mira Ceti" (reciprocally denied until December 1923, a few months after the publication of my first Note), and the discovery of a "companion" of Mira; this in full agreement with the fundamental assumption, which I had to make - sure boldly - around these stars, attributing them constitution of stars "complex"¹⁾; assuming they are gifted of two or more companions.

Concerning doubt *b*), concerning the Cepheids, just & remove it a *careful* examination of the $T=f(t)$ curves, also reported on my article in "Scientia". We therefore recall that the edges of the strip within which each of the curves remains inscribed, represent the law of correspondence $T=f(t)$ nei cases in which the velocity of propagation was *constant* and respectively equal to $c+v$, or $c-v$; that the straight line zz' (axis of the strip) represents the law of correspondence $T=f(t)$ in the case in which the speed of propagation of the radii was constant and equal to c .

Given this, let us observe the first two curves of figure 2^a of my writing, those corresponding to the values 0.1 and 0.16 of Kb . They have light maxima at their points of intersection with the straight line zz' ; said highs fall that is, in the moments T , in which *the component according to the line of sight of the tangential speed is zero*. And the analysis confirms that this must be done as long as the constant Kb from me considered is $\leq 1/2\pi$.

Instead, in the other curves (cases in which $Kb > 1/2\pi$) the maximums of light fall at the maxima and minima of $T=f(t)$ and therefore in *proximity of the points of tangency of the curves with the banks*, and that is *near the moments* in which the radial velocity reaches

¹⁾ Compare on this point my Note on "the constitution of variables of type Mira" Rend. Lincei vol. XXXIII Jan. 1924.

²⁾ Rend. Acc. Lincei vol. XXXII 1st semester p. 590, June 1923.

extreme values. The particularities observed in the Cepheids, so I agree with that case; while there is no shortage of facts which accord with the first. Also, on this point the theory therefore boasts a real success.

Finally, coming to the variables of the Algol type, I must point out, although it may seem superfluous, that my theory at no point and in no way does it oppose the "explanation of the eclipse" which has been given so far for these stars.

The basic assumption of my construction is this: *that all variables are double or "complex" gifted stars of one or more companions who turn in slightly inclined planes with respect to the view. So, my theory can't disavow that in certain particular cases the companion can come to place itself in the line of sight, and conceal wholly or in part, the light of the central star.*

The evidence of this point seemed so strong to me, at moment when I wrote my work, not to deserve one special comment! ! !

The existence of stars which generally present intensity constant, and affected by a single short and abrupt minimum, and which have radial velocity at the same time continuously variable does not *contradicts*, therefore, *at all my theory*. The change of light remains in these cases, independent of ballistic effect, and therefore not subject to conditions (relative to Kb) by which this effect is governed.

But also, for the interpretation of the phenomena presented from stars of this type, the aid is of great advantage of my theory. Not all "variables by eclipse" they present, in fact, the schematic behavior, very simple, mentioned by Mr. Salet. Many of them have a increase, small is true, but continuous of brightness, from end of the principal minimum until a second occurs and little noticeable minimum; several also have different intensity in the two phases of constant maximum, which they fall before and after the second minimum; finally others (always believed to be variable by eclipse) present a continuous variation (just like β Lyrae) which is difficult to reconcile with that hypothesis; finally, others have two real maxima which have *intensities, different* (η

Aquillae); circumstance this which is *irreconcilable* with the simple explanation for "eclipse".

For these reasons, in fact, *I stopped to study* these more complex cases (which I *didn't confuse* with the former)ed I have been trying to match - not replace – mine theory with the hypothesis of the eclipse, obtaining an explanation perfect of the most minute circumstances of the phenomenon; how anyone who wants to study my memory carefully can ascertain, and as I will try to explain more fully in a next job.

Another Note by the same Mr. Salet¹), aims to comfort the previous objection relating to variables of type Algol, with a "quantitative test" from which it would emerge that astronomical measurements (?) also allow us to exclude that a fraction ($\leq 1/200$) of the verge speed can add up with the normal speed of light.

Unfortunately, Mr. Salet tells us nothing about the conceptual line followed, nor on the "data" used in the calculation.

I will therefore try to make up for the defect, following that conceptual line that my theory points to, and using the few and uncertain *data* that around Algol (the only example that Mr. Salet explicitly mentions) I was able to collect.

This star has a *period* of 68^h. 48^m. 55^s. about 1/7 of this duration is taken from the change of light – the abrupt minimum - in the remaining *interval* the brightness varies very weakly presenting two very flat maxima and a secondary minimum, slightly accentuated. The extent of the change which takes place in this phase is slightly less than 0.1 step on the scale of magnitudes.

¹) C. R., 180 - 9 March 1925.

The total variation of light of this star can therefore be interpreted as the result of two changes, one abrupt that *happens* jerkily, the other not wide but with character continuous.

The first change can be traced back to the usual hypothesis of the eclipse (1), which, as I explained above is necessarily admitted by my theory. And this change takes place in ways that are entirely independent of the propagation of light and therefore by the law of changes of the speed. The other small change comes easily explained by my theory as long as it can be supposed that the quantity Kb , introduced by me, in the case of Algol, satisfies the limitation:

$$0,02 < Kb < 5$$

remaining, however, quite far from the value $Kb = 1/2\pi$ in proximity of which the amplitude of the light change becomes very grainy. Therefore, on this point only the disagreement between theory and numerical calculation can arise.

Therefore, according to what little Mr. Salet says in his brief Note, it should be believed that he has found for Kb a value too close to $1/2\pi$, i.e., such as to make us predict *continuous changes of light of large amplitude*, accompanied by parallel changes in radial velocity. Now that such a calculation can with serious foundation be fact is certainly to be excluded; because the result is strongly overcome by the serious uncertainty that dominates the measurements of parallax, an element, truly treacherous, that of necessity appears in the calculation.

For the case of β Persei, he indeed found the following numbers:

$$\pi = 0'',007 \pm 0,027 \text{ Russel}$$

$$\pi = 0'',122 \pm 0,026 \text{ Flirt}$$

$$\pi = 0'',037 \pm 0,025 \text{ Chase}$$

which, are *perfectly* discordant, despite the ostentatious equality of precision.

According to a more recent and more precise determination, made with the photographic method by Messrs. Lee and Joy at the observatory would be: $\pi = 0''.027 \pm 0''.010$.

But according to recent data kindly provided to me it would be:

$$\pi = 0''.052 \pm ? \text{ } ^1)$$

As can be seen from the set of numbers transcribed, we are far from possessing that *certain* element of *fact* that allows us to proceed to an unappealable *quantitative* judgment, and to despise the very numerous and beautiful confirmations which my theory has largely collected, in the field of phenomena photometric, spectroscopic, statistical presented by variable stars.

Later, when it will be possible to measure with *sufficient accuracy* the parallax of certain variables, it will be possible to establish the quantitative control that Mr. Salet desires; and perhaps then my theory will be found to open the way further simpler and more direct for measuring stellar distances.

¹⁾ As an orientation essay we can try to calculate the value of Kb which can be deduced from the above numbers. If we take for π the value $0''.027$, considered more approximate for the Algol-Terra distance, we find 121 light years and therefore for K the value $1.54 \cdot 10^{-4}$. And since b is $1.3 \cdot 10^{-4}$ for the main star, and $3 \cdot 10^{-4}$ for the companion, we find for Kb the values 2 for the main star and 4.62 for the companion. One should therefore conclude that the partner does not bring about change of $\ln c$, and that the main star gives rise to a change of small amplitude. But the uncertainty of π does not allow for any reliance on these results.

In conclusion, I take the liberty of restating mine here firm conviction on the solidity of my theoretical sketch. It does not lack the comfort of impressive confirmations, impressive for the vastness of number, for richness and variety of coincident details, for spontaneity, and for *sincerity*. The meaning and strength of these confirmations (infinitely vaster and more beautiful than those that the "theory of relativity" is still begging) would appear to everyone more than satisfying, *quite enthralling*, if you care "relativistic" had not hindered the simple reading and even printing my work. ¹⁾

But I trust that a large and peaceful discussion – how this by Mr. Salet provoked - will end up being recognized to all the value and fruitfulness of the "ballistic principle"; which not only promises much for the science of tomorrow - as Mr. Salet acknowledges - but who gives, and not a little, for one that can be built today.

Palermo, R. University, March 15, 1925.

Italian to English translation using Google Translate and Yandex Translate by Thomas E. Miles. Other Ritz & La Rosa related files located by Robert Fritzius at web site: http://shadetreephysics.com/ with other relating at Gen. Sci. Journal: https://gsjournal.net/

¹⁾ I regret having to declare that some magazines did not want to welcome a large summary of my work, which for convenience of foreign readers I had prepared.