THE RITZ POSTULATE ON THE SPEED OF THE LIGHT AND THE PHENOMENA OF VARIABLE STARS NEW THEORY OF THESE STARS

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1. - It is known that the theory of relativity hinges on a postulate essential which affirms "the constancy of the speed of light", that is, its own independence from the motion conditions of the source and of the observer.

Three years after the appearance of Einstein's first memoir, Ritz ([1]) had shown that the same end pursued by could be achieved Einstein, that is, the extension of the principle of relativity of mechanics to everyone physical phenomena ([2]), remaining on the solid ground of classical mechanics, and admitting only *that the veil of the light is composed with that of the source, according to Galileo's rule (ballistic hypothesis).*

Comstock ([3]) and Castelnuovo ([4]), independently of each other, thought then to the possibility of obtaining a decisive proof between the two opposites hypothesis, by means of suitable observations on "double stars". They signaled, in fact, that in the second hypothesis the time intervals between three consecutive passages of the rotating star for the "quadrature" points, should have been unequal ([5]).

But while Comstock himself was beginning to try, with no comments easy, to test this prediction, De Sitter ([6]) succeeded, with a few considerations, to instill in everyone the belief that observations on the stars "Double" ([7]) and on the laws of their movement provided the clearest and most solid test around the independence of the speed of light from the motion of the source.

([1]) RITZ, *Ann. d. Ch. et de Phys*., vol. XIII, p. 145, 1908.

([2]) A brief note on the physical origins of "relativity" and their critique it is contained in a note of mine; published in 1912 (*N. Cim*. vol. III, page 345). A wider one can be found in an article of mine in *Scientia*, October-November 1923.

([3]) *Phys. Rev*., vol. XXX, p. 267, 1910.

([4]) *Scientia*, vol. IX, p. 71, 1911.

([5]) These observations could not have provided evidence, except in the case in which it was possible to know in a certain way that the orbit described by the moving star was circular.

([6]) *Phys. Zeitschr*, Bd. XIV, p. 429, 1913.

([7]) The first discovery of pairs of stars, bound together by analogous relationships to those who run between the Sun and the Earth, that is, linked by mutual attraction and animated by a motion of

In fact, says De Sitter almost, if the speed of propagation of light composed with that of the rotation of the star, the light rays emitted in the first quadrature (position *A* of fig. 1) and traveling by hypothesis with the velocity *c-v*([1]) with respect to the observer (placed in *M*), they would end up overlapping and confusing with those emitted in the other quadrature, traveling with the speed *c+v*, so that it would be impossible to distinguish and separate the different positions of the star over time, and *it would be impossible to recognize the law of orbital motion*.

Now De Sitter's reasoning, if has the merit of great evidence intuitive - which is why it was easily accepted with almost no discussion - it is too simplistic and incomplete, and yet it embraces and confuses together cases for which the final conclusion is right, with cases (the majority undoubtedly) to which the same conclusion does not agree at all.

A more complete analysis of what the terrestrial observer should see in the hypothesis ballistics, allows us to easily recognize the error of conclusions by De Sitter, as it makes us recognize that *telescopic and spectroscopic observations on the law of movement of double stars, they are widely possible, safe from each drawback* due to the overlapping of light; not only that, but *this analysis it leads us to give a clear and simple explanation* - what is supremely important - *of a large group of astronomical facts* of the most interesting and obscure: that of variable stars, proving that *the ballistic hypothesis*, in the interpretation of astronomical phenomena; *proves incomparably more fruitful than results and closer to natural facts than Einstein's*.

DOUBLE STARS AND BALLISTIC HYPOTHESIS

2. - Let us assume, therefore, that the speed of light is added to that of the source (in motion) that emits it.

Let's imagine a star *S* rotating around a center according to an orbit, for circular simplicity, in the direction of the arrow, with the velocity *v*;([1]) and an observer placed in the plane of the circle, along the direction *SM*, at a distance *d* from center *O* of the circle (*d* extremely large compared to the radius *r* of the circle). Self

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rotation with respect to the common center of mass, it was made by Herschel, who succeeded in observing the elliptical trajectory described by a of the two stars around the other, and to show that this elliptical motion takes place in accordance with Kepler's 2nd law, This very important discovery allowed the extension of Newton's law outside our solar system, with the known fruits of that knowledge that we possess around the masses stellar.

([1]) Here it is implicitly assumed that the plane of the orbit is slightly inclined with respect to the visual range; and, in any case, that v is the projection of the velocity tangential on the plane determined by the view itself and by the normal to it lying in the plane of the orbit.

with t we denote the departure time of the light rays from the star, and with T that of arrival at the observer, and we agree to choose as a common origin the instant of a passage of the star for position A, we easily find that

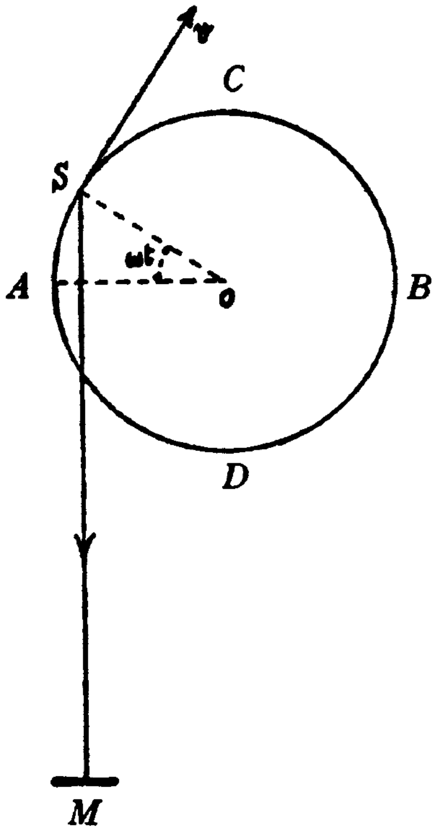

Fig. I

the observer will receive the rays emitted from any position S, in the instant T, given by:

$$T = t + \frac{d}{c - v \cos \omega t} = t + \frac{a}{1 - b \cos \omega t} \qquad [1]$$

where $\omega = 2\pi/\tau_0$ is the angular velocity of the star, τ_0 the time of a rotation, $a = d/c$; $d = v/c$.

The periodic term which is contained in T acquires a very different importance from case to case, according to the relative values of the three quantities a, b, τ_0 which concretely have very wide limits of variability.

In fact, we know examples of double stars for which the rotation time is τ_0 400 years old (ι Carinae, γ Leonis) and many are known for which it is the same time is only three days (the Persei) and even less.

Consequently, the speeds must also be strongly different tangential (and therefore the values of b) for which we know figures ranging from a minimum of 6 to 8 Km/sec. as for Sirius and Polaris (minimum that is that spectroscopic observation allows to reach) to an unspecified maximum which seems to reach 300 Km/sec. (β Aurigae 240 Km/sec.)

Wide limits of variability also occur in the values of *a*, as they are next to them double stars like α Centauri - which as we know, has the smallest distance from us (*d/c* = about 4.5 years) - and Sirio (*d/c* = 9 years), we find the τ Vulpis and the δ' Lyrae which are almost at the limit of visibility with the naked eye (53th.5 magnitude) for which the *d/c* ratio touches about 130 years; *to stop us at the stars so far safely known as doubles*.

So, if we want to acquire a clear notion of the importance that the term periodical content in *T* can buy in various cases, it is necessary that we put ourselves above the concrete ground, discussing certain particular cases to build the various ones *types* of phenomena that can occur in so many varied conditions.

3.- - Therefore set $a = K\tau_o$ we will write [1] as follows:

$$T = t + \tau_o\,(K + Kb\cos\omega t - Kb^2\cos^2\omega t + Kb^3\cos^3\omega t - \ldots) \qquad [1']$$

and we will observe that since *b* in reality is always small (it hardly reaches 10^{-3}) if *K* is not very large, (1′) can be limited, for concrete purposes that we are aiming for, at the first three terms only, that is, we can put:

$$T = t + K\,\tau_o + Kb\,\tau_o\cos\omega t. \qquad [2]$$

Indeed, whenever the product *Kb* is p. es. less than 10^{-2}, the influence of the same third term, the periodical, is very weak: since it is feared superposition of light rays emitted from different positions (i.e., equality of the *T*, between rays departed at different instants *t*) can take place for positions distances of small arcs (shorter, for example, by one hundredth of the length of the trajectory). *This overlapping cannot give practically appreciable disturbances to an observer who detects the successive positions of the star from time to time, or its radial speed* and this can then determine the projection of the orbit on the celestial sphere, and recognize without inconvenience if the 2nd law of Kepler is or is not applicable to the observed motion ([1]).

The effects of the overlap become conspicuous in cases where the product *Kb* is close to unity.

Also for the examination of these cases we can practically use the formula simpler [2], since *Kb* is close to 1 the amplitude of the third term will be of the same order of to (which

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([1]) To anyone wishing to know if the above conditions are supposed to be or not applicable to those stars for which direct verification of Kepler's law was done, I'll remember some examples.

The best-known double, and on which the best observations about the validity of Kepler's law have been made and the star closest to us, α Centauri.

means that superimposition of rays emitted at intervals of time comparable with the period, and therefore from points of the trajectory very far from each other) while that of the termination,([1]) for reason of the smallness of b, it will be of a much smaller order of magnitude; what that means that this secondary effect of superposition is limited between emitted rays from positions very close along the trajectory and therefore it is not very noticeable.

To facilitate our considerations, we will refer to the curves of figs. 2 and 3 which are graphical representations of the law [2], constructed ([2]) for certain cases

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For it we have: a = 1640 days; τ_o = 81.19 days; v = 24 Km./sec. that is $b = 8.10^{-5}$, and therefore $Kb = 1.6\ 10^{-3}$.

Another double well studied, because it is very close, is Syria, for which we have a = 9 years; τ_o = 48.84 years that is $K = 0.18$; v = 8 Km./sec. and therefore $b = 2.7\ 10^{-5}$; therefore $Kb = 5.10^{-5}$.

For α Aurigae, a = 4000 days in round numbers; τ_o = 104, K in round digit 40; v = 30 Km./sec.; $b = 10^{-4}$, $Kb = 4.10^{-3}$.

([1]) As an example, we can assume v = 60 Km./sec. which is very close to the average of the v measured on the so far known "doubles", namely: $b = 2.10^{-4}$. If the product Kb is close to 1, it means that K is of the order $0.5\ 10^{-4}$, and the [1'] in the hypothesis $K = 0.5\ 10^{-4}$ gives:

$$T = t + \tau_0 \left(0{,}5.10^{+4} + \cos \omega t - 2.10^{-4} \cos^2 \omega t \ldots\right)$$

that is, already the fourth term would bring superposition of rays emitted inside a time interval 2.10^{-4} to that is from positions distant 1/5000 of the length of the trajectory.

([2]) The construction by points and tangents of the curves is quickly reached

$$T = t + \frac{K}{1 - b \cos \omega t} \quad \text{o piuttosto} \quad T = t + \tau_0 (K + Kb \cos \omega t)$$

[editor note: 'o piuttosto' = 'or other'] looking for the points of intersection with the lines that are defined by it equation, when the most significant numerical values are put in place of cos ωt of this function, namely:

$$0\ ;\ \pm 1\ ;\ \pm \sqrt{1/2}\ ;\ \pm 1/2\ ;\ \pm \sqrt{3/2}$$

and also looking for the directing ratios of the tangent to the curve at such points. So, for example, in correspondence to the value cos ωt = 0 we will have the line $T = t + K\tau_o$ that cuts the curve in all the points of abscissa, t, so that it results cos ωt = 0, that is:

$$\omega t = \pi \left(2n \pm \frac{1}{2}\right) \quad \text{ossia} \quad t = \frac{\tau_0}{2} \left(2n \pm \frac{1}{2}\right)$$

[editor note: 'ossia' = 'i.e.'] and it is advisable to distinguish the points for which the fraction 1/2 has the + sign from the others, since the directing relationship of the tangent in both takes the values:

$$1 - 2\pi Kb \quad ; \quad 1 + 2\pi Kb$$

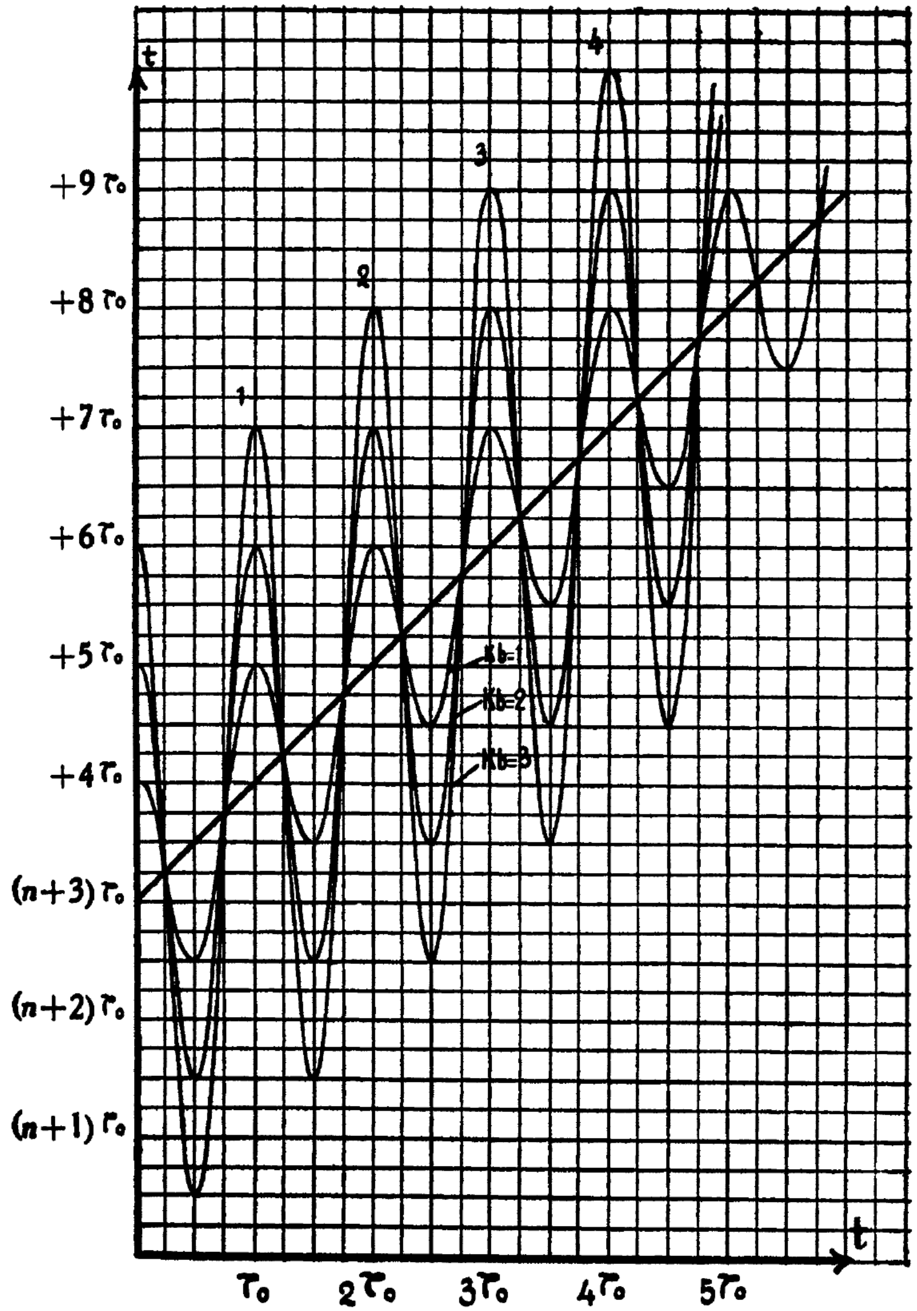

Fig. 3

more interesting concrete, precisely for the following values of the product *Kb*: 0.1; 0.16; 0.3; 0.6; 1; 2; 3. Let's take a closer look at the behavior of some of these curves; let's refer for example. to that defined by $Kb = 1$.

Beginning to consider things the moment the observer receives the light departed from the star at the instant $t = 0$, we will detect the following circumstances important:

a) the brightness of the star will appear as tending to a maximum (this which we will clarify better now);

b) at that moment the observer has already received all the light that the star it had issued in the positions occupied during just over three-quarters of the first round, and a good part of the 2nd round; precisely from nearby locations to the 4th square.

From this moment on - or more exactly from the maximum - the observer it receives at the same time, in every instant, light emitted by three different positions taken by the star: the first belonging to the end of the first turn and placed along an arc that begins beyond 3/4 of the trajectory (after the first conjunction), the other between the 2nd opposition and the 4th quadrature, therefore belonging to the 2nd quarter of the 2nd round; the third between this square is the second conjunction (belonging to the 3rd quarter of the 2nd round).

Note that the three portions of the curve([1]) between the parallel to the t axis ducts for points $T_o = (n + 4)\ \tau_o/2$; $T_1 = (n + 5)\ \tau_o/2$ are strongly inclined on this axis, what tells us that while the starting times of the rays bright vary within a very narrow range, those of arrival extend in a much greater range.

Consequently, the light that the observer receives from the moving star for each unit of time, in this interval, is smaller than the quantity x that he would have received if the star remained stationary.

When T is about to touch the T_1 value mentioned above, in light of the positions immediately following the light emitted by the star is added to the moment of the 6th square, around which the T passes through a maximum; so that in a very short ΔT interval the observer will receive more light emitted by the mobile star in a time somewhat longer than ΔT; *namely the*

It goes without saying that all these lines are inclined at 45° with respect to the axes, and that the two straight lines corresponding to the values ± 1 of cos ωt (that is, respectively at the values $t = 2n\tau_o/2$; $t = (2n + 1)\tau_o/2$) are tangent to the curve, which remains entirely within the strip limited by these two lines.

For obvious reasons in the figures, we have assumed that the t-axis is transported upwards parallel to itself by an amount convenient to the drawing.

([1]) We exclude for now the portion near the T-axis where a occurs maximum; that is, we consider the first parallel conducted not by T_o, but by maximum.

intensity apparent light of the star must rapidly rise to a maximum, in which the the light reached is several times greater than that, x, which would have been at a stationary star.

From this moment on, the light intensity must decrease, without returning to those very weak values first considered, because the observer will receive light coming from 5 different positions of the star, and why these positions correspond to arcs of our curve in which $\Delta T/\Delta t$ takes values always lower than those taken along the previous sections. Shortly after the instant $T_2 = (n + 5.5)\ \tau_o/2$ where the second conjunction takes place, the brightness will pass for a second minimum of somewhat greater value than the first, to return immediately to grow and reach a second maximum, immediately after the time $T_3 = (n + 6)\ \tau_o/2$ ([1]).

Finally, the light intensity will quickly return to the minimum value seen in the beginning, to start the same periodic cycle again.

In summary, if a star rotates around a center and satisfies the condition supposed by us (Kb = 1) *must have alternatives of brightness, which reveal themselves to us as a periodic change in its apparent size*, that is, the star must appear to us to be "variable" (with double periodicity). ([2]).

4. - Results essentially similar, although different in detail, we have, analyzing the other constructed curves.

For Kb = 0.6 the influence of the periodic term on the values of T can be said in its full development.

([1]) To get an idea of the average value of the apparent brightness it will present the star in these different phases, we can estimate the average values on the figure which in correspondence with them takes the $\Delta T/\Delta t$ ratio.

Immediately after the maximum that occurs for T=T_o, we find that in a duration ΔT= $\tau_o/4$ approximately, the observer receives the light that the star emits for a long time the three arcs indicated above which are covered in a time (sum of the projections of the three arcs on the t-axis) by about $\tau_o/_{10}$. On average the brightness. app. of the star in this interval will therefore be less than half of what it would have presented if it were immobile. Around the maximum we have that in a duration ΔT = 2/80 τ_o the observer receives light emitted in a time more than 4 times greater, and therefore the star will have a brightness 4 times greater than that that he would have presented standing still. Overall, from the minimum to the maximum the brightness varies from about 1 to 8; and therefore, a leap of the star of two classes on the scale of apparent quantities (because - as is well known - it is calculated that the relationship between the luminous intensities of two stars belonging to classes contiguous is about 2.5). In the second minimum, the apparent intensity is averaged equal to that which would correspond to the stationary star, since from the figure we have

$$\Delta T = {}^{22}/_{80}\ \tau_0 \quad \text{e} \quad \Delta t = {}^{20}/_{80}\ \tau_0 \ \text{circa.}$$

([2]) Later we will see how this conclusion is completed when yes suppose that the center of attraction is another star, with the first one being a system rotating around the common center of mass. For now we are content with aftermare that if for one of the two stars our condition is met, the appearance of variability must continue to exist, albeit to a lesser extent.

Starting the analysis from the usual maximum that immediately follows at the moment in which the observer receives the light emitted by the star at the instant $t = 0$ that is ($T_o = K\tau_o + Kb\tau_o$) the curve for an entire interval ΔT almost equal $\tau_o/6$ comes cut in a single point from the parallels to the t-axis, and has in this region a very large and almost constant $\Delta T/\Delta t$ ratio.

Shortly after the instant $T_o + \tau_o/6$, the brightness quickly reaches a maximum, since the light coming from the following positions (to those already considered) of the first round, and in which the $\Delta T/\Delta t$ is getting smaller, it is added *abruptly* that emitted at the moment of the 2nd quadrature of the 2nd turn, in where $\Delta T/\Delta t$ is very small; after which the light intensity decreases to a new low, somewhat higher than the first, and finally passes for a new one maximum equal to the first.

Overall, the observer will see the star, for about one sixth of the period as of minimum intensity (order of magnitude maximum), and in the other half, he will see it pass through two consecutive maximums, separated by a minimum – equidistant – somewhat higher than the initial one.([1])

The curve of FIG. 4 gives us with sufficient approximation the law of these changes when $Kb = 0.5$.

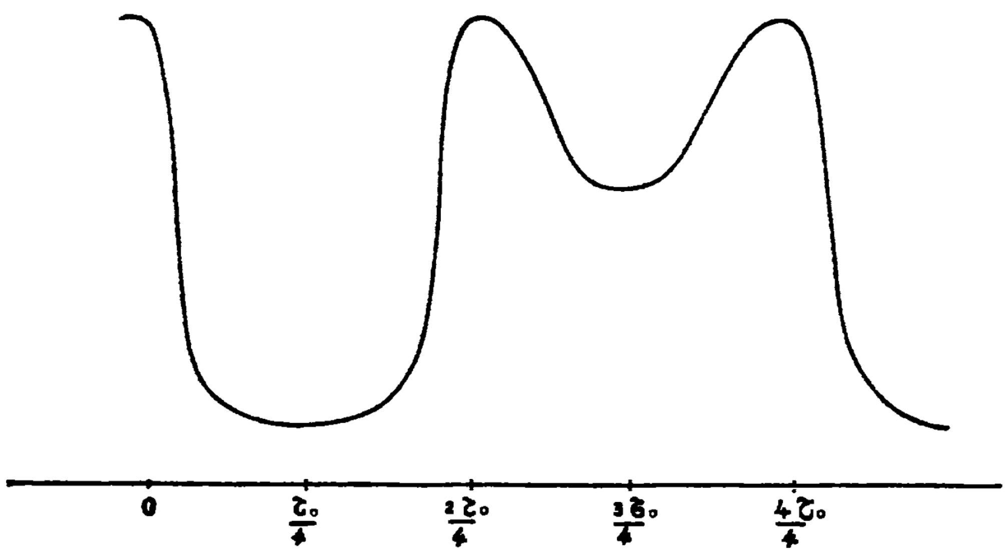

Fig. 4

For $Kb = 0.16$ we have a very interesting curve, made up of alternatives of long stretches almost straight and very little inclined with respect to the t-axis, with others very steep; to each other conveniently connected.

([1]) Wanting to make an estimate - on the figure itself - of the relative intensity of the maximums and the two minimums, it is found that in the vicinity of the maximums the luminosity average must become 5 to 6 times greater than % - the intensity being % luminous that the immobile star would have -; in the secondary minimum it must go down about 4 or 3.5%; and in the main minimum to 1/5%. The total width of the change of light and therefore higher than the ratio 25:1, what it means an apparent leap of 3.5 classes.

In these conditions we will therefore have *strong* fluctuations of light, compound of very intense maximums and of *short duration*, to which they occur with rapid change minimums with almost uniform brightness and *long duration*([1]).

As long as *Kb*≥ ½ π we are still presented with the facts of superposition of light emitted by the star in points of the trajectory quite distant from each other; (one parallel the *t*-axis can intersect the curve three times) and the double periodicity previously seen, with two almost equal maxima and two strongly different minima.

As the product *Kb* continues to decrease even more, the amplitude of variation in *T* becomes smaller and smaller, and the curve is always cut into a only point from the parallels to the *t*-axis; therefore we will not yet have fluctuations

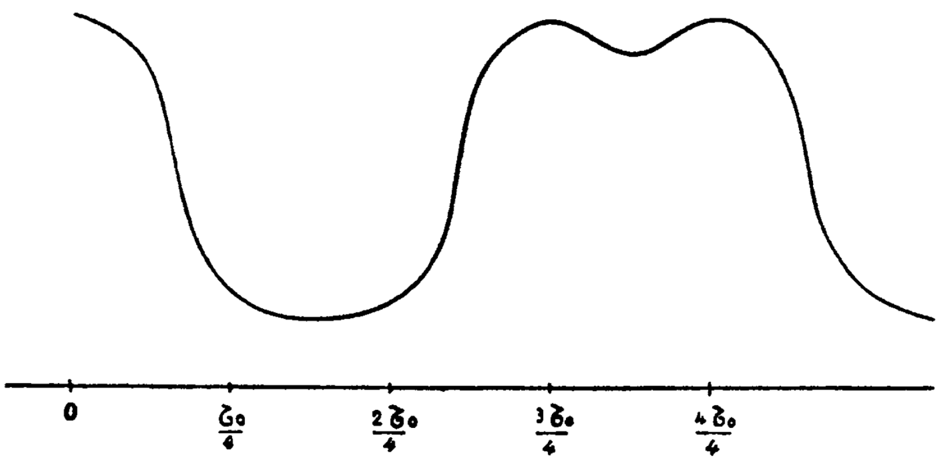

Fig. 5

in the observed brightness, because the ratio Δ*T*/*Δt* always undergoes changes sensitive. However, given the difficulty and poor precision of photometric measurements in general, and of those that can be done and that have been done in astrophysics, it is understood how soon these slight fluctuations become undetectable. In practice this can perhaps be assumed to be for *Kb* <1/10.

5. - With increasing *Kb* starting from 1/2 the essential character of the curves $T = f(t)$ is at first substantially the same; we will therefore have vicissitudes in the apparent brightness of the star, similar to those represented in fig. 4, with only these variants:

a) the phase of minimum occupies a shorter time than that of the maximum.

b) the difference in intensity between the maximums and the intermediate secondary minimums it becomes smaller and smaller as *Kb* increases.

([1]) From an estimate made on the figure, the intensity ratio between the ones and the others range at least from a maximum of several hundred *x* to a minimum of *x*/2; so that the amplitude of the total luminous oscillation is equivalent to a jump of at least 7 steps on the scale of sizes.

The two maxima appear ever closer together and tend to get confused in one.

Fig. 5[a] which refers to the case Kb = 0.70, compared with the 4[a], clearly shows these modifications.

The curves corresponding to values are presented with less and less interest of Kb always greater than 1. The superposition of light occurs for a number of increasingly large positions, belonging to increasingly different periods and phases, and all our observer will notice will be small oscillations of the luminous intensity in the moments in which the values of T reach the maximum and the minima of the curve under examination.

Already for $Kb = 5$ the number of intersection points of the curve $T = f(t)$ with one parallel to the t-axis (i.e., the light superposition positions) become in general 20. The light sent by the star will suffer in correspondence with the maxima and minimum of this curve, some slight reinforcements with period $\tau_o/2$ which will go to dilute in the almost constant total light coming from the other numerous one's locations.

It is therefore easy to understand how soon, that is, for the values of Kb no less than 10, any fluctuation in luminous intensity will become priceless; *the star will become unable to reveal us due to changes in the apparent gravity its periodic motion, that is, its condition as a "satellite"* of a "double", or a more complex system ([1]).

6. - The considerations made so far allow us to respond in a way precise to our first question:

Is the hypothesis of the composition between the speed of light compatible or not and the eventual one of the source, with the researches made on the "double stars"?

For telescopically solvable doubles (which are the only ones on which validity of Kepler's 2nd law was truly recognized and controlled) the condition desired for that purpose by our analysis, $Kb < 10^{-1}$ is largely satisfied. Therefore, *the observations made on them prove nothing against our hypothesis*.

For the other "doubles", those *spectroscopically* resolvable, the application of Kepler's 2nd law was not imposed by the measures but was made a title of reasonable generalization.

([1]) It does not take into account to discuss the case where the product Kb being a lot large, Kb^2 is of the order of unity. (See forms 1').

In this case the amplitude of the variation due to the 4th term would become of the order of τ_o, that is, it would allow for the superposition of light from positions somewhat distant occupied by the star on the trajectory. But as the 3[rd] term has a width a thousand times greater, the width of the strip within which the curve is included is about 2000 τ_o, which means that a parallel at the t-axis it will meet about 4000 times the curve $T = f(t)$; and therefore from all these various *different* positions a total of light will be collected in every instant practically constant.

Spectroscopic observation provided only the knowledge of the period of rotation, and that of the speeds of the supposed component stars; according to the which data, and with the support of Kepler's laws (assumed therefore applicable) the other elements of motion (the dimensions of the orbit) and the masses of the components.

Periods and velocities are deduced by means of the periodic shifts of the spectral lines, so that the point to be examined boils down to this: the measurements of such displacements are or are not disturbed by the superimpositions of light that our hypothesis foresees? ([1])

We have already seen, in the first pages of this memoir, that if the product *Kb* is small there will be no overlapping of light, except from points of the trajectory not far away; this means that the spectroscope will then arrive at the same time rays traveling with slightly different speeds; we will have therefore, albeit to an appreciable extent, a slight expansion of the lines, which varies periodically with the period of rotation of the star, which overlaps with the displacement periodic forecast based on ordinary hypotheses. No inconvenience therefore for the measure of this displacement.

The same conclusion still holds when the product *Kb* approaches 1. Precisely until the curve $T = f(t)$ is cut at one point by the parallel to the abscissa axis, what will happen as *Kb* increases will be an increase the expansion of the row, and the greater evidence of the periodic variation in width.

When *Kb* reaches values such that $Kb > 1/2\pi$ the curve can be cut *three times* from some parallels and we could have, in correspondence, multiple lines - if they correspond to the positions from which the light arrives at the same time somewhat different speeds - or simply expanded, with a periodicity character perfectly regular, so as to allow the determination of the period, and to allow, with the measurement of the distance of the components or of the width of the scale, the determination of the instantaneous speed possessed by the impeller body in various positions; that is, of those elements that are needed for the deduction of the radius of the orbit and of the mass of the body, according to Kepler's laws (*suppositories already applicable*).

Indeed, the dissymmetry of our curves, with respect to the parallels to the axis of

([1]) Here we assume that a serious question is implicitly resolved: that of way of considering the Doppler ellipse in the case of the ballistic hypothesis. Reserving me to deal with this question separately. I will limit myself here to pointing out that the difficulties around this important phenomenon arise only on the basis of consideration of the *wavelength*. Now it is good to remember that this concept is not *in the way essential bound to the periodic nature of the luminous phenomenon*, but it is subordinate to the image of the ether, which, by itself, is already irreconcilable with the hypothesis ballistics.

ordered, makes it easy for us to predict that the two components of a row ([1]) will appear then not equally displaced from the normal position; so that we will be led to attribute two different values to the speed of the source, values that are attributed in the current way of explaining the phenomenon to two different bodies - the two components of the double - which they should therefore have brightness, size and speed comparable to each other. Instead, in the way we explain the two values would belong *to digestive moments of the same revolving body* (around a large and little center mobile).

As the *Kb* product grows, the number of meeting points for the our curve with the parallel to the *t*-axis. As long as this number of points is small, 3, 5, we will generally have expanded lines, which can resolve at some time and have *two or more distinct components, as has been the case in certain cases observed, but not explained* (Mira Ceti) ([2]). When this number becomes large, we will have superimposition of light coming from many positions different, with different speeds, and therefore lines *strongly and constantly* expanded, in which the width will present small changes, which as *Kb* increases, they will become priceless.

Only, therefore, *when the product Kb has become greater than 10, the observation spectroscopic based on the theory of the periodic changes of the lines not it allows us more to ascertain the nature of "doubles" of the stars*.

Only for these cases would De Sitter's fears therefore have a good foundation.

But there is nothing wrong with believing that the astrophysical investigation has failed yet to reveal the true nature of a number of complex stars. Our hypotheses will help us a lot to discover them. The state of constant expansion presented by the spectral lines of many stars end an established fact ([3]); interpreted in the light of our hypothesis will allow us to recognize the nature of "doubles" or rather of complex systems of stars.

7. - The following statistical considerations support impressively this is our opinion about the probable existence of many systems complexes not yet resolved:

([1]) It is frequent the case that two of the three positions of the star elti the rays they arrive at the same time, be they such that the velocities of the rays are too much slightly different to give rise to two distinct lines. In these cases they will be observed therefore double lines, and of different intensity.

([2]) Frequent is the case of the simultaneous observation of the net line in normal position and two lateral expanded components. You immediately see how this is case fits perfectly with what can be predicted based on our curves.

([3]) Stars of the first spectral class are characterized by presence strongly expanded hydrogen lines.

The number of known spectroscopic doubles first grows rapidly as their apparent size increases, it soon reaches a maximum, and it decreases *precipitously*, so much so that very few are known of its size same as 5a 1/2

In the following mirror we have grouped in order of size - 1/2 size step - the doubles listed in a Campbell catalog, the only one I could have on hand:

Apparent magnitude	1a	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Number of known doubles	3	3	6	9	16	21	29	32	13	3	0

A graphical representation provides fig. 6

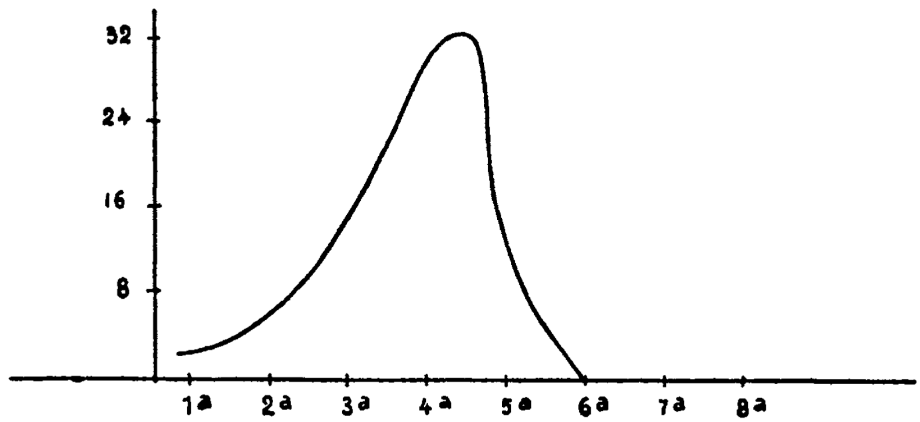

Fig. 6

Now such a behavior - it is almost superfluous to point out – is in stark contrast to what should have been foreseen, on the basis of ordinary criteria of the "probability", taking into account that the number of stars belonging at each of these intervals of size, it grows with rapidity and it as it grows of the order number of the range.

Therefore, the suspicion that some well-defined and constant cause arises spontaneously limits, and finally prevents, the possibility of the observation of "doubles" (certainly existing) by means of the study of splits and expansions changing and periodic lines; and a cause of this kind comes to us pointed out by our discussion.

Values $Kb > 10$ can appear more easily the greater is the distance a, that is the largest K, due to the necessary smallness of $b = v/c$. That is, the farther a "double" is, the lower the probability that it can manifest to us, with the usual observations, this nature of its own. When K is large, it will take increasingly smaller values of b for the threshold $Kb = 10$ is not exceeded;

and with small *b* values, observations are impossible for another reason: for the smallness of the expansion of the rows.

The efficiency of spectroscopic methods for the discovery of complex stars it must therefore, for these reasons, rapidly fail, as the distance of the stars grows, that is, that the order of the class grows.

On this point, our hypothesis is therefore in perfect harmony with the facts. We can therefore state:

1 ° that the observations on the known double stars do not prejudice the eventual accuracy of the ballistic hypothesis around the speed of propagation of light, much less affirm the truth of the 2nd postulate of Einstein's theory;

2 ° that the ballistic hypothesis gives us an excellent foundation to explain the curious thickening of the known doubles around the 4th and 5th steps of the scale of apparent quantities.

But the value and strength of our hypothesis is not limited to this alone.

BRIEF NEWS ABOUT VARIABLE STARS

8. - The reader has already noticed that in the brief and simple considerations around our curves we have drawn - without having had the purpose - the essential framework for a good theoretical explanation of a vast and most attractive field of astronomical facts, passionately and for a long time discussed, but still largely regarded as strange and full of mystery.

They are the phenomena presented by "variable stars" and "new stars".

It is not these sporadic facts, which can be ascribed to occasional circumstances, very rarely feasible and realized, as is implicitly admitted in those explanations of a catastrophic nature, given for most of the "variables" known; but they are certainly made dependent on normally existing causes, needing only particular and well-defined conditions to give effects to we posters.

To be convinced of this, just keep in mind that the number of "variables" known in a way *certainly a few years ago*, it exceeded a thousand; and that that of the stars considered as such exceeded 2000.

Perhaps the reader will not consider some brief information about this superfluous field of facts, and to the ideas that are linked to it. To the competent - what they can do unless I read these pages - I apologize for the gaps, employees from the poverty of the material that I had at my disposal on the subject, and from my unpreparedness in this special field of study.

The "variables" known so far are grouped into three distinct classes, (Scheiner) according to the following criteria:

Class I.

The "new stars" characterized by a great blaze *suddenly purchased* compared to an initial state of very weak brightness or even of invisibility; and the *slow and often irregular return* to initial conditions. Do not it is still ascertained whether their appearance is periodic or not, but if it was, it is it should have a very long period.

Class II.

Mostly red stars *with a rather long and not perfectly regular period*.

Subclass II-a. - Includes those with a longer period. *The increases of splendored always occur more rapidly* than decreases. The period is thick variable and can be expressed with the usual interpolation formulas with several terms. The fluctuations in light intensity are mostly very large.

Subclass II-b. - Quite irregular period; mostly small variations light intensity.

Class III.

Short periods (from a few tens of hours, up to a few weeks) and a few time very slowly variable; *very regular* fluctuations in light intensity. Mostly white or yellowish color.

Subclass III-a. - The light fluctuations are relatively small (not they reach the amplitude that corresponds to the passage of the stars from a class to the contiguous). Next to the main minima and alternating with them they occur other secondary minima that can correspond to luminous intensities notable.

Subclass III-b. - The phase of maximum intensity embraces the greatest part of the period; the minima, which occur with great regularity, flow fast.

9. - Obviously here, as in all classifications of objects or facts disparate around a few schematic types, one cannot expect to have described and exactly represented in a few words the various phenomena observed and therefore we consider it convenient to closely examine some typical concrete cases of the different ones classes; and discuss them, along with the hypotheses currently underway to explain them.

We will proceed with this investigation by going through the classification given in order inverse, and however let's examine some typical cases of class III b.

The most typical example is offered by β *Persei* (Algol). This is a star of variable magnitude, between 2.3 (maximum) and 3.5 (minimum) period exactly known of 2^d, 20^h, 48^m, 9^s and very constant (in about a century it has been observed a variation of 8^s). During most of this time the brightness of the star remains close to the maximum; goes down and goes through the phase of minimum in 9^h and 45^m.

It had long been assumed that the very regular changes in light observed in this star were due to the passage, in front of it (on the line aim) of a darker satellite circling it. This assumption does believes confirmed by means of the spectroscope which I show that certain spectrum lines are double. By measuring the distance, the lines were indeed, calculate the speeds according to the visual range, of the star and of the companion which resulted in 42 Km/sec. and 89 Km/sec. respectively.

Similar - but not entirely identical - behavior they exhibit several other stars (14 in all) which are called "Algol type" of which the nature of "*doubles*" *was also recognized by spectroscopy* i.e., which naturally led to extend to their variability in size the explanation mentioned above.

By way of news, we will say that not all stars of this type have the simple behavior of β Persei: some show a double period;

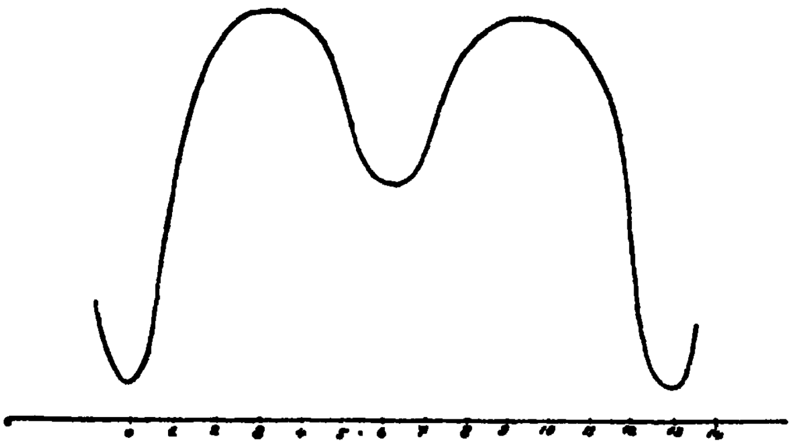

Fig. 7

thus, they Cygni presents a change in magnitude between the classes 7^a and $7^a.9$ with a period of $2^d\ 25^h\ 54^m$ in which a secondary minimum is observed with the following intervals with respect to the two maximums that comprise it: $1^d\ 10^h\ 11^m$ and $1^d\ 13^h\ 44^m$. Similarly, the *Z* Herculis, size $7^a.1$ to 8^a; period $3^d\ 23^h\ 49^m$ has a secondary minimum at intervals of $1^d\ 22^h\ 49^m$ $2^d\ 0^h\ 59^m$ from the two consecutive highs.

The behavior of the *variable* stars included in class IIIa is very close to this one just described; and the explanation is therefore substantially identical proposal, which he believes confirmed by spectroscopic research. We remember some examples.

The β Lyrae has a period of $12^d\ 22^h$, in which time the brightness it presents two great maxima of equal value, and two different minima. In the main minimum the star appears of magnitude 4.5, after $3^g\ 3^h$ it reaches the first maximum presenting itself as being of magnitude 3.4; after another $3^d\ 6^h$ it appears in the secondary minimum, of size 3.9; returns in $3^d\ 3^h$ at most first, to finally fall back to size 4.5. The period is slowly variable. It is interesting to compare the light curve of this star given by the figure 7a, with the light curve drawn according to the diagram $T = f(t)$ for $Kb = 0.5$ and represented by figure 4.

There η Aquilae, period $7^d\ 4^h\ 20^m$; from the minimum of size 4.7 comes in $2^d\ 6^h$ at size 3.5, main maximum, passes through the secondary minimum, grand. 4.1 after $1^d\ 15^h$ and goes back to the second maximum of magnitude 3.8 after 13 hours to finally return to the minimum primitive size after $2^h\ 18^m$. Figure 8a gives us the diagram of the brightness of this star.

The δ Cephei shows period $5^d\ 8^h\ 48^m$, change in apparent magnitude from a maximum of 3.7 to a minimum of 4.9; it is interesting because the secondary minimum and the maximum 20 merge together at an inflection point (fig. 9).

10. - The proposed explanation for the "variability" presented by the stars of this type, despite the solid basis that their nature of *double* o

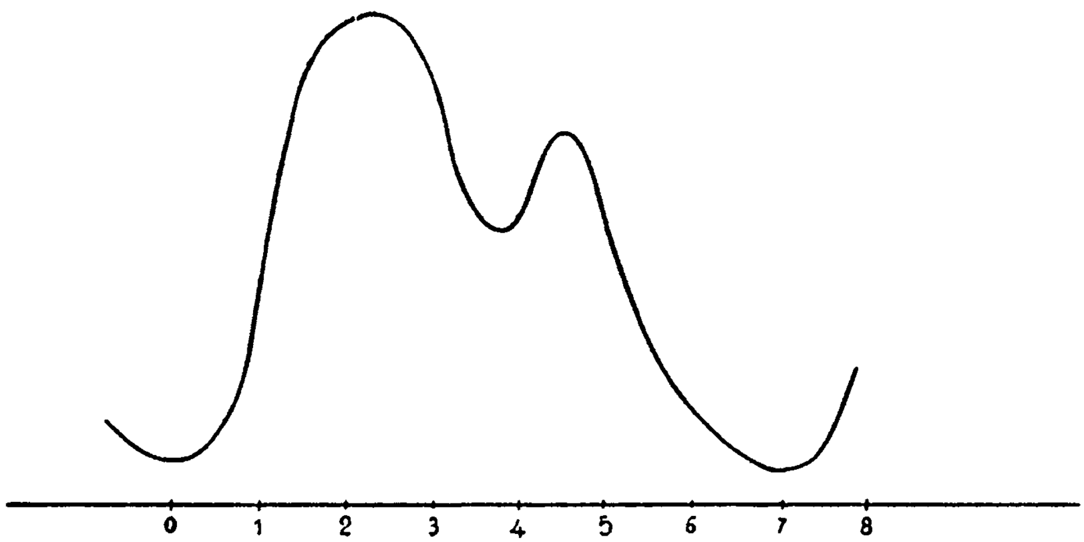

Fig. 8

best of *complexes*, with one (at least) impeller component, found in the spectral research, offers the side to some not slight objection, which is not easy to remove.

This explanation brilliantly clarifies simple behavior variables of the Algol type, admitting the periodic occultation of one of the two components of the double, by part of a darker satellite. Clarifies the behavior of the doubles of type β Lyrae assuming that the two components have different but always remarkable intensities; as then the two maxima would correspond to the squares, the main minimum at the *conjunction* (with the weakest star interposed on the line of sight) the secondary minimum to the opposition.

Again assuming - as has been done - that the trajectories are ellipses of no slight eccentricity, and that the major axis does not coincide with the radius visual, it easily makes us aware of the inequality of the intervals of time that elapse between the two maximums and the secondary minimum that follows them.

Where the explanation loses its persuasive power, that's where it comes to assign the reasons why the second maximum can be remarkably successful weaker than the first - as happens for η Aquilae, and for δ Cephei -

and the reason why the time interval between the secondary minimum and the second maximum, may become so short that it almost merges into a only point as it happens for δ Cephei.

To explain the different intensity of the two maxima it would be necessary to think that in one of the two quadratures there is a partial (apparent) superposition of the two component stars, which is absurd (equivalent that is to admit that in certain points of the trajectory the two stars have one distance *smaller* than the sum of their radii).

To explain the extreme smallness of the time interval between the minimum secondary and the 2nd maximum, it should be admitted that the transition from a

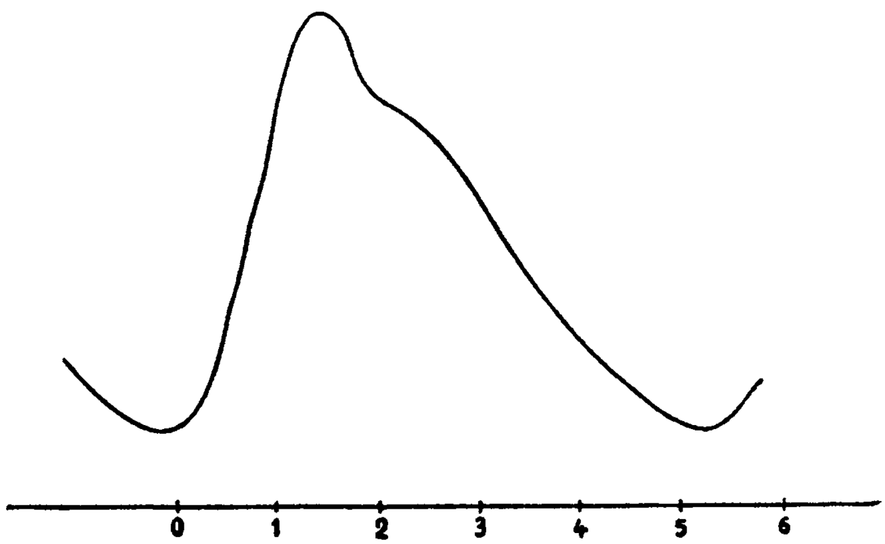

Fig. 9

conjunction to the next quadrature takes place in an extremely long time short, what fails in any way understandable.

Other difficulties that are not slight are still encountered to explain:

a) the presence of durations of the minimum phase greater than those of maximum;

b) the much greater rapidity with which the ascent to the maximum occurs in comparison with that of the descent to the minimum.

In conclusion, well *the occultation hypothesis* has a good foundation, in the spectroscopic knowledge of the nature of "doubles" of our "variables" it *is not enough to give us a clear and complete explanation of the facts* so far examined; facts that are the simplest but also the *least frequent*, presented from variable stars.

We come now to the II class.

II. - The maximum number of "variables" belongs to this class, and precisely to the IIa.

They have long and slowly varying periods, and show more marked that *very important* character of the *variables*, which is the increase abrupt brightness.

Typical examples of this class are: The "Mira Ceti" discovered since 1596, which has a period of about 332 days (which does not remain constant) and presents of the maxima of brightness oscillating between the sizes 1.7 and 5 and of the minima also oscillating between 8.0 and 9.5.

The α' Geminorum, which has a period of 86 days, among the shortest, of which 20 used in the ascent from the minimum (13th magnitude) to the maximum (9th magnitude), 66 in the descent.

R. Ursae Maj. with a period of 302 days and a fluctuation in the apparent size of *as many as 7.2 classes*; the X Cygni with a period of 406 days and an oscillation of magnitude of 9.5 classes (what matters a variation light intensity from 1 to 4000).

In the mass of very varied and obscure facts that the study of these has offered "variables" seems well established a *curious regularity*, which concerns the division of the stars of this class into different groups, distinct according to the length of their period.

In this regard, we report the following mirror that shows this law of breakdown by the 232 stars that until a few years ago had been in the way certainly assigned to this class IIa.

Period In Days	Number
10-20	7
21-50	7
21-100	7
101-150	9
151-200	18
201-250	30
251-300	39
301-350	45
351-400	53
401-450	18
451-500	6
500	3

It clearly shows that there is a curious preference for the period about a year; and more it is observed that the descent from the maximum occurs in a way somewhat faster than the climb.

The most distant of this interesting regularity has not yet been glimpsed reason.

For these "variables" the astronomers have excluded a priori *as insists the hypothesis of* *periodic occultation* by part of a satellite is possible, for a reason of the difficulty of explaining, in this way, the *irregularity of the period, the great amplitude of the change of light, the long duration of the idle and the abrupt passage from the minimum to the maximum*, all facts that cannot – as is natural – agree with this hypothesis.

For this reason, various artificial hypotheses had to be brought into play of which we will briefly recall those that have had the most credit.

According to Zöllner, a process of non-uniform cooling would have formed on the surface of these stars, vast dark crusts, accumulated preferably on certain regions. Due to the rotation of the star around to itself, the passage of these crusts on the visual ray giving rise to the variation of light with the *fundamental* period; the movement of these crusts on the surface of the star would give rise to irregularities found in the period; the vastness of such crust fields would explain the long idle life and a special configuration would explain (?) the asymmetry presented by the speed of increase and decrease of light.

An improvement on this hypothesis Sylden believed to give, admitting that the axis of rotation of the star does not coincide with its main axis of inertia, what would give rise to the changes of the period.

The most accredited explanation today differs from this one by nature of the screen which periodically hides the luminous star; to the crusts of Zöllner huge *spots* have been substituted for the rotation of the star as a reason of the fundamental period, the *periodic* training of such spots (?); the factors of the variability of the period would be the changes of position of them on the surface of the star and the rotation of this.

We will not stop to discuss the consistency of this hypothesis; assuming also the possibility of the formation of spots, similar to those of the Sun, *which in short time could totally cover the surface of the star* it could get to explain a change in intensity corresponding to the jump of 4 classes at most in the scale of apparent quantities (while yes they have at least 100 times greater variations in light; jumps of 9.5 classes) and each he sees what difficulties are encountered in supposing that similar phenomena extend to *the entire surface of the star*, occur and resolve *at close intervals than regular* and within relatively very short times - such as those of passage from minimum to maximum -.

Similar mysterious and strange apparitions in nature, vastness and speed phenomena imagined, have no comparison in the field of facts.

Another hypothesis deserves short news - in my view a lot more plausible at least less fortunate than the previous ones - due to Klinkerfues. He admits that variable stars are very narrow doubles which turning according to very eccentric orbits, at the moment of the passage for the periastro they would find themselves at such small distances as to cause each other deformations and displacements in the atmospheres of the two stars. Admitting that these atmospheres are highly absorbent, the gashes produced for these mutual deformations the observed increase would result light intensity. But even this hypothesis is insufficient to explain all the details of the observations; as the gigantic entity of the change of light, the presence of two maxima, the different interval between them and the minima, etc ...

12. - To complete our quick information, it remains for us to say a few thing of the stars of the first class or of the "new" ones.

For the sake of brevity, we will say only a few words about this very interesting one and a very rich field of observation, including systematic exploration you can say it just started yesterday.

Sudden appearances of new stars that shining even more than the stars of 1st magnitude, had an ephemeral life in the sky, were already observed and recorded in very ancient times (we have news of the year 134 BC to the year 393 d. Cr.) But their systematic study begins in 1863 with the appearance of the "new" of the Crown, or star of Birmingham, from name of the discoverer, who first found it on May 12th as *star of 2nd magnitude*, and observed its rapid and brief increase in brightness and the slow decline.

Better known are the vicissitudes of the Nova Cygni which was discovered by Schmidt on November 24, 1876 as a *star of 3rd magnitude*, which he submitted for a few days constant splendor then decreasing rapidly, so much so that later *just two weeks* it was reduced to size 6 1/2.

We have even more exact knowledge for several others, let us just remember the most famous; the "Nova Aurigae" and the "Nova Persei".

The first, discovered by Andersen on January 23, 1892, was not previously known - and in any case it could only exist as a smaller star than the The greatness - since until November 2, 1891 it is not found in the photograph made of that region of the sky on this date. It was later found. Already as a star of size 5 1/2 above one made on December 10, and as a star of 4th magnitude above another photograph taken 10 days later. After the discovery it rapidly diminished in splendor and in April 1892 was barely visible with the most powerful telescopes. *In August* 1892 - important detail - it *became brighter* again as it went up to the 9th 1/2 magnitude, and has since become soon very weak, but always remaining telescopically visible.

The "Nova Persei" discovered on February 21, 1901, also by Andersen as one star size 2 1/2, it reached its maximum in a few days, acquiring greater splendor than the stars of 1st magnitude. It is interesting to note that 28 *hours before* the discovery a photograph had been taken by Williams of that region of the sky, *on which there was no trace of the* "Nova", which therefore it had to be in the state of a star below the 12th magnitude.

Around these more recent "Novae" a vast and valuable has been collected material that we cannot examine here; we will be content to remember that the brightness curves in the decreasing phase always have character asymptotic but sometimes - as in the case of "Nova Persei" – oscillations remarkable and regular: that the spectrum, complex, always shows lines diamonds *split* and often divided into a greater number of components and it almost always shows the most intense components shifted towards red; show a continuous background that weakens rapidly and unevenly in the different regions, until it disappears completely; finally that the spectrum of lines, survivor, it is also gradually losing most of its elements, reducing to *a single line*, characteristic of nebulae.

It is not the case here to venture to recall the various hypotheses that have existed put forth, to explain the phenomena of these mysterious meteors. Every "Nova" ignited the fantasies and left a very long trail of opinion and discussions.

From the hypothesis of the violent conflagration between two peaceful inhabitants of sky; from the botched one by Zöllner, based on colossal eruptions and fires on the very plot of his theory of variables, on the other no less curious - and today absurd - of Lohse around successive stages of sudden and very violent chemical reactions reached by the star for subsequent cooling, to that of Wilsing based on the very mold of the hypothesis Klinkerfues' on variables to Vogel's of the collision between two integers planetary systems, to another that tries to base itself on anomalous dispersion of light, to that of the explosions of enormous gaseous masses, or of colossal electrical discharges, ultimately comes to the conclusion *that every "Nova" together with a rich and very interesting baggage of observations, he brought us a new puzzle*.

BALLISTIC HYPOTHESIS AND THEORY OF VARIABLES

13. - This imposing set of complex and varied facts is left behind well enough to coordinate and explain on the ground of our hypothesis.

Let's start with the simplest case, that is, with the variables of III class. According to what we have seen, our hypothesis explains all details observed in the study of these stars, in the most direct, immediate way and evident, and with an indisputable superiority over the occultation hypothesis.

Wanting to hold firm to the essential scheme of this explanation, admitting that is, that these variables are systems of two stars, slightly different from each other, and revolving around the common center of mass, our hypothesis leads us to consider two curves of the type studied, having the same period but difference of phase = 1/2.([1]) -

However, since the *Kb* limitation close to 1 is quite restricted, it is necessary so that the periodic term can acquire considerable importance, it will happen that if one of the two component stars satisfies the condition closely enough *Kb* = 1, the other cannot satisfy it as well.

Except for the very particular case, very unlikely, in which the masses of the two component stars were equal, the velocities of these will be, in fact, the values of *b* will be different and therefore different.

The two light curves will therefore generally have amplitude of oscillation different and the overall effect being a differential effect, we cannot expect very large changes in the brightness of the double. Moreover, being the total time of a rotation small, the concentrations of light, even when they extend to notable fractions of the period, they occur in limited time frames and therefore are always of moderate magnitude. We understand in such a way as the amplitude of the variation can remain inferior one step of the class of quantities (ratio of luminosity 2.5: 1).

These are the general lines. Coming to the details, let's remember how the discussion already done has led us to predict the double periodicity *with two minima of somewhat different intensities*, as observed in these variables (I recall the case of β Lyrae, whose brightness curve is perfectly corresponding to the diagram of fig. 4, drawn according to the curve $T = f(t)$ for Kb = 0.5).

Pushing the exam forward and also introducing into our considerations the hypothesis, perfectly natural and already in use in the theory of these variables - that is, that the orbits are remarkably eccentric ellipses, and that some are also slowly perturbed (by other nearby bodies, as in the case of planets) it is easy to explain:

a) the difference between the intensities of the two maxima (found for η Aquilae);

b) the dissymmetry of the intervals between the two maximums and the minimum included;

c) the degeneration of the following minimum and maximum in a point of inflection;

d) the slow variability of the period.

([1]) The ballistic hypothesis leads us to ascribe a more rational constitution to these variables; that is, to think of them as formed by a rotating component (which alone would give doubled lines) around a not very mobile central star, which would give lines in normal position. It would be understood in a simple and natural way the often-observed fact of the decomposition of lines into three components, one of which always in normal position, and two placed mostly by bands opposite, with respect to this, but sometimes also from the same band.

all facts that we have encountered, and which are not explained below by the theory of occultation.

The different velocities that the star can have at the moment of the two squares ([1]) depending on the eccentricity and the position of the orbit with respect to at the visual range, they immediately explain the first fact; the length different of the arcs to be traversed and the

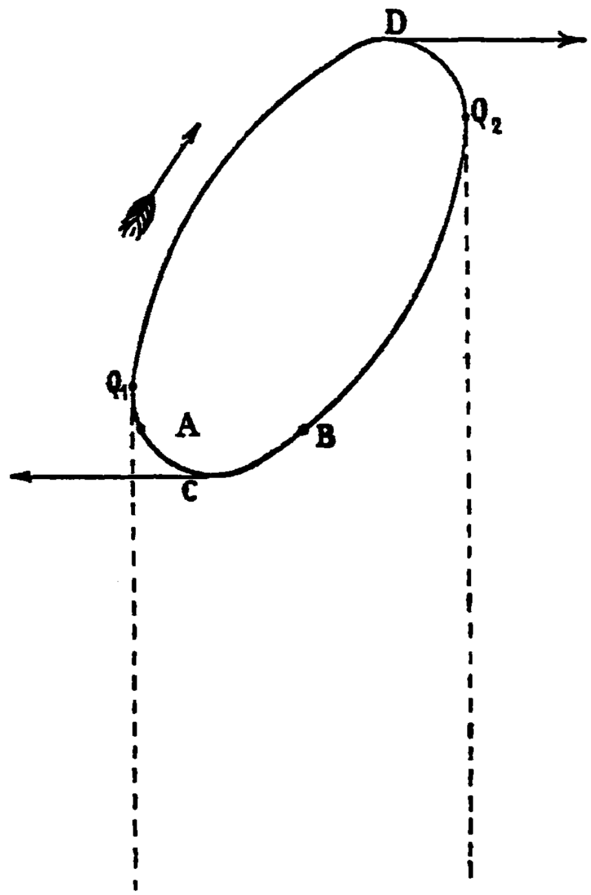

Fig. 10

different values of the travel speeds among the four fundamental positions they explain the second well; the same, with the contribution of a convenient value of the product *Kb*, they explain the third; while the slow change of the orientation of the ellipse with respect to the radius visual immediately explains the fourth.

([1]) In our hypothesis the four fundamental points are no longer the colon of quadrature, that of opposition and that of conjunction; but the points where the component of the velocity according to the radius passes through the minimum, maximum values and null. Their positions on the orbit depend on eccentricity and inclination of this, with respect to the visual range. Considering that in the vicinity of the periastron the tangential speed becomes maximum, we realize that points *A* and *B* – del minimum and maximum speed of light emission - can result very close to *C*. Consequently, we explain ourselves as the time interval between the two passages for *C* and *A* can be very short, and therefore how yes may have the fusion of the minimum with the maximum in the light curve, as well as yes observe for δ Cephei.

14 · - Our hypothesis also gives us reason for another important fact and that is, the *very low percentage of the variables belonging to this is obscure III class.*

A few years statistic are, comprising 310 period variables exactly known, it assigns 32 stars to the 3rd class and 13 stars to the class IIIb, that is 45 in all for the III Class; the rest are almost entirely assigned to class Ila.

Recalling that the basis of the classification is precisely the length of the period, and that the short-term ones, ours, have been placed in the third class hypothesis leads us to predict that the number of variable stars in this class *must be small* compared to the number of those in II.

Admitting - albeit provisionally - that all the variables are double (or more generally systems equipped with rotating components) which appear to us as such when the condition $Kb = 1$ is almost satisfied, we immediately see that since τo must be small, a must not be large. That is *a small period double can appear to us as a variable if it it is relatively close to it, and vice versa.* But as the total number of stars that we have a distance less than a certain limit, decreases very rapidly as the magnitude of this limit decreases, we understand how *the probability of observing small-period variables must be much lower than that of long-term variables*.

Indeed, by pushing this reasoning forward, we manage to find the key of that strange and interesting interdependence, which we have already pointed out, for Class II variables, between the length of the period and the number of stars known.

As the period grows, the distance must grow - in our opinion necessary for the condition $Kb = 1$ to be verified. But as a the number of stars known to us grows very and very rapidly, therefore it grows more and more rapidly the probability that the existing doubles appear to us as variables; this however can be said up to a certain point, because beyond one certain distance, that is, below a certain apparent magnitude, the conditions necessary to observe the changes in light become more and more unfavorable, and little by little only the very ones will become appreciable conspicuous.

The frequency curve with respect to the period must therefore present us with a maximum. And we can also predict that this curve must be asymmetrical compared to the maximum, since given the difficulty of photometric measurements, in general, and the even more serious one of ascertaining long-term changes, yes, he understands how observations of this kind are becoming more and more difficult that the order of apparent magnitude grows. Under current conditions of stellar photometry, it is in fact to be considered impossible to discover a change, long-term, of a size corresponding to the leap of a class, on the scale of apparent quantities, if the star belongs to the 9^{gr}, or is smaller.

Also, in this way we find, therefore, *a* valid argument in favor of our explanation.

We don't want to close this part of our exam without trying some essay of quantitative verification of our hypothesis; applying it that is, to some variable star whose nature of double is known, the elements motion, and roughly also the distance.

Let us therefore refer to some concrete examples and see if it is legitimate suppose our condition verified.

For β Persei we have: $\tau_o = 2.81$ days, $v = 42$ Km/see. for one component, 84 Km/sec. for the other (the second results from the spectral measurements). The *a* in based on the apparent size of the star it can be considered (average size 2.8) in round numbers 25 light-years.

Consequently, we would have $K = 3.1 \cdot 10^3$; while for b we have the two values (relative to the two components) $1.4 \cdot 10^{-4}$; $2.8 \cdot 10^{-4}$ and therefore for Kb the two values 0.43; 0.86; perfectly convenient for the purposes of limited "variability").

For β Lyrae we have τ_o = approximately 12.9, $v = 180$ Km/sec.: *a*, being of a star of the 4th magnitude, it can be assumed in round numbers 60 light-years.

From these data we can deduce: $K = 1.7 \cdot 10^3$; $b = 0.6 \cdot 10^{-3}$; $Kb = 1.02$ ([1]).

Evidently the uncertainty in the values of *a* does not allow us to insist on the *goodness* of the numerical verification; but it is not out of place to observe that when our hypothesis will be checked and ascertained, it will give us an excellent one method for measuring the effective distance of variable stars well founded on the exact determination of the luminosity curve of the star and of the velocity along the line of sight.

In conclusion *the simple overlap of the hypothesis about the composition of the speed of light and that of the source on what is known about the constitution of the doubles, allows us to explain the phenomena presented by the stars variables of the III Class, in a complete way and in all details*.

15. - After such complete success in this first evaluate we are conducted spontaneously and naturally to attempt to extend the same explanation to the facts observed on the variables of Class II and I.

The behavior of class II variable stars differs from the one examined for the following details:

a) longer and often irregular period,

b) very rapid increase in brightness,

([1]) Remember the reader that in the beginning of this memoir we also have seen some examples of doubles for which $Kb > 1/10$, which do not occur as variables.

c) very long luminosity minima,

d) amplitude of the oscillation of brightness, very large.

Now not only do none of these details conflict with the our hypothesis; but they easily adapt to it and find clear explanation so much so that taking as a basis how much we have come to know for the our solar system, we can easily build a *unique* image, harmonic and faithful of these grandiose phenomena of variability that they present to us the stars.

The grandeur of the period is a fact that has nothing characteristic of it in itself it can fit in with any hypothesis. But there is a circumstance that it is important to note: the curious interdependence between the value of the period and the number of variables presenting it; interdependence of which it would be extremely difficult to give a reason other than the one we have ahead developed based on our hypothesis.

Reserving ourselves, therefore, to say something about the irregularity of the period, let's deal with the other two facts:

The very rapid increases in brightness and the presence of long lows duration are circumstances that put together perfectly fit the picture of our hypothesis (just examine the curves for which *Kb* is close to $1/2\pi$). What we are talking about, in the present case, is not therefore the possibility of carrying out such circumstances, but the big frequency with which they occur in long-term variables ([1]).

Recalling that our hypothesis leads us to admit that the double a long period can appear to us as *variables* only if they are far enough away, we are immediately persuaded that the variability can be made manifest if the amplitude of the changes is great, that is, if they occur in the observation post very conspicuous concentrations of light. Why such a strong concentration of light takes place, it is necessary that in a short time (that of the maximum) the light emitted by the star arrives in a very large fraction of the period, that is, the maximums must be of short duration compared to the minimums. We succeed so easily and naturally to understand the reason why the observed variables have long-lasting lows and short, rapid-onset highs.

It is superfluous, then, to say that the conspicuous size of the period, its irregularity and the other circumstances observed on these stars lead us to think about them as systems differently formed from the doubles examined previously; they lead us to think of very large and somewhat eccentric orbits; probably described by a "satellite" star around one hundred central

([1]) Our discussion leads us to believe that these long-run variable characters are unnecessary; it just tells us that they are the most favorable to the observations; it is therefore legitimate to think that they will be able to discover themselves in the future long-term variables in which they are not realized.

much larger ([1]); conditions that greatly favor the gap between the maximums and minimums both in terms of their intensity and in respect of relative durations; as then the strong concentrations of light would occur in proximity of the periastro, where the strong changes in velocity occur, and they would take a small fraction of the period.

These same considerations implicitly answer the fourth of the characteristic circumstances listed above: the great amplitude of the oscillation bright.

There remains, therefore, to say a few words only about the most important fact that the observation of these stars has presented: the irregularity of the period.

This consists of:

a) in a slow variation of the time interval between reproduction of two identical phases (e.g., the reproduction of the same minimum, or maximum) that is a slow change of the period;

b) in the change over time of the same elements of the curve of the apparent brightness, mainly of the intensity of the maxima and minima.

A typical example of this second case (which makes what) is the one offered by "Mira Ceti" the oldest known variable and so called precisely for his wonderful behavior. It has a period variable that can be roughly represented with an interpolation formula rather complicated; whose average value is 332 days and presents of the maximum variables between sizes 1.7 and 5.0; and also, variable minima between sizes 8 and 9.5.

To explain the fact a) it is enough to admit a displacement of the periastro; which implies the supposition of the existence of a third disturbing star, that is, the existence of more complicated star systems than "doubles".

And I like to point out here that in doing so we are not relying on the sea some convenient hypotheses, but we remain on the solid ground of the facts indisputably make certain.

The existence of complex star systems can no longer fall into any doubt. I am happy to quote, to remain in the field of the best visible stars, the η Orionis which is a double optic, of which the brightest component it is in turn a double spectroscopic; and the α Geminorum which is recognized long ago as a system composed *at least* of three stars, two of which they rotate according to ellipses, which slowly change their orientation in the space.

([1]) It is superfluous to warn that such systems may exist - indeed there are - among the stars close to us. But being τ_o large they *not* they may appear to us as variables; instead, they must appear to us as double optics, of the type precisely α Centauri, Syria, etc.

The slow change of the period of our variables, therefore, cannot encounter no difficulty in explaining the ballistic hypothesis on the ground. And the reader has already noticed how this knowledge about existence of star "complexes" are enough to prove us right in an immediate and natural way, even more complicated facts presented by "Mira Ceti".

The existence of two satellites revolving around the central star puts us in the presence of two periodic changes in brightness, that is, in size apparent system, with different periods; changes that are made up in an overall one with double periodicity, or rather periodically variable, and with periodically variable pure amplitudes (a sort of beat curve).

In summary, we can say that the *ballistic hypothesis* is purely grafted and simply on the knowledge already acquired around the constitution of the stars, it also gives *us a complete and more than satisfactory explanation of the phenomena presented by the Class II variables*.

16. - Finally, it is not difficult to show how also the phenomena presented from the "new stars" effortlessly re-enter the synthesis so far drawn.

Still a few tweaks, quite spontaneous, are enough to give us an explanation convincing of these phenomena so full of mystery.

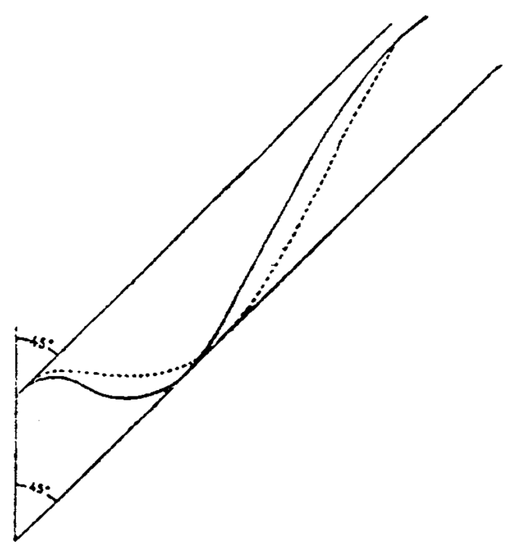

Fig. 11

If we imagine very distant stellar complexes, of which one component moves according to an elliptical orbit of very large size and strongly eccentric, with a very long period, or imagine a wandering star that can describe a parabolic orbit around some other on the way encountered, if we think that any of these orbits could have a suitable one orientation with respect to the visual ray, and we think of the great and fast speed changes that will take place in the vicinity of the periastro, we succeed to understand how the sudden arrival of a large amount of light, emitted by the star perhaps over the years and years of its journey, and therefore explain to us the sudden ignition of a new and also large star, the subsequent and slow (with respect to the ignition phase) return to the weak conditions of light (due to such distant stars) and even the unexpected and small revival of splendor (fig. 11) that it has sometimes been observed, as on the "Nova Aurigae".

Fig. 11, which represents approximately the forms that in this case takes the curve $T=f(t)$, it gives a very clear and adequate image of these facts.

And if we admit that the traveling star carries a small satellite with it, which revolves around it with a short period, we find that the splendor of the star, although slowly degrading, must show oscillations regular period, such as those that were observed (period of four about days) on the "Nova Persei", of which fig. 12 gives the brightness curve, which was observed.

CONSEQUENCES OF THE NEW THEORY OF VARIABLES.

The framework of the phenomena of variables in its essential lines and so clearly and entirely rebuilt. The only condition that comes implicitly admitted - beyond the law of composition of the speed of light with that of the source - is the existence of a large number of

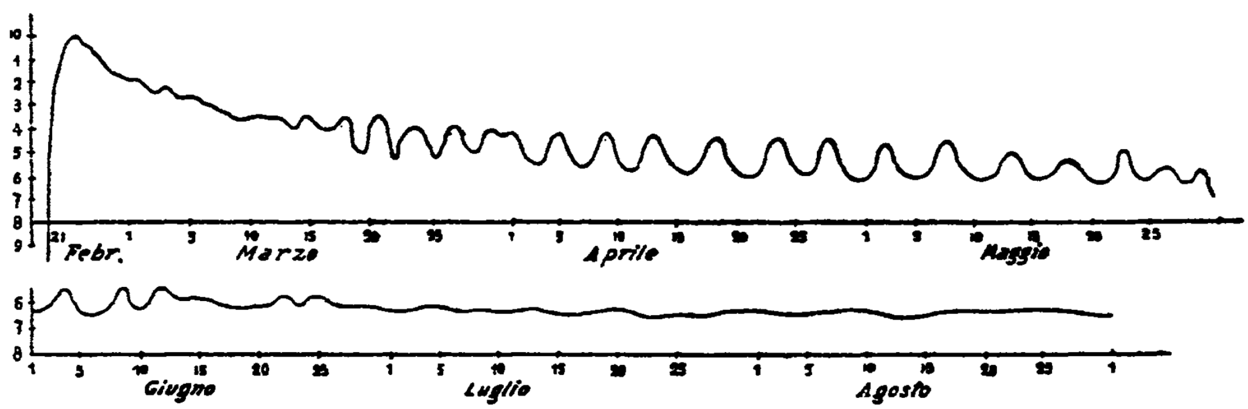

Fig. 12

stars double, or even more complex; systems like ours (planetary) though in a less advanced stage of evolution, in which the secondary bodies, I planets, are still at very high temperatures, and therefore capable of emitting light on its own.

Now the supposition of the existence of such a large number of systems complexes is clearly pointed out as extremely probable every day more from modern astrophysical research. The number of telescopically resolvable double stars, thanks to observations made with modern powerful telescopes, it has already risen by so much that the ratio of it to the total number of stars is evaluated as 1:12 approximately. Spectral analysis has significantly increased this number; we report by way of example, that the research carried out in the Lick Observatory, over a limited celestial area, they gave, several years ago, the existence of one multiple stars for every seven stars observed.

Taking into account that the spectral methods can no longer reveal the presence of satellites, when their speed drops below 6 Km/sec. holding I realize that speeds of this order must be presented by all systems that have orbits slightly inclined with respect to the plane normal to the visual, taking into account that while the total number of stars is sufficiently known, up to the 15th magnitude, that of the multiples must remain considerably below the truth, because the ghostly, laborious, delicate and still studies uncertain, they are far from embracing all the stars in the sky, it doesn't seem Campbell and others' conclusion that *the case of existence is exaggerated of isolated stars must be considered as less probable than that of complex stars* ([1]).

Faced with so many copies of existing complex stars, it appears to be very small indeed the number of known variables.

The narrowness of the interval into which the product *Kb* must fall in order for a complex star to appear to us as "variable" makes us quite aware of the smallness of this number.

But other circumstances must, in my opinion, intervene in determining the tenuity of our relationship and especially the difficulty of photometric measurements, the little attention so far placed in this research address, the means however imperfect that are used; therefore it does not seem imprudent to me hazard the prediction that you study more diligently, prepared and directed to this end, they will greatly enlarge the number of "variables", enrich and clarify our knowledge of the great facts of heaven.

CONCLUSIONS.

This research demonstrates:

1 ° that it is incorrect to believe - with De Sitter - that the observations on the double stars provide any evidence in favor of the postulate of Einstein on the constancy of the speed of light.

2 ° that all the phenomena known up to now in the field of "new" stars and "variables" who had not received a satisfactory explanation, they find a clear, simple and natural general explanation in the opposite hypothesis it is to this of Einstein, that is *in the hypothesis that the speed of light is composed with that of the source*.

([1]) The application of Michelson's interferential method will allow rapidly extend this knowledge.

It must therefore be held not only as having no basis, but as the opposite to natural facts, Einstein's 2nd postulate, and must therefore be rejected by force of this testimony of the facts - as well as for logical reasons and otherwise work I pointed out ([1]) - the "theory of relativity" because with the second postulate the hinge of the whole theoretical edifice falls.

It is almost superfluous to warn that the hypothesis we have made - that is, the ballistic hypothesis - fully conforms to the relativity principle properly said; and that therefore the suffrage found by us in astronomical facts constitutes a new support for the extension of this principle, from the field of strictly mechanical facts, to the field of all physical facts, that is, of facts natural.

The physical phenomena known up to now therefore all find their place in new hypothesis, Michelson and Morley experience and ray deflection included. Optics - understood in the most general sense - to agree with this hypothesis, he will only have to strive to find how to conceive light, because it can be endowed with the interesting property of propagating with a speed that is composed with that of the source. A return to Ritz's conceptions, already heralded in various ways, appear promising. Another way to test could be the one indicated by J. J. Thomson: the light, made of perturbation of the electromagnetic field, would travel with constant velocity along the induction tubes exiting from the center (electrons) of the field; and therefore it would propagate with a speed equal to the resultant of that now said, and of the speed of the center in the case in which this was in motion with respect to the observer.

On this essential point which is currently the subject of my study, I hope to be able to make a useful contribution in a future work.

From the Physical Institute of the Royal University of Palermo, May 1923-

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]) Scientia, l. c. October 1923.