ASTRONOMIC EVIDENCE CONTRARY TO "RELATIVITY": NEW THEORY OF STAR VARIABLES, BASED ON THE RITZ POSTULATE.

Memory of M. La Rosa.

It is well known that the "theory of relativity" originates from this need to reconcile the electromagnetic theory of Lorentz with experiences of the "Michelson" type, i.e., *aimed at discovering the motion of a body with respect to the ether.*

Attempts at conciliation had been made by means of particular and specious "expedients", such as that of contraction; but the main road, glimpsed with ingenious clarity by Einstein and beaten by himself, it was and is without a doubt this: *extend the principle of relativity of Mechanics to all physical phenomena*.

No dissent of opinion on this fundamental point there can be, at least until new and *safe* experiences they will not come to try the chance to find out the motion with respect to the ether[1]). Until then Physics must therefore it must satisfy our principle, that is, it must be "relativistic". Until that moment great merit will remain end indisputable of Einstein to have recognized this.

The point that still remains the subject of discussion and controversy is about how to reconcile the "principle of relativity" with the general theory of optical and electromagnetic phenomena.

Einstein's "theory of relativity" is *one possible modes*, one of the many theoretical schemes of a *relativistic* nature that they can be constructed to represent phenomena;

[1]) Recent experiences with the Michelson device made upstream at Wilson Mountain would have given a positive result, although cheaper than that planned. But in this regard, it will be necessary to wait for more ample confirmation.

it was built on the "essential" basis of another postulate: that of the "constancy of the speed of light", or better "than the independence of this speed from the motion of the source" [1]).

This statement concerns a "pure fact of experience" and as such *subject to the necessary constraint of the sanction experimental*.

A whole bunch of theoretical schemes *of a strictly character relativistic* can be constructed, more or less easily, starting from an opposite hypothesis: the *ballistic hypothesis* on speed of the light. By making this assumption, that is, admitting that the speed of propagation of light can be compounded with that of the source (when it is in motion with respect to to the observer) according to Galileo's usual rule, yes explains, in fact, immediately the negative outcome of all experiences, done and to be done, of the Michelson type, i.e., suddenly extends the "principle of relativity" from Mechanics to all physics.

The most natural idea that comes to mind when trying to build a concrete scheme of this kind, it certainly is the same one that we find at the base of the old ones conceptions of the "emissive" type; that seemed to us for so many years as definitively overtaken, but that in the latter times we have seen furtively and obscurely recur in the strenuous efforts of theoretical synthesis.

And in fact, a bold attempt in this direction was undertaken at the Ritz, with little luck though, so much so that it has remained so far isolated and almost entirely unknown [2]).

Both the one and the other scheme have strengths and weaknesses, advantages and disadvantages, brilliant and obscure synthetic views gaps; so the choice. between the two would require an analysis, diligent, delicate. and perhaps not easy.

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[1]) A short news. on the physical origins of "relativity" and the their criticism. it is contained in a Note of mine published in 1912 (*N. Cim*., vol. III, p. 345). A more extensive one can be found in my article appeared in "*Scientia*", issues of October and November 1923.

[2]) Ritz, *An. d. Ch. et de Phys*., vol. XIII, p. 145-1908.

But before we can come to the examination of these two particular schemes it is necessary that a "prejudicial" task be fulfilled; to guide the research in a safe way theoretical, directing it or on the path attempted by Einstein: revision of Mechanics, as basically required by the postulate of constancy of the speed of light; or on the one indicated by Ritz: revision of electrodynamics, as required by the principle of "velocity composition" extended to light.

After this first step has been done under the guide of *experience - the only one who has the right to decide the choice* - the work of theorists will be able to proceed safely in the elaboration of the new scheme, both by resuming and adapting one or the other of the two already built, either by devising one ex novo others, better responding.

1. - The question to be resolved, independently - I repeat - cost by Ritz's theory, as well as by Einstein's, is the following:

The light emitted by a source moving with respect to us propagates, or not, with a speed independent of the motion of the source?

It is evident that *terrestrial* experiences cannot provide us the *decisive, indisputable* proof that we need for the choice.

The speeds we can imprint on a source of light in our laboratories are always very small compared to the speed c of propagation of light (from a source stop). The ratio between the velocity v of the source and the c will always be a very small fraction.

The interferential methods, which we can only employ to discover any small changes in propagation times along short paths (which we can make in laboratory), force us to make the rays run along paths which fold back on themselves (i.e., decomposable into parts equivalents and paths in opposite directions) for which each disappears difference that is of first degree in the *v/c* ratio (comp nso of the effects of the same order).

In laboratory research we are therefore forced to rely on any effects dependent on the square of *v/c*, and these effects are almost illusory, on account of their extreme smallness.

Things are different if we turn our at attention to astronomical facts.

In fact, the speeds by which many celestial bodies are animated, are much larger than those we can impress a terrestrial source, so the *v/c* ratio for the light of those bodies can take much fewer small values than those achievable on the earth's surface.

More if we try to find a dependent effect by the delay with which the incoming rays should reach us from a star, when they are emitted with different speeds - delay that depends on the first power of *v/c* - that's legitimate expect results of a *meridian evidence*

The immeasurable distances of the stars from us make the office of a huge multiplication, in exaggerating every little difference of travel speed, and give rise to *delays enormous*, even when the rays emitted have very little speed different.

And above such kind of effects the motion of the earth cannot have appreciable influence; having to stay unthinkably small every perturbation that our speed is of our instruments will be able to produce such great delays, accumulated over years and years of travel.

For these reasons, the possibility of make use of the "*double stars* observations" to obtain the desired "decisive evidence".

Comstock[1]) and Castelnuovo[2]), independently of each other on the other, they drew attention to certain anomalies which

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

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

according to the ballistic hypothesis, they should have been found in the time intervals that elapse between three consecutive passages of the rotating "companion" for the "quadrature" points.

But as Comstock himself began to attempt, with not easy observations, to submit this prediction to verification, De Sitter[1]) managed, with few considerations, to instill in all the belief that observations of the stars "double" [2]) and on the laws of their movement they formed the clearer and more solid evidence around the independence of speed of light from the motion of the source.

In fact - says De Sitter more or less - if the speed of propagation of light was compounded with that of rotation of the star, the light rays emitted in the first quadrature (position A of fig. 1) and traveling by hypothesis with the speed c-v [3]) with respect to the observer (located at a great distance long SM), they would end up overlapping and confusing with those issued in the other quadrature, B, traveling with the velocity c+v, so that it would be impossible to distinguish and separate over time the different positions of the star, and *impossible recognize the laws of orbital motion*.

Now this reasoning by De Sitter, which has merit of great intuitive evidence - which is why it was

[1]) Phys. Zeitschr. Bd. XIV, p. 429, 1913.

[2]) The first discovery of pairs of stars, linked by relationships analogous to those that run between the Sun and the Earth, that is, linked by attraction reciprocal and animated by a motion of rotation with respect to the common center of mass, was made by Herschel, who managed to observe the elliptical trajectory described by one of the two stars around the other, ed to show that this elliptical motion occurs in accordance with the 2nd law by Kepler, on the mute of the planets: *to the 'law of the arks*. This very important discovery allowed the extension of Newton's law outside of our system. solar, with the well-known fruits of that knowledge which we possess around the stellar masses.

[3]) It is assumed here implicitly that the plane of the orbit is small inclined on the visual range; and that *v* is the projection of the tangential velocity on the plane determined by the view itself and by the normal to it lying in the plane of the orbit.

easily accepted, almost without discussion - that's too simplistic and incomplete, and yet embraces and confuses at the same time cases for which the final conclusion is right, with cases (the majority undoubtedly) to which the same conclusion does not it's worth it at all.

I won't delay in searching for the "sweet spot" of this one reasoning; it will clearly come to light in the course of my discussion.

What matters to me is to do a "complete" analysis of what the *terrestrial observer must see* when – propagating the light in accordance with the ballistic hypothesis – he point your telescope or spectroscope at one "double" - or a more complex star - more or less distant.

This analysis leads us to *predict a whole vast field of facts* that were completely unknown to me at the time which I resumed and completed De Sitter's reasoning. Facts complex and interesting that proved to be fully compliant to the astronomical observations of many generations; facts remained until now wrapped in the deepest mystery, because they were rebels to all efforts of coordination and interpretation.

This perfect correspondence between the easy theoretical prediction, made in *virgin ground*, and the observations, *carried out outside of any "suggestion"* on the part of preconceived hypotheses, which unfortunately often even the experimental measurement underlies, constitutes, in my opinion, that very strong piece of *proof* that we need to decide the choice in favor of the *postulate by Ritz*.

In saying that - it goes without saying - I don't mean it to assert that the theory of Ritz, instead of Einstein's; I just state the facts require the theorist to renew the foundations of his work. Having abandoned Einstein's position, he can try each new way to build a general view of the world which, however, must respect this statement by Ritz: *the speed of light is compounded with that of the source*.

But let's get to the analysis.

Double stars and ballistic hypothesis.

2. - Let us therefore admit that the speed of light does sums with that of the source (in motion) that the emits.

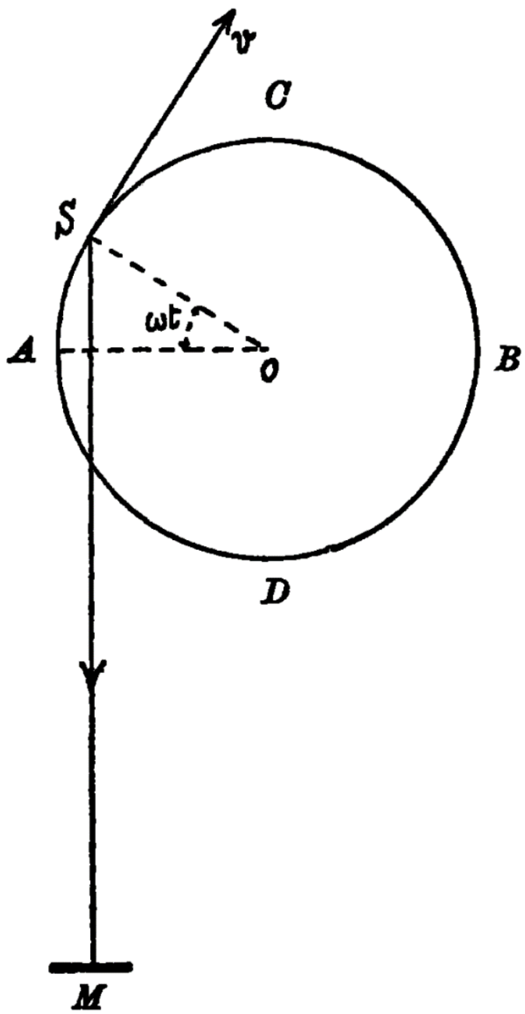

Fig. 1.

Imagine a star *S* revolving around a center according to an orbit, for simplicity, circular *ACBD*, in the direction of the arrow, with speed *v*; and an observer placed in the plane of the circle, along the *SM* direction, at a distance *d* from the center *0* of the circle (*d* extremely large compared at the radius *r* of the circle). If with *t* we inquire the departure time of the rays bright from the star, and with *T* that of the *I* arrive at the observer, and we agree to choose as a common origin the instant of a passage of the star for position *A*, we find it easily that the observer will receive the rays emitted from a position *S* any at time *T*, given by:

$$(1)\quad T = t + \frac{d}{c - v\cos\omega t} = t + \frac{a}{1 - b\cos\omega t}$$

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

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

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

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

Wide limits of variability are also presented to us in the values of *a*, since next to double stars like α Centauri - which, as we know, has the smallest distance from us, $d/c = 4.5$ years about-e Sirius ($d/c = 9$ years), we find the τ Vulpis and the δ′ Lyrae which are almost at the limit of visibility to the eye nude (5th size) for which the *d/c* ratio touches approx. the 130 years; *to stop at the stars hitherto definitely known as "double"*.

Therefore, if we want to acquire a clear notion of the importance that the periodic term contained in *T* can buy in the various cases, we need to put on the concrete ground, discussing certain particular cases, to build on the various *types* of phenomena that can occur to us under such a variety of conditions.

3. − Therefore, setting $a = K\tau_0$ we will write (l) as follows:

$$(1') \qquad T = t + \tau_0 \left(k + kb\cdot\cos\omega t - kb^2\cdot\cos^2\omega t + kb^3\cdot\cos^3\omega t - \ldots\right)$$

and we will point out that since *b* is always small in reality (hardly reaches 10^{-3}) if *K* is not very large, la, (*1′*) can be limited, for the concrete purposes that we have aims, only at the first three terms, i.e., it can be set:

$$(2) \qquad T = t + K\tau_0 + Kb\tau_0\cdot\cos\omega t\,.$$

Indeed, whenever the product *Kb* is e.g., minor of 10^{-2}, the finale of the same third term, the periodic, it is very weak; as the dreaded overlap of light rays emitted from different positions (i.e., the ugliness of the T, between rays departing in different instants t) can take place for distant positions of small (minor arcs eg. of one hundredth of the length of the trajectory). *Such overlapping cannot cause practically appreciable disturbances to an observer who detects the successive ones from time to time positions of the celestial body, and its radial velocity*. In such cases, contrary to De Sitter's conclusions, the observer will be able determine the projection of the orbit on the celestial sphere, and recognize without drawbacks if Kepler's 2nd law is or not applicable to observed motion [1]).

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

Also, for the examination of these cases we can practically make use of the simplest formula (2), since being close *Kb* at 1 the amplitude of the third term will be of the order same as τ_0 (which means that overlap occurs of rays emitted at time intervals comparable with the period, and therefore from points of the trajectory very distant between them) while that of $4.^0$ term [2]), due to the smallness than *b*, will be of an order of magnitude much smaller (which means that this secondary effect of overlay it is limited between rays emitted from very few positions deviates along the trajectory and therefore is not very noticeable).

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[1]) To those who want to know if the above conditions are or not applicable to those stars for which the direct verification of the law of Kepler was done, I will recall a few examples.

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

For it we have: a= 1640 days; τ_0=81.19 days; v=24 Km/sec. i.e., $b=8.10^{-3}$, and therefore $Kb= 1.6\cdot10^{-3}$.

Another well-studied double, because it is very close, is Sirius, for the which we have a= 9 years, τ_0 = 48.84 years that is K= 0.18; v=8 Km/sec. and therefore $b=2.7\cdot10^{-3}$; therefore $Kb=5.10^{-3}$.

For α Aurigae, a= 4000 days in round numbers; τ_0=104, K in digits round 40; v=30 Km/sec.; $b = 10^{-4}$, $Kb = 4.10^{-3}$.

[2]) As an example, we can assume v=60 Km/sec. which is a lot close to the mean of the v's measured on the hitherto known "doubles", and

To facilitate our considerations we will refer to curves of fig. 2 and 3 which are graphic representations of the law (2), construct [1]) for certain more interesting concrete cases, precisely for the following product values Kb : 0.1; 0.16; 0.3; 0.6; 1, fig. 2.a; 1; 2; 3, fig. 3a.

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that is: $b = 2.10^{-4}$. If the product Kb is close to 1, it means that K is of the order $0.5\cdot10^{-4}$, and (1′) in the hypothesis $K = 0.5\cdot10^{4}$ gives:

$$T = t + \tau_0\,(0.5\cdot10^{4} + \cos\omega t - 2\cdot10^{-4}\cos^2\omega t + t\ldots.)$$

that is, the fourth term would already lead to the superimposition of the emitted rays within a time interval $2.10^{-4}\,\tau_0$ i.e., from positions 1/5000 away of the length of the trajectory.

[1]) We quickly arrive at the construction by points and tangents of curves

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

[Editor: “o piuttosto” = “or rather”] by operating the points of interaction with the straight lines that are defined by the same equation, when numerical values are put in place of cos ωt most notable of this function viz

$$0\ ;\ \pm1\ ;\ \pm\sqrt{2}/2\ ;\ \pm1/2\ ;\ \pm\sqrt{3}/2$$

and looking for the directing ratios of the tangent to the curve in such points. Cases e.g., in correspondence to the value $\cos\omega t = 0$ we will have the straight line $T = t+K\tau_0$ which cuts the curve at all points of abscissa t, for which it results $\cos\omega t = 0$ i.e.,

$$\omega t = \pi(2n\pm1/2) \text{ or } t: =\frac{\tau_0}{2}\,(2n\pm1/2)$$

and it is convenient to distinguish the points for which the fraction 1/2 has the + sign from the others, since the direct relationship of the tangent in both others takes the values:

$$1 - 2\pi Kb\ ;\ 1 + 2\pi Kb\,.$$

It goes without saying that all these straight lines are inclined at 45° with respect to them to the axes, and that the two straight lines corresponding to the ±1 values of cos ωt (i.e., respectively to the values

$$t = 2n\,\tau_0/2\ ;\ t = (2n+1)\,\tau_0/2$$

are tangent to the curve, which remains entirely within the strip. bounded by these two straight lines.

For obvious reasons in the figures, we have assumed the axis to be transported of the t upwards parallel to itself by a suitable amount to the disgrace.

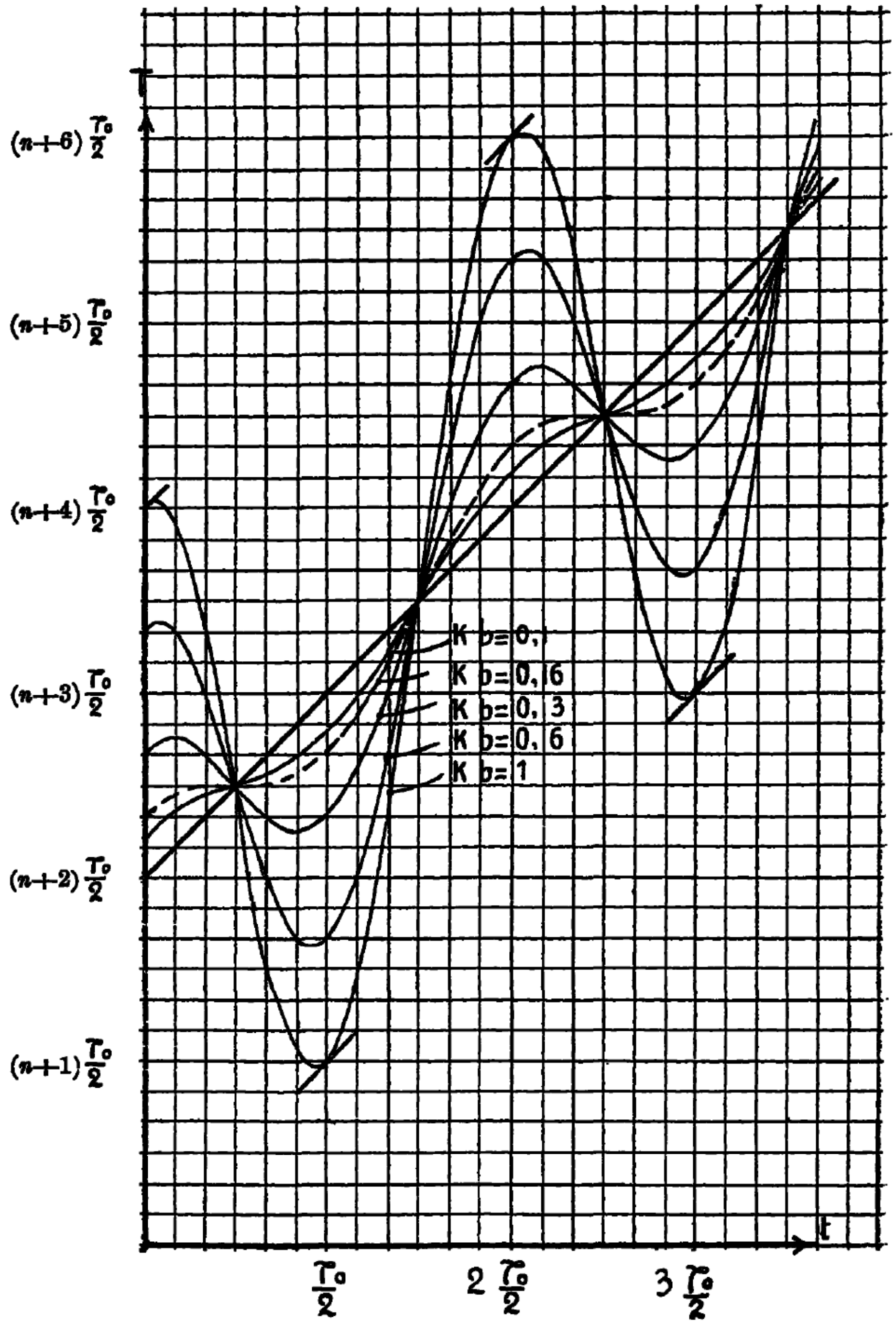

Fig. 2

Let us now examine closely the performance of some of such curves, let us refer e.g., to that defined by *Kb*=1 fig. 2.a.

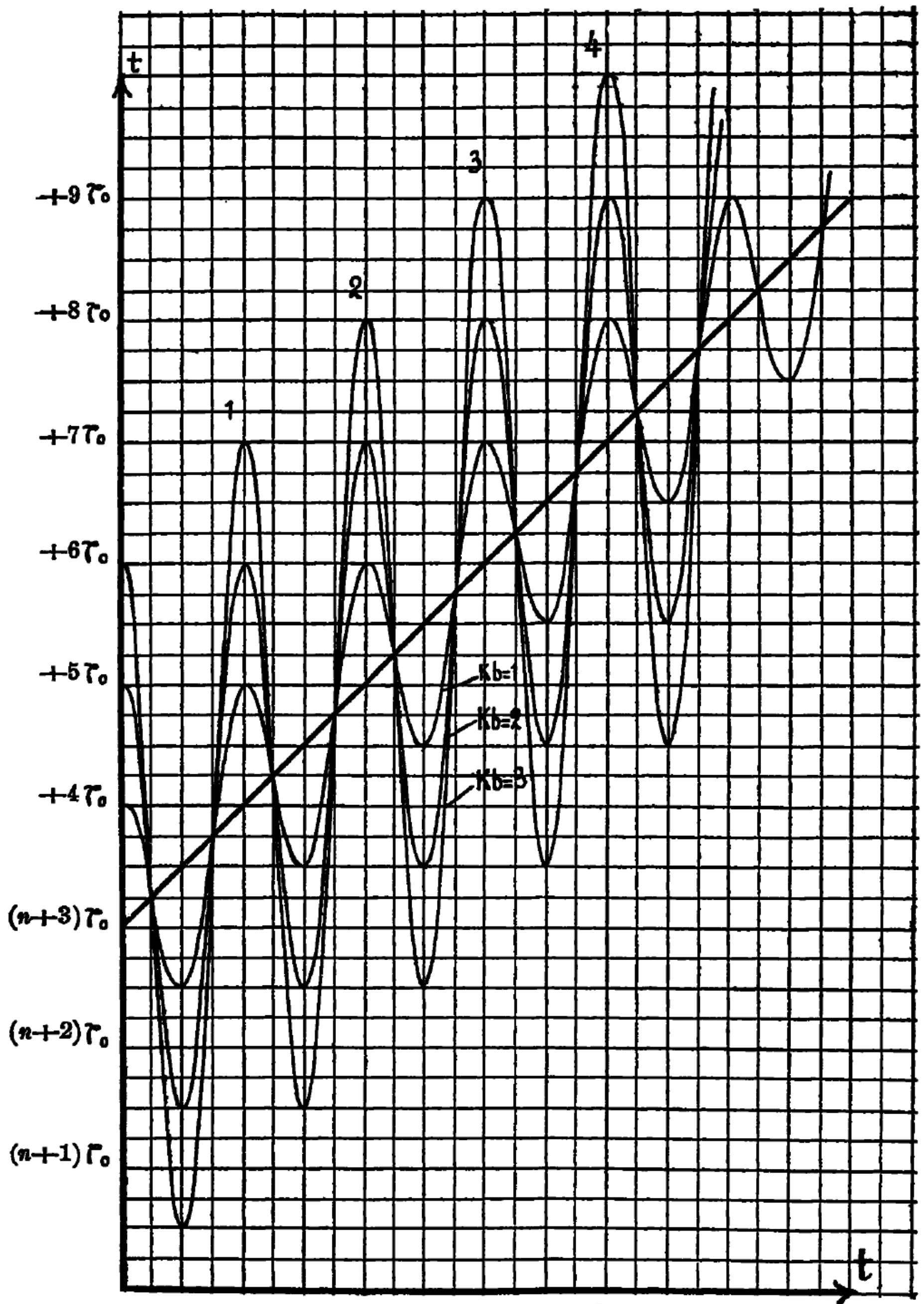

Fig. 3.

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

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

b) at that moment the observer has already received all the light that the star had emitted at the positions it occupied during just over three quarters of the first lap and one part of $2.^0$; precisely what includes the passage for *B* (4^a quadrature).

From now on - or more exactly from the very top - the observer receives simultaneously, in each instant, light emitted from three different positions taken from the star: the first one belonging to the end of the first round e placed along an arc that begins beyond the 3/4 of the trajectory (after the first conjunction), the other between the $2.^0$ opposition and the $4.^0$ quadrature, therefore belonging at the $2.^0$ quarter of the $2.^0$ round; the third included between this quadrature and the second conjunction (belonging to the fourth $3.^0$ of the $2.^0$ turn).

It should be noted that the three portions of the curve between the parallels to axis t conducted through the points $T_0=(n+4)\tau_0/2$; $T_1=(n+5)\tau_0/2$ are strongly inclined on this axis, what tells us that while the departure times of the rays luminous fluxes vary within a very narrow range, those of arrival extend over a much greater range.

Consequently, the light that the observer receives from the star mobile for each unit of time, in this interval it is more smaller than what he would have received if the star had remained stopped.

When T is about to touch the above T_1 value, in the light of the immediately following positions, the emitted light is added from the star at the moment of the 6^a square, around which the T passes through a maximum; so that in an interval ΔT much shortly the observer will receive the light emitted by the star mobile in a somewhat longer time than ΔT; and *that is, the in apparent luminous intensity of the star must rise rapidly to a maximum, in which the light reached is several times greater than what it would have been when the star was still*.

From this moment on the light intensity must go decrescendo, without returning to those very weak values considered first, because the observer will receive incoming light from 5 different star positions, and *why these positions or correspond to beautiful arches in our curves which ΔT/Δt takes values that are always smaller than those taken along the previous strokes*. Shortly after the instant T_2 = (n + 5.5)τ_0/2 in which the second conjunction takes place, the luminosity will pass for a second minimum, somewhat larger in value than the first, to immediately return to growth and reach a second maximum, immediately after the time T_3= (n + 6)τ_0/2 [1]).

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

4. - Essentially similar results, although different in detail, we have analyzed the other curves built.

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

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

Immediately after the maximum that occurs in the vicinity of T_0 we find that in approximately a duration ΔT=-τ_0/4, the observer receives the light that the star emits along the three arcs indicated above which are traveled in a time (sum of the projections of the three arcs on the t-axis) of about τ_0/10. On average brightness app. of the star in this interval will result therefore less than half of what it would have presented if it were motionless. Around the maximum we have that in a duration ΔT-=2/80τ_0 the observer receives emitted light in more than 4 times greater time, and therefore the star will present a splendor 4 times greater than that which he would present standing still. Overall, from the 0 minimum at l.0 maximum the brightness varies from about l to 8; and therefore, a leap of the star of two classes in the scale of apparent sizes (because - as it is known - it is calculated that the ratio of the luminous intensities of two stars belonging to contiguous classes is about 2.5). In the second minimum the apparent intensity is on average equal to that which would correspond at the stationary star, since from the figure we have ΔT=22/80τ_0, and Δt=20/80τ_0 approx.

Starting the analysis from the usual maximum that immediately follows at the moment in which the observer receives the light emitted by star at instant $t= 0$ (i.e., $T_0 = K\tau_0 + Kb\tau_0$), the curve for an entire interval $\Delta T= \tau_0/6$ is cut in a single point from the parallels to the t-axis and presents in this region a very large and almost constant $\Delta T/\Delta t$ ratio.

Near the instant $T_0+\tau_0/6$ the luminosity reaches quickly a maximum, since in the light coming from subsequent positions (to those already considered) of the first lap, and in which the $\Delta T/\Delta t$ is getting smaller, it is added *abruptly* the one issued at the time of the 2nd quadrature of the 2.0 turn, where $\Delta T/\Delta t$ is very small; after which the intensity bright decreases to a new low, somewhat higher than the first, and finally retraces for a new high equal to the first.

Overall, the observer will see the star, for about 1/6 of the period as of minimum intensity (maximum order of magnitude) and then he will see it go through two consecutive, separate highs from a minimum - equidistant - somewhat higher than the initial one [1]).

The curve of fig. 4 represents with sufficient approximation the law of these changes.

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

In these conditions we will therefore have *strong* oscillations of light, composed of very intense and brief maxima

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[1]) Wanting to make an estimate - on the figure itself - of the intensity relative of the maxima and the two minima, it is found that near the maxima the average luminosity must become 5 to 6 times greater than x, - being x the luminous intensity that the celestial body would have if it were motionless - in the the minor low must drop to about 4 or 3.5x, in the major low at $1/5x$. The total amplitude of the change of light is therefore higher to the ratio 25:1, which means a leap in apparent size of as many as 3, 5 classes.

duration to which with rapid change minims follow a almost uniform brightness and *long lasting*[1]).

As long as $Kb \geq 1/2\pi$ we still have the superposition facts of light emitted by the celestial body in points of the trajectory somewhat distant from each other;

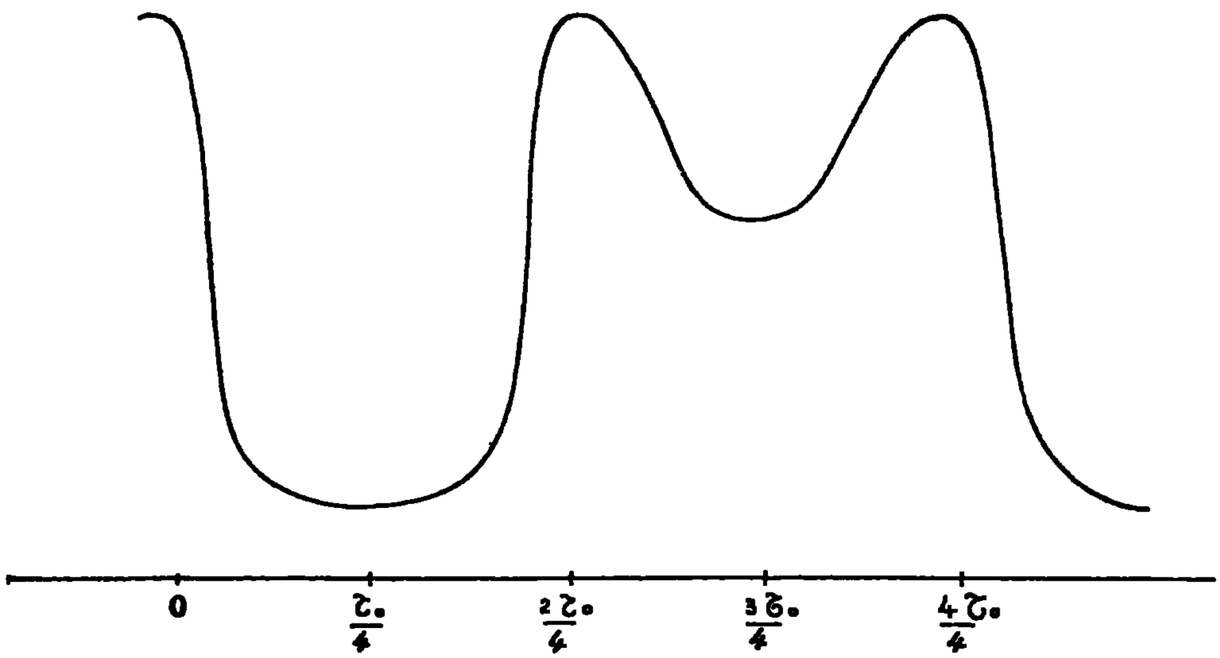

Fig. 4

(a parallel to the *t*-axis can intersect the curve three times) and double periodicity previously sight, with two almost equal maxima and two very different minimums.

As the product *Kb* continues to decrease even more the amplitude of variation of *T* becomes more and more small, and the curve is cut off at one point by the parallels to the *t*-axis; not therefore we will still have fluctuations in the observed luminosity, because the ratio $\Delta T/\Delta t$ always undergoes significant changes. But given the difficulty and the poor precision of photometric measurements in general, and of those that can be done and that have been done in astrophysics, in particular, it is understood how soon these slight oscillations

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[1]) From an estimate made on the figure the intensity ratio between the two and the others it ranges from at least a maximum equal to a few hundred *x* at a minimum of 1/2; hence the amplitude of the total luminous oscillation it is equivalent to a leap of at least 7 hails in the scale of greatness.

become undetectable. Practically you can perhaps assume that this occurs for *Kb* < 1/30.

5. - For increasing *Kb* starting from 0.3 the essential character of the curves *T*=*f*(*t*) it is initially substantially the same; we will therefore have vicissitudes in the apparent luminosity of the star similar to those represented in fig. 4, with only these variants:

a) The minimum phase is occupying shorter durations than those of the maximum.

b) The difference in intensity between the maxima and the minima interposed secondary is getting smaller and smaller.

The two maximums are getting closer and closer and tend to merge into one.

The corresponding cases show less and less interest to values of *Kb* always greater than 1. A simple inspection to the curves of fig. 3.[a] is enough to make it clear that the superimposition of light occurs for a number of positions bigger and bigger, belonging to more and more periods and phases different; and all that our observer will be able to notice is reduced to small oscillations in light intensity, which yes occur in the moments in which the values of *T* touch the maximum and the minima of the curve under consideration.

Already for *Kb* = 5 the number of intersection points of the curve *T*= *f*(*t*), with one parallel to the axis *t* (i.e., the positions of superimposition of light) become in general 20. The light sent by the celestial body will suffer in correspondence with the maxima and minima of the curve of slight reinforcements, with period $\tau_0/2$, which will dilute in the total light, almost constant, from many other locations.

It is therefore easy to understand, how soon, e.g., for *Kb* values close to 10, each oscillation in the luminous intensity will become invaluable; *the star will become unable to reveal us due to changes in size apparent its periodic motion that is its condition of* "companion" of a "double", or of a more complex system[1]).

In summary: if a star revolves around a center and satisfies tested condition *Kb* ~ 1 *must present of the alternatives of luminosity, which reveal themselves to us as a periodic change of its apparent size*, i.e., the star must appear to us as "variable"[2]).

If, on the other hand, the product *Kb* is < 1/30, it practically no longer takes place no overlapping of rays departing from positions distinct, and therefore any appearance of variability ceases. *In such case the star can be clearly seen in every position*.

Finally, if the product *Kb* > 10 overlap occurs of rays departing from many distinct positions, corresponding to phases all different from the curve $T= f(t)$, so that each appearance of variability. If so the star should be seen *simultaneously* in many different positions, so that *one should present oneself as a* "*swarm of stars*". But the condition *Kb* > 10 leads in general to very values larger than *K*, i.e., and the single positions will not be telescopically solvable.

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[1])It does not count to discuss the case in which the product *Kb* being very large, results *Kb* of the order of the unit. (See form (1')).

If so the amplitude. of the change due to the 4th term would become of the order of τ_0, i.e., it would allow us to predict overlap of light from somewhat distant positions occupied by the celestial body on its trajectory. But since the 3.0 term is a thousand times wider, the width of the strip in which the curve is included is approx. 2000 τ_0, it means that a parallel to the axis t will meet about 4000 times the curve $T=f(t)$; and then from all these various *different* positions it will come collected in every instant a total of practically constant light.

[2]) Later we will see how this conclusion should be completed when suppose that the fixed center is another star, constituent with the first one a system that rotates around the common center of gravity. For now, we are satisfied to state that if for one of the two stars the our condition, the appearance of variability must continue to exist albeit to a lesser extent.

6. - The considerations made so far allow us to respond precisely to the question opened by De Sitter:

Is the hypothesis of the composition between the speed of light and the eventual one of the source, with the observations made on "double stars"?

Taking the necessary astronomical data, we find that in the case of telescopically solvable doubles (which are then the sun on which the validity of Kepler's 2nd law really was recognized and checked) the condition $Kb < 1/30$ it is largely satisfied with our analysis. *The remarks made on them prove nothing against the Baltic hypothesis*.

For the other "doubles", those *spectroscopically* resolvable, I will observe that the application of Kepler's 2nd law is not been imposed by the measures, but was made on a reasonable basis generalization.

Spectroscopic observation has only provided knowledge of the period of rotation, and that of the speeds of the suppositories component stars; based on these data, and with the stock of Kepler's laws (*supposedly already applicable*) have been deduced the other elements of the motion (the dimensions of the orbit) and the component masses.

Periods and velocities are deduced from the displacements periodic of the spectral lines, so that the point to be examined boils down to this: the measures of those displacements come or not disturbed by the superimpositions of light that the our guess? [1]).

Now we have already seen, that if the product Kb is small there will be no superimposition of light, except from points of the trajectory not far away;

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[1]) Here we assume implicitly resolved a serious issue; that of the way to consider the Doppler effect in the case of the ballistic hypothesis. Reserving the right to deal with this question separately, I limit myself here to pointing out that the difficulties around this important phenomenon only arise based on the consideration *of the wavelengths*. This concept therefore it is not essential to establish *the periodic nature of the luminous phenomenon*, but it depends only on the image of the ether, which is irreconcilable with the hypothesis ballistics.

this means that to the spectroscope then simultaneously rays traveling with will arrive slightly different speeds: we will therefore have, even if to a certain extent appreciable, a slight expansion of the lines, variable periodically with the rotation period of the celestial body, which yes overlaps the predicted periodic shift based on ordinary hypotheses. There is therefore no inconvenience for the measure of this shift.

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

When *Kb* reaches values such that ($Kb > 1/2\pi$) the curve can be cut *three times or more* by some parallels, we will have, in correspondence, multiple rows -- if at positions from which the light comes simultaneously correspond somewhat different speeds - or simply expanded, with character of perfectly regular periodicity, so as to allow the determination of the period; and to allow, with the measure of the distance of the components or of the width of the line, the determination of the instantaneous speed possessed from the rotating body in the various positions; that is, of those elements needed to deduce the radius of the orbit and the mass of the body, based on Kepler's laws (supposed already applicable).

Indeed the asymmetry of our curves, compared to the parallels of the ordinate axis, makes us easily predict that the two components of a line will then appear not equally displaced from the normal position; yes well we will be led to attribute two different values to the speed of the source; values, than in the currently running mode to explain the phenomenon, are attributed to two different bodies - the two components from the double - which should therefore have comparable brightness, magnitude and speed between them; while in the way of explaining that we have proposed the two values would belong *to different moments of the same end single rotating body* (around a large and not very mobile center).

As the product *Kb* increases, the number of points increases meeting point of our curve with the parallels to axis *t*; as long as this number of stitches is small, 3; 5, we will have in general expanded rows, which may resolve themselves at some point and present *two or more distinct components – as has in some cases been observed but not explained* (Mira Ceti[1]) while when this number becomes large, we will have superimposition of light coming from many different positions, with different speeds, and therefore rows *constantly* expanded, that is in which the width will not present that small changes, which will disappear as *Kb* increases.

Only, therefore*, when the product Kb will have become more greater than 10, the spectroscopic observation based on the study of the periodic changes of the rows will no longer allow us to ascertain the nature of "double" stars.*

Only for these cases would De Sitter's fears have; so, good foundation!

But there is nothing wrong with believing that the astrophysical investigation has not yet managed to reveal the true nature of a certain number of "complex stars". Our hypothesis will help us a lot to discover them.

The presented state of constant expansion is an established fact from the spectral lines of many stars [2]); it in the light of our hypothesis interpreted *already allows us to attribute their nature of "double" or more complex systems*.

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[1]) Frequent and the case of the contemporary observation of the line net in normal position and two lateral expanded components. It shows immediately as this case coincides perfectly with what can be expected based on our curves.

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

7. - The following considerations statistics support this prediction to which we are led around existence of many complex systems not yet solved.

The number of known spectroscopic doubles grows at first rapidly as their apparent size increases, it quickly reaches a maximum, and decreases wisely just exceeded the magnitude that corresponds to the maximum.

In the following handout we have grouped them in order of size - step of 1/2 size - the double reported in a Campbell catalogue, the only one I could have at hand:

Size of apparent	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
No. of doubles known	3	3	6	9	16	21	29	32	13	5

Now behavior of this kind - it is almost superfluous to point it out - is in stark contrast to what should be done predict, on the basis of the ordinary criteria of "probability", bearing in mind that the number of stars belonging to each of these size ranges grows rapidly enormous as the order number of the interval increases.

The suspicion therefore arises spontaneously that some cause well definite and constant limits, and finally prevents, the possibility of the observation of "double" (certainly existing) for means of the study of doublings and mutable expansions and serials of the lines; and such a cause is pointed out to us by our analysis.

Kb values >10 can occur all the more easily the greater the distance a, i.e., the greater K, a reason for the necessary smallness of $b = v/c$. That is how much the farther a "double" is, the smaller the probability that it can show us, with the usual observations, this its nature.

When *K* is large it will take more and more values of *b* small so that the threshold *Kb*~10 is not exceeded; and with smaller and smaller values of *b*, the observations always succeed more difficult for another reason: for the smallness of the expansion of the lines.

The efficiency of spectroscopic methods for the discovery of complex stars must therefore - in our opinion - come quickly less as the distance of the stars increases, i.e. the order of the class grows.

On this point our hypothesis is therefore perfect harmony with the facts.

We can therefore state: 10) *cke the observations on Known double stars do not affect any accuracy of the ballistic hypothesis* about the velocity of propagation of light, and *much less do they affirm the truth of the 20th postulate* of *Einstein's* theory; 20) that the ballistic hypothesis provides a good argument to *explain the curious thickening of the known doubles around the 4th and 5th steps of the scale of apparent sizes.

We can therefore state: 1°) *that the observations on the known double stars do not affect any accuracy of the ballistic hypothesis* about the velocity of propagation of light, and *much less do they affirm the truth of the 2nd postulate* of *Einstein's* theory; 2°) that the ballistic hypothesis provides a good argument to *explain the curious thickening of the known doubles around the 4th and 5th steps of the scale of apparent sizes.*

Brief news on variable stars.

8. - But let's get to the really important part of our analysis, to its positive content: *the prediction of "variability" of the apparent size*, that the rotating star *must* in some cases present.

The reader has already noticed that the brief and simple considerations around our curves, they tricked us into plotting the essential warping of this vast and very attractive field of astronomical facts, passionately and at length discussed, but still largely regarded as strange and full of mystery.

The phenomena of "variable stars" are not sporadic that can be ascribed to occasional circumstances, very much rarely achievable and realized, as is admitted in those explanations of a catastrophic nature given for the most known "variables"; but they certainly are facts dependent on normally existing, needful causes only of particular and well-defined conditions to give effects manifest to us.

To be convinced of this, it is enough to bear in mind that the number of the "variables" known in a certain way a few years ago exceeded a thousand; and that that of the stars suspected as such exceeded 2000.

Perhaps the reader will not consider some brief information superfluous around this field of facts, and the ideas that exist in it intertwined. To the competent, who can do without reading of these pages, I apologize for the gaps, employees from the poverty of the material that around the topic I had at my disposal, 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 acquired* with respect to an initial state of very faint luminosity or even invisibility; and from the *slow and often irregular return* to the initial conditions. It is not yet certain whether or not their appearance is periodic, but it may be said that if it were it should have period very long.

***CLASS II*.**

Stars mostly red *of rather long period and not perfectly regular*.

SUBCLASS II.*a* - Includes those of the longer period long. *Shine boosts happen faster and faster* of the decreases. The period is often variable and yes let’s express with the usual interpolation formulas with several terms. The oscillations of light intensity are mostly very impressive.

SUBCLASS II.*b* - Somewhat irregular period; for the smallest variations in light intensity.

CLASS III.

Short periods (of a few tens of hours, up to a few weeks) and sometimes very slowly variable; swings of light intensity *very regular*. Color for it more white or yellowish.

SUBCLASS III.*a* - The light swings are relatively small (they do not reach the corresponding amplitude when the stars pass from one class to the contiguous one). Next to the main lows and with them alternating occur other secondary minima, which may also match at high light intensities.

SUBCLASS III.*b* - The phase of maximum intensity spans most of the period; the least, yes they present with great regularity, they flow quickly.

9. - Here, as in all classifications of objects or of disparate facts around a few schematic types, one cannot claim to have described and accurately represented in a nutshell the various phenomena observed, and therefore we believe convenient to closely examine some typical cases concrete of the different classes and discuss them together with the hypotheses currently in progress to explain them.

We will proceed with this investigation by going through the classification given in reverse order but let us examine some cases typical 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) of exactly known period of 2d, 20h, 48m, 9s and very constant (in about a century it has been observed a variation of 8s). During most of this time the brightness of the star keeps close at the maximum; descends and runs through the minimum phase in 9h and 45m.

It had long been assumed that the regular light changes observed in this star were due on the pass, in front of it (on the line of sight) of a dark satellite that circled around it. This assumption is believed to be confirmed by means of the spectroscope the which showed that certain bright lines of the spectrum present a shift, periodically variable. By measuring this shift in various periods have indeed been calculated the speeds according to the visual ray 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 have other stars (14 in all) which are called precisely of ″Algol type″ of which by spectroscopic way and *the nature of "doubles"* has also been recognized, what it has naturally led to extend the above explanation mentioned.

By way of news we will say that not all stars of this type exhibit the simple behavior of the β Persei; some show a double period; so the Y Cygni has a change in size between 7a.1 and 7a.9 with a period of 2d , 25h , 54m in which a minimum is observed secondary with the signaling intervals with respect to the two maximums principals that include it: 1d , 10h , 11m and 1d , 13h , 44m. Similarly, the Z Hercules, greatness 7a.1 to 8a; period 3d , 11h , 49m presents. a secondary minimum at intervals of 1d , 22h , 49m; 2d , 0h , 59m from two consecutive highs.

Very close to this now described is the behavior of the *variable* stars included in class III.a; and basically identical is therefore the proposed explanation, the which for some is believed to be confirmed also here by research spectroscopic. Let us recall some examples.

β Lyrae has a period of 12d . 22h , in which time the luminosity presents two great maxima, of equal value, and two different lows. In the principal minimum the star appears as magnitude 4.5, after 3d . 3h reaches the first maximum presenting itself of magnitude 3.4 ; after another 3d . 6h appears in the secondary minimum, of magnitude 3.9; come back to 3d . 3h maximum than before, to finally fall back to greatness 4.5. The period is slowly variable. The exam is interesting of the intensity curve given by Figure 5a, which is very similar to the curve in fig. 4,

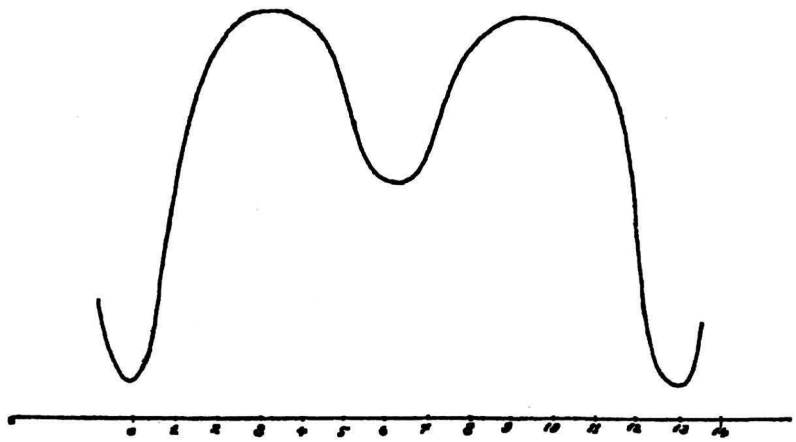

Fig. 5

which is the light curve predicted by the relation $T=f(t)$ in the case Kb=0.6.

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

The δ Cephei has period 5d . 8h . 48m, change of apparent magnitude from maximum 3.7 to minimum 4.9; and interesting because the secondary minimum and the 2.0 maximum they blend together at an inflection point (fig. 7ª).

10. - The proposed explanation for the phenomena presented from stars of this type despite the solid basis that the observations have given to its essential supposition - that of their nature of "*double stars*" - offers the side to some no slight objection, which is not easy to remove.

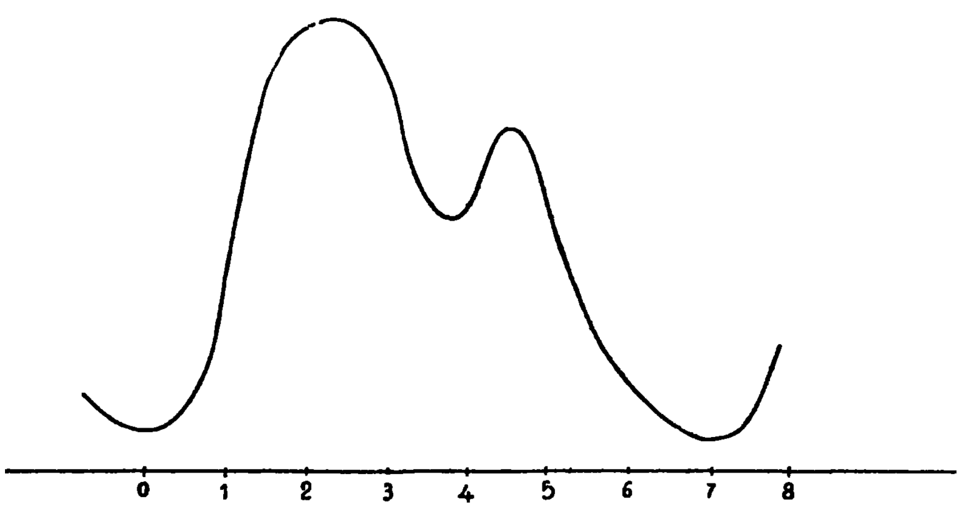

Fig. 6.

This explanation brilliantly clarifies the behavior simple of the variables of type Algol, admitting

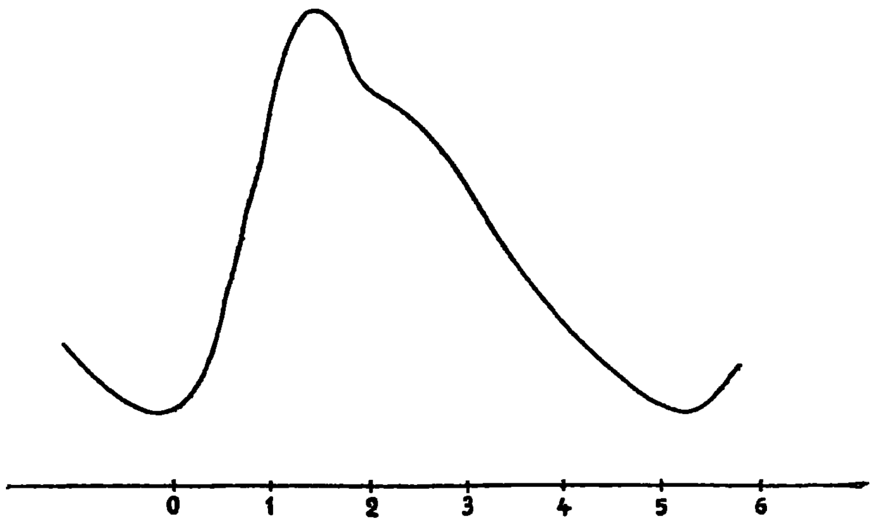

Fig. 7.

the periodic occultation of one of the two components double, for part of a darker satellite. Clarifies the behavior of doubles of type β Lyrae assuming that the two components have different but always significant intensities; since then the two maxima would correspond to the quadrature, the principal minimum at the "conjunction" (con the weakest star interposed on the line of sight), the minimum secondary to the opposition.

Still admitting - as has been done - that the trajectories are ellipses of no slight eccentricity, and that the axis major does not coincide with the visual range, you can also easily explain the inequality. of time intervals which run between the two maximums and the secondary minimum which follows them.

Where the explanation loses its persuasiveness, it is where it is a matter of assigning the reasons why the second maximum can be considerably weaker than the first - as happens for η Aquilae, and for δ Cephei – and those for which the time interval between the secondary minimum and the second maximum, can become so short as merge into a single inflection point as occurs for δ Cephei.

To explain the different intensity of the two maxima would be necessary to think that in one of the two quadratures it has place a partial (apparent) overlap of the two stars components, which is absurd (equivalent to admitting that at certain points of the trajectory an overlap takes place effective, i.e,. that the two stars have a distance *less* than the sum of their radii).

To explain the extreme smallness of the time interval between the secondary minimum and the $2.^0$ maximum, one would have to admit than the transition from one conjunction to the next squaring takes place in an extremely short time, that is which fails in any way understandable.

Other not slight difficulties are still encountered in explaining:

a) the presence of longer minimum phase durations of those of the maximum;

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

In conclusion, although the *occult hypothesis* has a solid foundation, in the direct knowledge of nature of "doubles" of our "variables" it *is not sujftcient to give us a clear and complete explanation of the facts* up to far examined; facts that are the simplest and also the *less frequent*, presented by the "variable stars".

11.-The maximum number of these stars belongs to II.a class, and precisely to the II a.

These have long and slowly variable periods, and show more markedly that *very important* character of the "variables", which is the abrupt increase in brightness.

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

The α′ Geminorum, which has a period of 86 days (between shorter) of which 20 employed in the ascent from the minimum (13a size) at most (9th size), 66 in the descent.

The R. Ursae Maj, with a period of 302 days and one oscillation in the apparent size of *well* 7.2 *classes*; the X Oygni with a period of 406 days and an oscillation of magnitude of 9.5 classes (what matters is a variation of the 1' light intensity from l to 6000).

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

In this regard, we report the following mirror that shows such a distribution law for the 232 stars that up to a few years ago they had been assigned to this class Ila.

Period in Days	Number
≤ 20	7
21-50	7
51-100	7
101-150	9
151-200	18
201-250	30
251-300	39
301-350	45
351-400	43
401-450	18
451-500	6
500	3

It clearly shows that there is a curious preference for the period of about one year; and more it is observed that the descent from the maximum occurs somewhat more rapidly and irregular of the climb.

The remotest reason for this *interesting regularity has not yet been glimpsed.*

For these "variables" astronomers ruled out a priori *as untenable the hypothesis of periodic occultation* by a satellite, due to the difficulty of explaining, by this route; the *irregularity of the period*, the great amplitude of the change in light, the *long idle duration* and *the abrupt transition from minimum to maximum*, facts all that they cannot - of course - agree with that hypothesis.

For this, various hypotheses had to be brought into play, artificial, of which we will briefly recall those they have got more credit.

According to Zollner for a non-uniform cooling process would have formed on the surface of these stars, of the vast dark crusts, preferably accumulated on certain ones regions. Due to the rotation of the celestial body around itself, the passage of these crusts would periodically occur on the visual ray resulting in the variation of light with period *fundamental*; the movement of these crusts to the surface of the star would give rise to the irregularities found In the period; there. vastness of such fields of crusts would explain the long duration of the idle and a special configuration (???) the dissymmetry presented by the speed of the increase and the dimming of light.

An improvement on this hypothesis was believed to give Sylden, assuming 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, due to the nature of the screen which periodically hides the celestial body light; Zollner's scabs have been replaced with huge ones *spots*, to the rotation of the star as a reason for the period fundamental, the *periodic* training of such is replaced spots (?); factors of the variability of the period would be the changes of position of them on the surface of the celestial body 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, analogous to those of the Sun, *which in a short time could totally cover the surface of the celestial body* one could come to explain a change in corresponding intensity to the leap of 4 classes at most in the scale of magnitudes apparent (while there are as many as 100 light variations times greater; jumps of 9.5 classes) and everyone sees which ones difficulties are encountered in assuming that similar phenomena extend to *all the surface of the star*, occur and are resolved *at almost regular intervals* and within relatively long times very short - such as those passing through the minimum at most. -

Similar mysterious and strange apparitions for nature, the vastness and rapidity of the imagined phenomena, they do not have no comparison in the field *of the facts*.

Another hypothesis deserves a brief notice - in my way to see the more plausible the less fortunate of the earlier - due to Klinkerfues. He admits that the variable stars are very "narrow" "doubles" which are circling in very eccentric orbits at the moment of the passage through the periastrum would be found at distances so small, as to cause reciprocal deformations and displacements in the atmospheres of the two stars. Assuming that these atmospheres are strongly absorbent, the gashes produced for these mutual deformations would result the observed increase in intensity. bright. But this too hypothesis is insufficient to explain all the particulars of observations; like the presence of two maxima, the different interval between them and the minima, etc ...

12. - To complete our quick information we have left to say something about the "variable stars" of the Class I, i.e., "novae".

For the sake of brevity, we will say only a few words about this very interesting and very rich field of observation, of which the systematic exploration can be said to have just begun yesterday.

Sudden appearances of new stars, which also shine more than the stars of 1st magnitude, they had one in the sky ephemeral life, were already observed and recorded a long time ago ancient (we have news from the year 134 BC to the year 393 d. Cr.). But their systematic study can be said to have begun in 1866 with the appearance of the "new" Crown, o star of Birmingham named after the discoverer, who found it for the first time on May 12 as *star, 2nd magnitude*, and observed its rapid and brief increase in splendor and the slow decrease.

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

Acquaintances yet more exact we have for several others, we only mention the most famous; the "Nova Aurigae" and the "Nova Persei".

The first discovery by Andersen on January 23, 1892 not it was previously known - and in any case could not exist that as the smallest star of the 11th magnitude – since until November 2, 1891, it is not found on the photograph taken of that region of the sky on this date.

It was later found, already as a star of magnitude 5 1/2 above one photograph taken on December 10, and as a 4th magnitude star above another photograph taken 10 days later. After discovery rapidly diminished in splendor and in April 1892 it was barely visible with the most powerful telescopes.

In August 1892 - an important detail - *I become more brilliant* going up to the 9th 1/2 size, and thereafter became soon very weak, but always remaining visible.

The "Nova Persei" discovered on February 21, 1901 as well by Andersen as a star of magnitude 2 1/2, reached in a few days its maximum, buying more splendor of stars of 1st magnitude. Interestingly which 28 *hours before* the discovery had been taken by Williams a photograph of that region of the sky, *on which not it was a trace of the "Nova"*, which therefore had to be found to star status below the 12th magnitude.

Around these newer "Novae" has been gathered a vast and precious material which we cannot examine here; we will content ourselves with recalling that the luminosity curves in the decreasing phase they have an asymptotic character, presenting sometimes - as for the "Nova Persei" – oscillations notable and regular; that the spectrum, complex, always shows brilliant stripes doubled (and often divided into a greater number of components) and almost always shows the components more intense shifted towards red; shows a continuous background which weakens rapidly and unevenly in the different regions, until they disappear completely; finally that it spectrum of lines, surviving, is also gradually losing most of its elements, reducing *to one line sola*, characteristic of nebulae.

This is not the place to venture to mention the various ones hypotheses that have been put forward to explain the phenomena of these mysterious meteors. Each "Nova" lit the fantasies and has left a very long trail of opinions and discussions.

From the hypothesis of the violent conflagration between two modest men inhabitants of the sky; from the one cobbled together by Zollner, at base of colossal eruptions and fires on the very plot of his "theory of variables", on the other no less curious – ed nowadays absurd - of Lobse around later stages of sudden and very violent chemical reactions achieved by the star for subsequent cooling, to that of Wilsing trodden on the mold itself of the hypothesis of Klinkersfues on "variables"; to that of Vogel of the collision between two integers planetary systems; to another that tries to be based on dispersion abnormal light; to that of the explosions of huge gaseous masses, or colossal electric discharges, yes finally arrives at the conclusion *that every "nova" together with a rich and very interesting baggage of observations has us brought a new puzzle*.

Ballistic hypothesis and theory of "variables".

13. - *Now this impressive set of facts, complexes and varied, corresponds in a wonderful motto to what we have foreseen in the first part of this work*, and it rests on it all with a few and justified tweaks.

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

Keeping in mind the essential scheme of this explanation, that is, assuming that these "variables" are systems of two stars, slightly different from each other, and revolving around to the common center of mass, our analysis takes us to consider two curves of the type studied, having period equal but phase difference = 1/2 [1]).

Their oscillation amplitudes will result however in general somewhat different, precisely because being enough restricted the limitation relating to the *Kb*, necessary for the deadline periodical may acquire considerable importance, it will happen that if one of the two component stars satisfies enough to close to the *Kb* ~ 1/2π condition, the other cannot as well good to satisfy it. [2])

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[1]) The ballistic hypothesis leads us to assign a more rational constitution to these variables. It leads us to think of them as formed by a great central star, not very mobile, around which a certain number of *mates* rotate minors. Some of these companions *may* give rise to fluctuations of light, depending on the limitation on the values of product *Kb*; and in certain cases only one can give. It is understood then, how those changes in apparent size can be explained presented by "variables" of the Algol type, which have small amplitude, while they are perfectly regular.

The phenomena presented are also easily explained on the same basis from the "variables" of the 2nd class; even spectroscopic ones. But that will be said later.

[2]) Keep in mind that the largest light changes occur close to the value *Kb* =l/2π, as shown by examining the curve *Kb*=0.16 of fig. 2.

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

The two light curves corresponding to these, will have in general somewhat different amplitudes of oscillation, and however will give rise to an overall effect, which to be differential will be accentuated.

More as for the stars of this class time of the rotation is relatively small - a few days, - we cannot expect modest concentrations of moons, which take up small time frames, even when you extend to large fractions of the period. We understand in thus how the amplitude of the variation must remain small, what has full confirmation with the facts, since for the variables of this class the change of light is almost always lower than a step of the class of quantities (ratio of luminosities 2.5:1).

These are the general lines. Coming to the details let us remember that the discussion already made has led us to predict the double periodicity *with two quite different minima of intensity*, as is observed in these variables (recall the case of β Lyrae, whose luminosity curve is perfectly corresponding to the diagram drawn based on the curve Kb=0.6).

Pushing forward the exam and also introducing in the our considerations the hypothesis - perfectly natural and already in use in the theory of these "variables" - that the orbits are notably eccentric ellipses, and that some are also slowly perturbed (by other nearby bodies, as in case of the planets) one can easily explain:

Pushing forward the exam and also introducing in the our considerations the hypothesis - perfectly natural and already in use in the theory of these "variables" - that the orbits are notably eccentric ellipses, and that some are also slowly perturbed (by other nearby bodies, as in case of the planets) one can easily explain:

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

b) the asymmetry of the intervals between the two maxima and the minimum included;

c) the degeneration of the minimum and the following maximum at an inflection point (δ Cephei);

d) the slow variability of the period.

All facts that we have come across that are not explained from the theory of occultation.

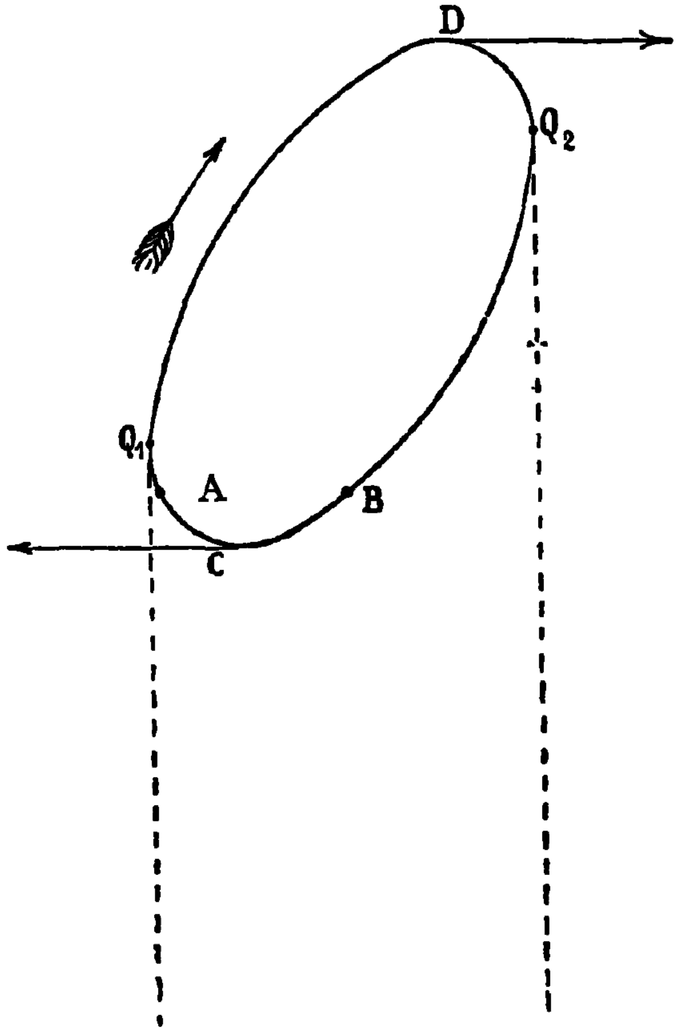

Fig. 8.

The different speeds that the celestial body can have at the moment of the two quadratures, depending on the eccentricity and from the position of the orbit with respect to the visual ray they explain immediately the first fact; the different length of the arcs to be traveled and the different values of the travel speeds among the four fundamental positions [1]) explain well the according to; the same,

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[1]) In our hypothesis the four fundamental bridges are no longer I two quadrature bridges, the one of opposition and the one of conjunction; but the bridges in which the component of the speed according to the radius passes for minimum, maximum and null values. Their positions on

together 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.

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

A statistic of a few years ago, including 310 "variables" with an exactly known period, assigns 32 stars to the IIIa class and 13 stars to the IIIb class, i.e., 45 in all for the III class; the rest are almost entirely assigned to class IIa.

Recalling that the basis of classification is precisely the length of the period, and that those of the III class must have a short period, our hypothesis leads us to predict than the number of variable stars in this class *must be* small compared to the number of those in II. Assuming - the usual assumption of our analysis – that all "variables" are "dual" (or more generally systems complex) that appear to us when it is almost satisfied the condition $Kb \sim 1/2\pi$, we immediately see that since τ_0 small, in order for *K* not to be very large it must be a not very big. That is *a double of small period can appear to us as a "variable" if it is relatively close to it.* But since the total number of stars that have distance from us less than a certain limit, it decreases very rapidly

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the orbit of- they depend on the eccentricity of this, and on its inclination with respect to the visual range.

Taking into account that in the vicinity of periastrum the tangential speed becomes maximum, we notice that the points *A* and *B* - of the minimum and the maximum of the speed of emission of light - can result very close to *C*. Therefore, we explain how the interval of time between the two passages for *C* and for *A* may be very short, and so how can we have the fusion of the minimum with the maximum in the curve of light, as observed for δ Cephei.

as the magnitude of this limit decreases, it becomes clear as *the probability of small-period "variables" should be much smaller than that of the long-term "variables"*.

On the contrary, by pushing forward this reasoning we are able to find the key to that strange and interesting interdependence, already indicated by us, for the "variables" of the II class, between the length of the period and the number of stars known.

As the period grows, it must grow - according to we - the distance necessary for the condition $Kb \sim 1/2\pi$ can be verified. But as a grow, and grows a lot very quickly the number of stars known to us, therefore the probability that doubles is growing more and more rapidly existing ones appear to us as "variables"; but this can say up to a certain point, because beyond a certain distance, i.e. below a certain apparent size, the conditions necessary for the observation of the changes of light become more and more unfavorable, and gradually not only those very conspicuous will make themselves appreciable.

The curve of the frequencies with respect to the period must therefore introduce us to a maximum. And we can also predict that this curve must be asymmetrical with respect to the maximum, since given the difficulty of photometric measurements in general, and the even more serious one of ascertaining long-term changes, one understands how observations of this kind become more and more difficult as the order of magnitude increases apparent. In the current conditions of photometry stellar it is in fact to be considered impossible the discovery of a long-term change of amplitudes corresponding to the leap of one class in the scale of apparent magnitudes, if the star belongs to the 9th class, or is smaller.

In this way too we find, therefore, an argument valid in favor of our explanation.

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

Let us therefore refer to some concrete examples and see whether it is legitimate to assume that our condition has been verified.

For β Persei we have: τ_0 = 2.81 days, v = 42 Km/sec. for one component, 84 Km/sec. for the other (according to results from spectral measurements) to base on the apparent magnitude of the star can be considered (average magnitude 2.8) *a* in figures round 25 light-years.

Consequently we will have : $K = 3.1 \cdot 10^3$; while for *b* we have the two values (related 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 the restricted "variability".

For β Lyrae we have τ_0 = approximately 12.9, v=180 Km/sec., τ_o, since it is a star of the 4th magnitude, it can be assumed in round figure 60 light-years.

From these data we get:

$$K = 1.7 \cdot 10^3 \qquad b = 0.6 \cdot 10^{-3} \qquad Kb = 1.02$$

Evidently the uncertainty in the values of a does not allow us to insist on the *goodness* of the numerical verification; but not it is out of place to observe that our hypothesis if accepted can deduce an excellent method for measuring distance effective of the "variable" stars based on the exact determination of the luminosity curve of the star and of the speed along the line of sight.

In conclusion *the simple overlapping of the hypothesis about the composition of the speed of light and that of the source in what is known about the constitution of doubles allows us to trace a* VERY FAITHFUL *image of the phenomena presented by the "variable stars" of the III class, which have them represents in a complete way and in all the particulars*.

15. - We now come to the observed facts about "variables" of the II and I classes.

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

a) longer and often irregular period;

b) very rapid increase in brightness;

c) very long luminosity minima;

d) amplitude of the oscillation of brightness very great.

All these particulars fit easily and find clear explanation in our picture. Taking as basis what we know about our solar system, we do easily to build a *unique*, harmonious and faithful image of all these grandiose phenomena of variability of the stars.

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

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 presence long-term lows are conditions that join together they fit perfectly into the framework of our explanation (just examine the curves for which Kb is close to $1/2\ \pi$). What it is a matter of clarifying in the present case is therefore not the possibility of realization of such circumstances, but the high frequency with which they occur in the "variables" long term [1]).

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[1]) Our discussion leads us to believe that these characters of "variables" long, period are not needed; it just tells us that they are the most open to comments; it is therefore legitimate to think that they will be able to in the future to discover long-term variables in which they are not made.

Recalling that our analysis leads us to admit that long-period doubles can appear to us as *variables* only if they are far enough away, we persuade each other immediately that variability can be made manifest to us if the breadth of the changes is large, that is, if they occur in the place of observation of very conspicuous concentrations of light. Because such a strong concentration of light must take place that in a short time (that of the maximum) light arrives emitted by the astro in a very large fraction of the period, it is necessary that is, that the highs are short-lived compared to the lows. We are so easily and naturally able to understand the reason why observed "variables" have minima long-lasting and short, rapidly appearing maxima.

It is superfluous, then, to say that the conspicuous magnitude of the period its irregularity and other circumstances observed on these stars lead us to think of them as systems differently formats of the "double" previously examined; they lead us to think of very large and somewhat eccentric orbits; probably described by a "satellite" star around a much larger plant [1]), conditions that they greatly favor the gap between the maximums and minimums, both out of respect for their intensity, and out of respect for the durations related; for then strong concentrations of light would take place near the periastrum, where the forts take place speed changes, and would take a small fraction of the period.

These same considerations respond implicitly to the fourth of the characteristic circumstances listed below; the large amplitude of the luminous oscillation.

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[1]) It is superfious to warn that systems of this kind are possible find among the stars close to us. And indeed they are found. Just quote α Centauri, Sirius, α Aurigae etc. They don't *may appear to us as variables* because of the size of τ_o and the smallness of α, but therefore itself are revealed to us as double, or complex, even upon observation telescopic.

We therefore only have to say a few words around it to the more important fact than the observation of these stars presented: the irregularity of the period.

This consists of:

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

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

A typical example of this second case (which makes us understand better) and the one offered by "Mira Ceti" the oldest known variable and so called precisely for his wonderful behavior. It has no period variable that can be roughly represented by a rather complicated interpolation formula, the value of which average is 332 days and has variable maxima between sizes 1.7 and 5.0; and minimums also variable between the sizes 8^a and 9.5.

To explain fact *a*) it is enough to admit a displacement of the periastrum; which implies the assumption of existence of a third disturbing star, that is the existence of systems of stars more complicated than the "double".

And I like to point out here that doing so won't do us let's entrust the sea with convenient hypotheses, but let's stay on solid ground of indisputably established facts.

About the existence of complex star systems cannot now no more doubts. I'm content to mention, to stay in the field of the best visible stars, the η Orionis what it is a "double" optic, of which the brightest component it is in turn a spectroscopic "double"; and the α′ Geminorum, recognized for a long time as a composite system *at least* of three stars, two of which revolve in ellipses, of which slowly change their orientation in space.

The slow change of the period of our "variables" therefore it cannot encounter any difficulty of explanation on the ground of the ballistic hypothesis. And the reader is already there noticed how this knowledge about the existence of stellar "complexes" is enough to prove us right in an immediate way and natural, even of the most complicated facts presented by "Mira Ceti".

The hypothesis of the existence of two satellites, which revolve around the celestial body central, presents us with two periodic changes in the luminosity, i.e., in the apparent size of the system, with different periods; changes that compose into one overall with double periodicity, or better periodically variable, and with also periodically variable amplitudes [1]).

Summarizing we can say that the *ballistic hypothesis* is engaged purely and simply on the knowledge already acquired around the constitution of the stars, it also *provides us with one complete and more than satisfactory explanation of the phenomena presented from the "variables"* of the II class.

16. - Finally, it is not a difficult task to show how even I phenomena presented by the "new stars" fall effortlessly in the summary outlined above.

Still a few retouches, by no means spontaneous, are enough to give us a convincing explanation of these suggestive phenomena and full of mystery.

If we imagine very distant stellar complexes, of which a component moves in an elliptical orbit of large

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[1]) After the publication of my Preliminary Note on the "*Reports dei Lincei*" and the printing of this work in the "*Memorie della Società Astronomica Italiana*" was discovered for the first time of companions of the "variables" of the 2nd class: a companion has been found Note of "Mira Ceti". This discovery makes it all the more plausible the existence of other comrades, and thus confirms "my theory" about their "variability". I have explained this more extensively part of my work of a Note which appears in the fasc. l (January) of the "*Reports of the Lincei*".

very different size and strongly eccentric, with period, very long; or let's imagine a wandering star that can describe a parabolic orbit around some other on the path encountered, if we think that some of these orbits can have a convenient orientation with respect to the beam visual, and we think of the huge and rapid changes of speeds that take place near periastrum, we succeed to understand how the sudden arrival can happen in a short time of a large amount of light, emitted from the star perhaps along years and years of its journey, and therefore explain to us the sudden light up of a new and also great astro, the next and slow (compared to the ignition phase) return to weak lighting conditions (belonging to stars so far away) and even the unexpected little splendor resurgence which has sometimes been observed, as "Nova Aurigae".

The fig. 9a, which approximately represents the shapes which in this case takes the curve *T*=*f*(*t*), gives an image very clear and adequate of these facts.

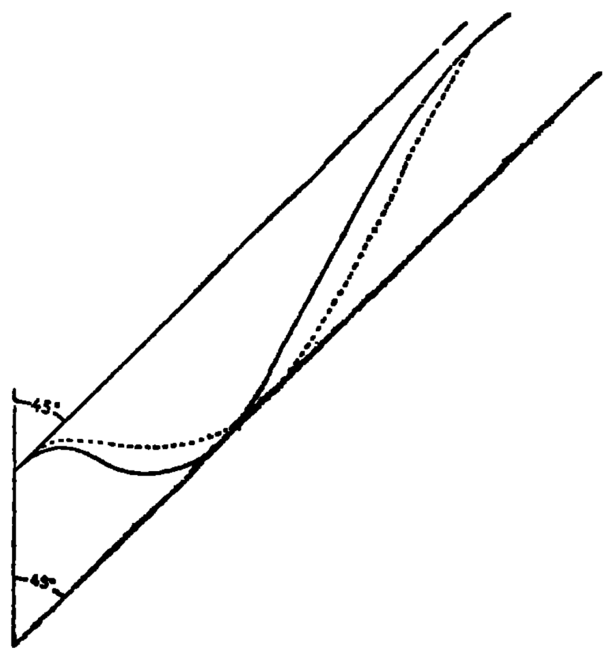

Fig. 9.

And if we assume that the traveling star carries with it a small satellite, which revolves around it with period brief, we find that the brightness of the star thougth slowly degrading, it must have period oscillations regular, such as those that were observed (four-year period)

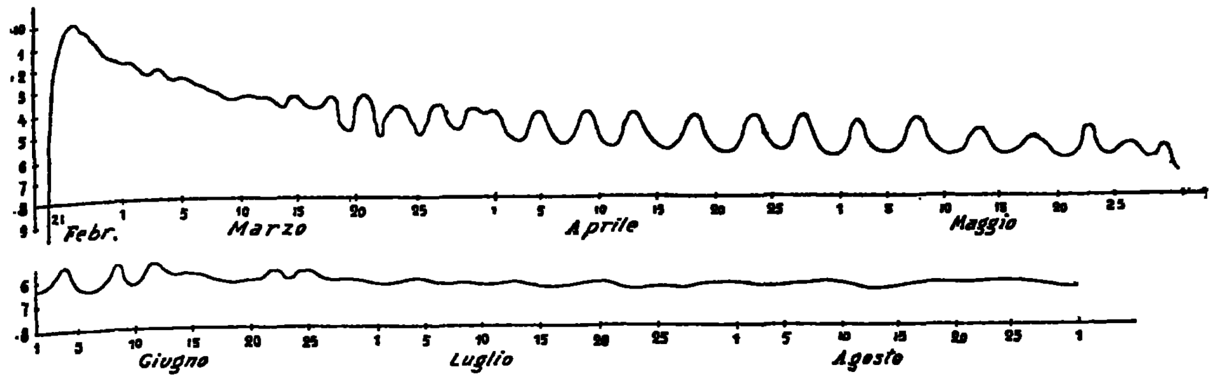

Fig. 10.

three days) on the "Nuova Persei" of which fig. 10 gives the brightness curve, as observed.

Consequences of the new theory of "variables".

17. - *The framework of the phenomena of the variables in its lines essential is thus clearly and entirely reconstructed*. There only condition that is 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 stars doubles, or rather of systems like ours (planetary) but in a less advanced stage of evolution, in which I secondary bodies, i.e., the planets, are still at temperature very tall, and therefore capable of emitting light on their own.

Now the assumption of the existence of such a large number of complex systems is clearly pointed out as extremely probable every day more by modern research astrophysics.

The number of telescopically resolvable double stars, thanks to the observations made with modern powerful telescopes, it has already risen so much that the ratio of it to the number total of stars is valued as approximately 1:12. The analysis spectra has significantly increased this number, we refer, by way of example, that the searches made in the Observatory of Lick, over a limited celestial region, gave several years ago, the existence of a multiple star for each seven stars observed.

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

Faced with such a copy of existing complex stars, it appears if anything, the number of known "variables" is small.

The narrowness of the interval within which the product *Kb* until a complex star can appear to us as a "variable" *can account quite well for the smallness of this number*.

But other circumstances must, in my opinion, intervene in the determine the smallness of the ratio; especially the difficulty of photometric measurements, the lack of attention so far placed in this research address, the means however imperfect which are used; so it doesn't seem like it. Imprudence hazards the prediction that you study more diligently, get ready and directed to this end they will greatly increase the number of the "variables", they will enrich and clarify ours knowledge about the great facts of the sky.

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

Conclusions.

This research demonstrates:

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

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

It must therefore be considered not only as having no basis, but *as contrary to natural facts, Einstein's 2.0 postulate, and must therefore be rejected on the strength of this testimony of facts* the "theory of relativity" because with the second postulate falls the cornerstone of the whole theoretical edifice.

It is almost superfluous to warn that the hypothesis we have made - i.e., the ballistic hypothesis - is fully in accordance with the principle of relativity proper; and that therefore the suffrage gives we found in astronomical facts constitutes a new outfit of evidence in favor of the extension of this principle, from field of strictly mechanical facts, to the field of all physical facts, i.e., natural facts.

The physical phenomena known up to now therefore find everyone their place in the new hypothesis, experiences of Michelson and Morley and beam deflection included. The optics – in more general sense understood - to agree with this hypothesis, however, will have to strive to find as needed conceive the light, so that it can succeed endowed with interesting property of propagating with a speed that it composes with that of the source.

A reexamination of Ritz's conceptions, it appears, at least, very timely. Another way to test is indicated by a nice idea by J. J. Thomson: Light, made of perturbation of the electromagnetic field, it would travel with speed constant along the induction tubes leaving the center (electrons) of the field, and yet it would propagate with the same speed to the resultant of that said hour, and of the velocity of the centre if this were in motion with respect to the observer.

But it seems difficult either way to see can replace the wave conception at the same time and the "quantum" one so strongly imposed by many experimental facts. But of this very important point I will make it a special object of my next work.

From the Physics Institute of R. University. of Palermo

May 1923.