ASTRONOMIC TESTS AGAINST RELATIVITY

PART ONE:

The "variable stars"

The reader who has read the conclusions of my paper *On the concept of time according to Einstein's theory*[1] will have been certainly stung by the curiosity to know something around those astronomical facts which, in my opinion, they would give us a very serious, even *decisive* test against the "postulate of the constancy of the speed of light", which stands at the basis of the "theory of relativity".

An affirmation of so much responsibility imposes on me the duty to satisfy this curiosity[2]. But for that my only good will is not enough; I still need the support of direction of this beautiful magazine and of the reader himself. To that I must address a new and imprudent wide appeal hospitality, to this I must ask the sacrifice of flowing first these few pages, so that he can take possession of the matter on which I will then have to think.

Reading these pages offers, moreover, for itself enough interest to every cultured person, for the charm that they have on each the great phenomena of the sky, and that so particular springs from these which I will have to talk about, for reason of the halo of mystery in which they are nevertheless enveloped.

[1] "Scientia", October-November 1923.

[2] I take the opportunity here to testify my particular gratitude a how many wanted to send me kind words of sympathy and consent, that I they have greatly encouraged in the reading that I have undertaken.

The reader knows that the sun sends light and heat around it - or rather "radiant energy" - in a degree that gives thousands and thousands of centuries it is preserved unchanged.[1] Viewed from far away our Sun must therefore appear as a star of constant brilliance, that is, of invariable "apparent magnitude".

As it is to be remembered, that the classification of the stars according to a scale of "magnitude"[2] was made by astronomers based *on the amount of light* that each of them sends us, this quantity being the only accessible element, so general, to comparisons.

Now astronomical observations have allowed us to find that while the greatest number of stars possess invariable "apparent magnitude", a few thousand appear to us instead now as smaller, now as larger, they have that is, variable "apparent magnitude", and are therefore called: "*variable stars*". For some of these "variables" the change of greatness - which is nothing but change of the luminous splendor - it presents us with a character of very regular periodicity. In other words, the brightness of these stars passes through a succession of vicissitudes that they reproduce in a perfectly identical way at intervals equal in time. The value of this interval is called the "period" of the variable.

A typical example of this behavior is the one given by "Algol" that is from the β of the constellation of Perseus. His apparent size varies from 2.3 (maximum) to 3.5 (minimum) in an exactly known and rigorously constant time (the whole period is just under 3 days).

The simplest idea that could have presented itself, and that it presented itself, to explain these periodic changes of light was that of eclipses. The star was admitted to possess a satellite (*companion*) less bright, which revolved around it in

[1] Strong geological reason have led us to this belief.

[2] It is known that all the stars known up to now are divided into 16 classes; they belong to the first, and are called "*stars of the first greatess*", the brightest, such as Sirius, Achene, Betelgeuse, etc., 20 in all; the weakest visible add naked eye belong to the 6th; the others are visible only to the telescope; and those of 16th magnitude only with the most powerful of these instruments.

order to come and place, at regular intervals of time, on the line of sight, i.e., on the line joining the star with the Earth.[1]

One of this supposition has recently been given confirmation by means of spectroscopic observations. These have shown that the *lines* of the spectrum of this star are displaced with respect to the normal position of one quantity that varies in size and meaning with the period same as the change of light.

And since we know that a moving light source is respectful to the observer it gives rise to shifted spectral lines, he concluded that the periodic shift was a sign of a movement periodic of the star, and therefore confirmed the presence of the satellite swivel. Indeed, on the basis of the measures of these displacements of lines it was possible to calculate the speed of the satellite and that of the star, and the other elements of motion could be deduced (period, trajectory, etc.).

Variability phenomena with similar trends - but not identical - to these of Algol they present another 13 stars (form all Scheiner class III), on which they were also made spectroscopic observations with similar results; for consequently their change of light was explained in the identical way.

Close to this just described is the behavior of a another group of *variables*, also not very numerous (32) and for which has also been adopted the same scheme of explanation.

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[1] When the *companion* is interposed between the Earth and the central star we will receive light only from that, that is, we will have a *minimum* of brightness and therefore a minimum of the apparent magnitude. After a quarter of turn the companion will reappear placed next to the star and at the maximum distance. We will then have light from both stars and the apparent greatness will pass through a *maximum*. After a new quarter turn the teammate will hide behind the star, and the apparent size will pass through a new minimum, which can be greater than the first, if the brightness of the star is greater than that of the partner. After another quarter of a turn the two stars will appear to us again next to each other and at the maximum distance and we will have a new one *maximum* of the size, equal to the first.

Recalling that astronomers call "conjunction" and "opposition" the 1st and 3rd of the indicated positions, and the 2nd and 4th "quadratures", we can briefly to say that for each turn the apparent size of the "double" will present us two *maxima in correspondence of the quadratures, two minima. at the conjunction and the opposition*. If these are of intensity different the minimum *principal* corrresponds to the first, the *secondary* to the other position.

The period of these is, however, somewhat longer, and it is even less regular than that of the former.

Typical example of this group (Scheiner class III *A*) I am:

The β Lyrre, which has a period of 12d, 22h, during which the brightness has two large maxima, of equal value, and two different minima. In the main minìmo the star appears of size 4.5; after 3d, 3h reaches the first maximum of size 3.4; after another 3d, 6h appears in the secondary minimum, of size 3.9; returns in 3d, 3h to the maximum than before, to finally fall back to size 4.5. The period is slowly variable.

The curve next drawn represents the events for which the heuinosity of the star passes.

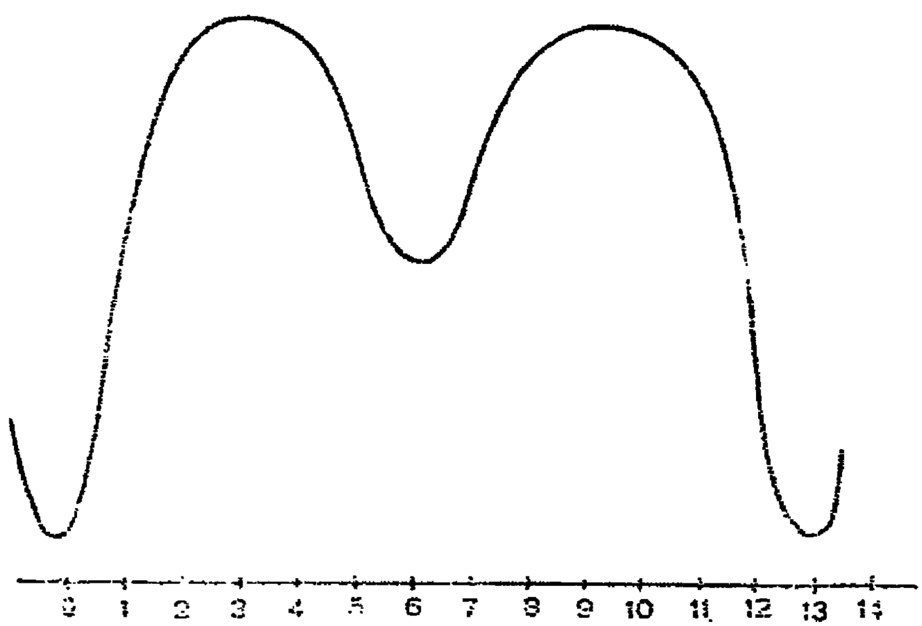

Fig. 1.

The η Aquilae, which has a period of 7g, 4h, 20m, during which from the minimum of size 4.7 it reaches the size in 2g, 6h 3.5 main maximum, passes, after lg, 15h, for a secondary minimum, size 4.1 and dates back to the second maximum of size 3.8 after 13 hours, to finally return to the minimum size primitive after 2h, 18.

Fig. 2 gives the diagram of its brightness.

The δ Cephei has a period of 5g, 8h, 48m, in which the magnitude apparent passes from a maximum of 3.7 to a minimum of 4.9; is interesting because the secondary minimum and the 2nd maximum are confused together (at an inflection point).

The explanation of the eclipse, proposed for "variability" of these 46 stars, it is not entirely satisfactory. It loses his persuasiveness when it comes to assigning

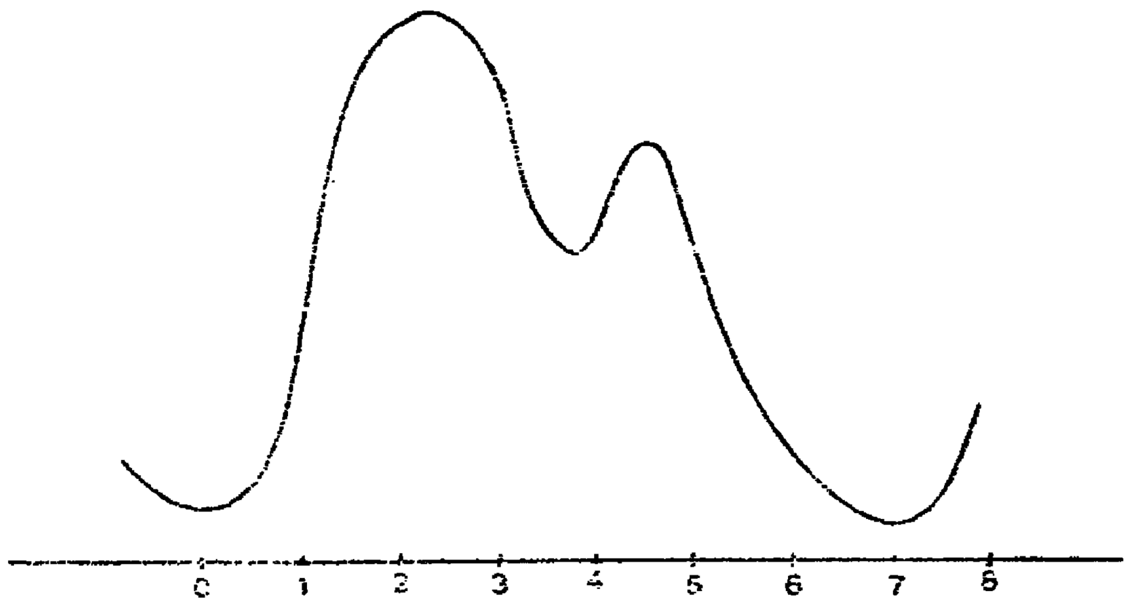

Fig. 2.

reasons for which the second maximum may be much weaker of the first - as happens for η Aquilae, and for δ Cephei - and the reasons why the time interval

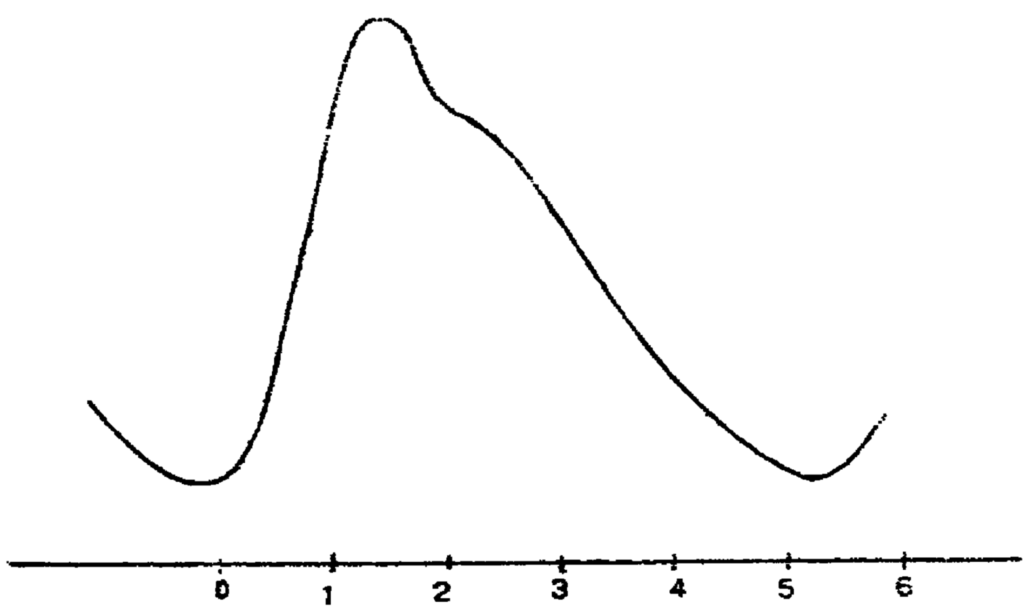

Fig. 3.

between the minimum secondary and the second maximum can become so short to be confused almost in a single point, which happens for δ Cephei (fig. 3).

To explain the different intensity of the two maxima would be it is necessary to think that in one of the positions in which the stars appear to us arranged side by side, take place a partial superposition of the two component stars, the which is absurd.

To explain the extreme smallness of the time interval between the secondary minimum and the 2nd maximum, we must think that the passage from the position of "*opposition*" to the next "*squaring*" happens in an extremely short time, that which fails in any understandable way.

Other difficulties that are not slight are encountered to explain:

a) the presence of longer periods of the minimum phase tli those of the maximum;

b) the much greater rapidity with which the ascent to maximum compared to descent to minimum.

In conclusion, although *the occultation hypothesis* has a solid foundation, in the spectroscopic knowledge of nature of "doubles" of our "variables" it *is not enough to give us a clear and complete explanation of the facts* examined so far; facts that are the simplest but also the *least frequent* observed in this field of investigation.

Many "variable" stars - the greatest number - have long and slowly changing periods, and characteristics salient an abrupt transition from minimal brightness to the maximum. Typical examples of this class are:

The o della Balena, also known as "Mira Ceti", discovered since from 1596, which has a period of about 332 days (which does not remains constant) and has maximum brightness oscillating between the sizes 1.7 and 5.44 and of the minimums also oscillating between 8.0 and 9.5.

The α Geminorum, which has a period of 86 days (among the most short) of which 20 employed in the minimum phase (13^a largeness) and 66 in that of maximum (9^a magnitude).

The R Ursre Maj. which has a period of 302 days and a swing in the apparent size of *well 7.2 classes*.

The X Cygni which has a period of 406 days and a swing of magnitude of *9.5 classes* (what matters is a variation of the intensity of light in the ratio of 1 to 6000).

In the mass of very varied and obscure facts it offered the study of these "values" (class II *A*) seems to ascertain a *curious regularity*, which occurs in the distribution in different groups, distinguished according to the length of their period.

We report in this regard the following mirror which refers to the stars that until a few years ago they had been assigned to this class (II *A*):

Period in days	Number
up to 20	38
21-50	27
51-100	24
101-150	37
151-200	43
201-250	112
251-300	111
301-350	119
351-400	85
401-450	41
451-500	19
500	17

These numbers clearly show there is a curious one preference for the period of about 300 days; and more, interesting circumstance, such as the total number of stars with periods greater than the preferred one is much smaller than that of stars with minor periods.

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

Since the behavior of these "variables" is not possible to apply the explanation of the eclipse, it never was admitted that they may have "companions", that is they can be "doubles" or more "complex" stars.

To explain their changes in size they have to bring into play various artificial hypotheses, of which we will recall just those that have had the most credit.

According to Zöllner, the surface of these stars would be large dark crusts formed upon cooling. Because of the non-uniformity of the process, they would preferably be accumulated on certain regions, which would come periodically to pass on the visual range as a result of the rotation of the star around itself, thus giving rise to variation of light with the period of rotation. A hypothetical movement of the crusts on the surface of the star would cause the irregularities found during the period; the vastness of these fields of scabs would explain the long duration of the idle; a special their distribution on the surface of the star would explain (???) the asymmetry observed in the speed of the increase and the decrease in light.

An improvement on this hypothesis was believed to give Sylden, assuming that the star's rotation axis does not coincide with its principal axis of inertia, what it would give rise to the chances of the period.

The most accredited explanation today differs from this one due to the nature of the screen which periodically hides the star light; enormous Zöllner's crusts have been replaced spots, to the rotation of the star with the reason for the period fundamental is replaced the *periodic* formation of such spots (?). The factors of the variability of the period would be the changes in their position 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, analogous to those of the Sun, *which in a short time could totally cover the surface of the star*, it could come to explain a corresponding intensity change to the jump of 4 classes at most in the scale of apparent quantities (while there are variations in light more than 100 times higher, i.e., jumps of 9.5 classes). And everyone sees what difficulties meet in assuming that similar phenomena, which they should *extend to the entire surface of the star*, occur and resolve *at almost regular intervals* and within times relatively very short - like those of passage from the minimum at most.

Similar apparitions, mysterious and strange, to nature, the vastness and rapidity of the imagined phenomena have no foundation whatsoever in the field of facts.

Another hypothesis, due to Klinkerfues, deserves a brief note. He admits that variable stars are gods "very narrow doubles" which rotate according to orbits a lot eccentric. At the time of closest approach two o'clock stars would be at such small distances as to cause strong deformations and displacements in their atmospheres, the which would be highly absorbent for the lnce issued by underlying core. The gashes produced by these mutual perturbations would result in an increase in intensity bright. Even this hypothesis is insufficient to explain everyone the details of the observations; with presence. of two maximums, the diflerent interval between them and the lower ones, etc. which would be highly absorbent for the lnce issued by underlying core. The gashes produced by these mutual perturbations would result in an increase in intensity bright. Even this hypothesis is insufficient

to explain everyone the details of the observations; like the presence of two maxima, the different interval between them and the minima, etc.

To complete this quick information on the stars variables we still have to say a few words about the "new stars". Since the year 134 A.C. apparitions were observed and recorded *sudden* of new stars that, shining even more stars of greatness, had an ephemeral life in the sky. But their systematic study can be said to begin in 1863 with the appearance of the "new" of the Crown, or star of Birmingham, from the name of the discoverer, who found it for the first time on May 12, as a *star of 2nd magnitude*, and no observed the rapid and brief increase in brightness and the slow decrease.

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

Even more exact knowledge is obtained for several others; we only mention the most famous: the "Nova Aurigae" and the "Nova Persei".

The first, discovered by Andersen on January 23, 1892, is not it was previously known - and in any case it could not exist than as a star smaller than the II in size - why up on November 2, 1891, a photograph was made of that region of the sky on which the "new one" was not found. It was found instead, as a star of size 5 1/2, above a photograph made on December 10, and as a 4th magnitude star above another photograph taken 10 days later. After the discovery it rapidly diminished in splendor, and in April 1892 it was barely there visible with powerful telescopes. *In August 1892* - detail important - *became more brilliant* and went up. up to 9^{a} 1/2 size, and from then on it soon became very weak, remaining however visible with the most powerful telescopes.

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

Around these more recent "Novae" was collected a vast and precious material, which I cannot examine here; I will content myself with mentioning that the brightness curves are always characterized by a very rapid increase to which it happens a slow and gradual decrease to very high values little ones. Sometimes, however, in the phase of decrease they present a new increase - like the one noted for the "Nova Aurigae" -; some others show - like the Nova Persei – fluctuations of light in a rather small and regular period, yes they gradually fade. Spectral analysis showed always the presence of bright lines *split* and often divided into a greater number of components, and components more intense shifted towards red. The spectrum features a continuous background that weakens quickly and unevenly in the different regions, until it disappears completely, leaving surviving the spectrum of lines, which is also gradually losing little by little the greater part of its elements, to be reduced *to one single line*, characteristic of nebulae.

It is not the case here to venture to recall the various hypotheses which have been put forward, to explain the phenomena of these mysterious meteors. Each "Nova" ignited the fantasies and has left a very long trail of opinions and discussions.

From the hypothesis of the violent conflagration between two peaceful ones dwellers of the sky; from Zöllner's botched one, based of colossal eruptions and fires on the very plot of his "theory of variables"; on the other no less curious – ed absurd today - by Lobse, around successive stages of sudden and violent chemical reactions, achieved by the star for subsequent cooling; to that of Wilsing-, trodden on the the same mold of Klinkerfues' hypothesis on "variables"; to that of the collision between two entire planetary systems; to another that tries to base itself on the anomalous dispersion of the light; to that of the explosions of enormous gaseous masses, or of colossal electrical discharges, finally arrives at the conclusion sion that *each "Nova"·together with a rich and interesting my wealth of observations has brought us a new enigma.*

All this imposing set of complicated facts and mysterious, it lets itself be coordinated and explained in a simple way and immediate on the basis of a simple hypothesis about the speed of light: "*the ballistic hypothesis*" enunciated by Ritz.

This young and talented theorist - unfortunately too early missed life - shortly after the publication of the Einstein's early work, showed that the conflict between mechanics classical and electromagnetic theory, could. take off of blow, assuming that the light of a moving source does propagate with the speed obtained, by composing the characteristic speed of light (from a source at rest) with the speed of the source.

With this simple hypothesis the principle of relativity of Mechanics was extended in the most immediate and natural way to the whole domain of physical facts, and therefore came to drop the famous contradictions between experience (of the Michelson type and Morley) and theory.

The intact conservation of our conceptual heritage, with the obvious advantage of a huge economy of thought, it was not enough reason to attract the attention of the theoretical scholars on this simple conception. The charm of the "new" and a very ambitious new one, he started in quite another direction the scientific investigation.

Entirely isolated voices were those who attacked some interest in the suggestions of our young theorist; and ready was the scientific opinion to grant unlimited how much uncontrolled trust in brief and incomplete considerations with which De Sitter - a Dutch astronomer – believed to be able to reject the ballistic hypothesis. And from then to today De Sitter's arguments were regarded as irrefutable proof of the "*physical truth*", of the postulate of the constancy of the speed of light.

An elementary examination, accessible to all of these topics allowed me to prove the inaccuracy of the conclusions, and to affirm the right of existence and citizenship that the ballistic hypothesis boasts in the face of science.

This same examination revealed the fecundity of the "ballistic principle", by giving us the explanation of a field of facts as vast and important as what I have described.

And that is enough to give it a very high place in the hierarchy assumptions.

But the reader will judge of this when he has read mine following article.

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