Radial velocities and ballistic theory of variable stars.

By M. La Rosa.

I can receive a new communication from Prof. *de Sitter*, which aims at the usual purpose, namely the ballistic one theory in general and mine in relation to that phenomena of the "variable stars" designed in the be but to refute it from the ground up, not with silence pass over.

The principal argument by which *de Sitter* believes to be able to prove the absurdity of the theory, lies in the following consequence, which he means of a short and not clear calculation from it arises: "that the star would in a part of its orbit have three different velocities at the same time. "

Now this calculation is from Prof. *de Sitter* only form 11 correctly; factually it is wrong, because this the whole argument is that of the calculation itself foundation and guidance.

The reasoning he provides is indeed supportive to certain hypotheses that are "a priori" incompatible, so that the weirdness of the end result not the absurdity of the ballistic theory, but only the impossibility proves to bring the hypotheses together themselves.

I will therefore try to fix this error of mine to present opposing arguments and continue following correct conclusion of my theory to illuminate and corroborate facts: that it is possible is, in one and the same moment several to observe radial velocity values, which, however, correspond to rays that are simultaneously at the observers arrive, but from the star in different moments and from different positions.

The hypotheses on which the argumentation of Prof. *de Sitter* supports are as follows:

1. that the light obeys the ballistic principle (i.e., its speed increases to that of the light source added);

2. that observed on the variable stars radial velocities are represented by the Law:

$$V = V_0 + v \sin\left[2\pi \cdot (t - t_0)/\tau\right] . \tag{1}$$

3. that in the particular case to which he applies the 2nd hypothesis applies, it can also be assumed that the constant a introduced to him (*kb* of my work) is equal to 1/2.

Finally, the following hypothesis is included:

4. that the multiples have a companion who moves around the central celestial body in an orbit that lies on a plane passing through the line of vision. Latter hypothesis and the first make - what not to remember superfluous - the essential basis of my theory.

If Prof. *de Sitter* wanted to proceed correctly, he would have start from these two basic hypotheses and make sure need whether the 2nd and the 3rd, both on their own taken together are compatible with those. Just this I want to do it myself right away.

So, let's assume (4th hypothesis) that the variable star has a companion that rotates along a circle and therefore with the effective (and not observed) radial velocity given by (1).

Suppose further (I. Hypothesis) that any of the star at moment t with velocity V in in relation to the observer, the ray emitted at the observing place arrive at the moment T given through

$$T = t + \Delta/(c - V)\,. \tag{2}$$

As a result of these hypotheses, the law according to which the radial velocities on arrival coincide will follow, that is the law of observed speeds

$$V = V_0 + v \sin\left[2\pi/\tau \cdot \{[T - \Delta/(c - V)] - [T_0 - \Delta/(c - V_0)]\}\right]$$

be what with the usual approximation of the 1st order in the ratio V/c can be written:

$$y = \sin[2\pi\,(x - \alpha y)] \tag{3}$$

where

$$(V - V_0)/v = y \qquad (T - T_0)/\tau = x \qquad v\Delta/\tau c^2 = \alpha$$

has been set.

One sees that the basic hypotheses of the ballistic theory led to the observed radial speeds the law (3) and not the simple assign sine law, consequently, it is proved that the 2, *de Sitter*'s hypothesis with the 1 and 4 in general is not compatible. We will see below that it becomes almost incompatible if one takes $\alpha = 1/2$ sets (3rd hypothesis). The calculation only gives us the following: a way to match the ballistic theory to be checked with the observed facts, i.e., that is a means, not their "inner coherence," probably but to verify their "truth" in the physical sense.

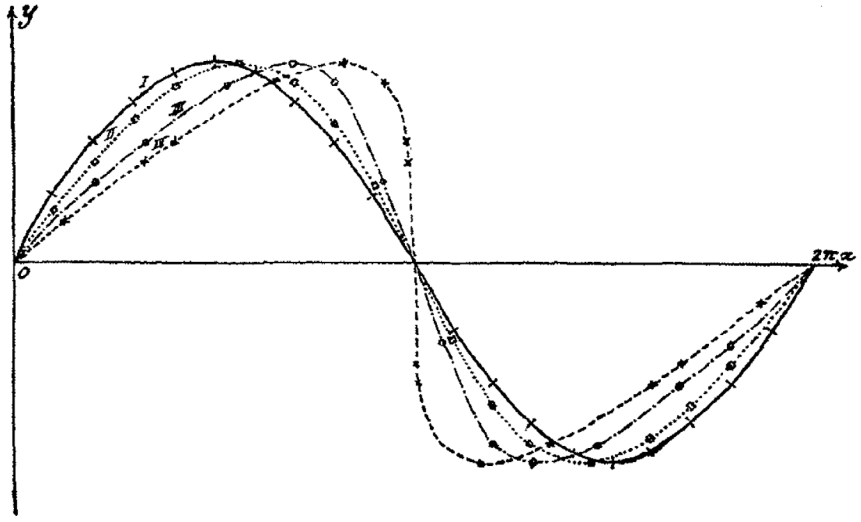
If the relationship (3) proves to be incompatible with the observations should prove, then - and only then - would it, given the contradiction between theory and facts proved to be inevitable to abandon them, even if its construction - as it is - logically unassailable would.

The task was and is the following: Equation (3) to compare with the observations. I will therefore the examination of what my theory forward to the fields from which observed radial velocities can be expected, resume to include the relevant remarks in to add to my original paper.

The variety of manifestations that us in the concrete case with these observations of the "radial velocities" should be of the value of the parameter τ, the only one in equation (3) is included depend.

It is immediately evident that, since $y < 1$, when α is very small, equation (3) is practical with that simple sine law coincides. To give the reader a precise idea of the significance of the deviations to give that in relation to this we have the equation (3). I find it useful to use

diagrams I, II, III, IV reproduce, to which the equation (3) for the values $\alpha = 0$, that is the pure sine curve, resp. $\alpha = 0.032$, $\alpha = 0.1$, $\alpha = 0.16$ leads.



From the drawing one sees that as long as $\alpha < 0.03$ is, the deviations of the true law from the pure sine waves are smaller than that (in this type of observation anything but small) measurement errors; that the deviations become more and more noticeable when a from 0.03 to 0.16 grows, but that nevertheless the curves (Type III) retain the general course of a sine wave and only have the following changes: approximation of the two extreme values, lower slope of the ascending section of the curve opposite the descending one.

But what matters is the proof that the general character of these curves or more correctly the essential property of being a single-valued function of T as long as maintained is conserved as $\alpha \leq 1/2\pi$. We will do this easily achieve if instead of the relation (3) we ourselves of the relationship (2) that connects T with t we will consider that as long as each value of T a only value of t, this will mean that at any instant the observer a single ray of the moving stars will see arrival and therefore only one speed will be able to record.

Yes, more generally if we count the number of find values of t that correspond to one and the same T, so we shall find the number of the different rays, which arrive superimposed at the moment T, and consequently the number of different radial velocities that the observer at that moment will have to register.

In other words, the known problem, the number of the different radials observed at each moment determining speeds is limited to that problem of overlays, which I have discussed at length.

Then that's the easiest way to go can, following: determination of the number of points in which the curves $T = f(t)$ drawn in my work from any straight line T= const. be cut through. We recognize immediately that a necessary prerequisite for that the straight lines intersect the curves at several points can, which is that they have maxima or minima, and that therefore the condition

$$dT/dt = 1 + \Delta/c\ V' = 1 + 2\pi\alpha \cos[2\pi \cdot (t-t_0)/\tau] = 0$$

will be fulfilled, which can only happen if $2\pi\alpha \geq 1$, that is $\alpha \geq 1/2\pi$.

If one examines the 2nd differential quotient of *T*, so one finds that the for the existence of several sections score sufficient condition which is that $\alpha > 1/2\pi$. So long so we have $\alpha \leq 1/2\pi$, curve (3) is the observed one velocity single-valued, that is it preserves this one basic character of the sine law (for $\alpha = 1/2\pi$ gets one curve IV).

In order not to lengthen, I want the following mention general result[1]) arising from my analysis results in: the straight-line T = const. must curve in a number from points containing between $2n$-1 and $2n$+1 is, depending on the product kb, i.e., that is α, of restriction

$$(2n\text{-}1) < 4Kb < (2n\text{+}1)$$

where n can be equal to 1, 2, 3 ... suffices.

From all of this it follows that:

1. the law of variation of the observed radial velocities may have sinusoidal shape if $\alpha < 0.03$;
2. that this form is the main thing, among more and more important ones deviations, as long as $\alpha \leq 1/2\pi$ is;
3. that the hypothesis of the quasi-sinusoidal shape of the observed speeds with the premises of ballistic theory becomes incompatible when one $\alpha > 1/2\pi$ accepts;
4. that in the latter case the number of simultaneously observed radial velocities between $2n$-1 and $2n$+1 must be contained if the constant 4α is within of the same limits.

It almost goes without saying that the 3rd conclusion yet another flaw in the argument *de Sitter*'s brings to light: namely, that he refers to the observed velocities the sine·law in a concrete case ($\alpha = 1/2$) has applied in which the same with was incompatible with the other hypotheses of the theory.

After the conclusions have been found, to which us the ballistic theory with regard to the observed radial velocities, let's try them to be briefly compared with the results of the observations.

To this end it is of interest the following to mention the result of my investigation: that the variability phenomenon can prove to be clearly perceptible, if the constant $kb = \alpha$ of the relation

$$1/50 < \alpha < 5$$

suffices, and further, that the light changes as prove to be all the greater, the more α is more than $1/2\pi$, be it for increasing or for decreasing values, approaches.

So, the theory allows us to suspect the existence of "binary stars" and to foresee "variable stars" where the observed radial velocities correspond to the follow the law of sines very carefully (the cases mentioned by *de Sitter* allusion to).

[1]) I hope to publish soon a translation of my complete paper in a language better known as the Italian is, which I am convinced will do much to understand my thought and to avoid further misunderstandings will have happened.

On this point there is no contradiction between theory and facts!

Regarding these stars, the theory compels us, only this one assuming that α is less than 0.03, and hence, that the variability is of small amplitude, and although of the smaller, the more true to the simple sine law is followed.

However, in reality, these are cases where the velocity curve obtained from the observations is a pure sine wave, very rare (if at all exist). The curves that the observation has provided are rather deviating sinusoids and exactly of the type curves III and IV of our figure ($0.03 < \alpha < 1/2\pi$). And it is known that these deviations are elliptical due to the shape of the web.

The only change that the ballistic hypothesis can bring to the interpretation of those curves is this: a change in the values calculated in this way of eccentricity[1]). And this is certainly not a cause of the conflict between theory and fact, but rather a new way that studies on this so little expand the explored area.

The theory still allows to foresee the existence of "variables" corresponding to the observation three or more different speeds at the same moment perform, that is the spectra with multiple (double, triple etc.) lines or simply with broadened lines exhibit when the number of components is fairly large, and their distances are small[2]).

Now multiple spectral lines are in almost all "new stars" after *Vogel* first confirmed the presence of double lines in the spectrum of "Nova Auriga" (1892) and multiple lines are also included the actual variable stars have been observed. Suffice it to mention Mira Ceti, where *Campbell* managed to the presence of triple lines throughout a part of the period, and β Lyrae, in which *Vogel* photographed double and more complex lines. Widened lines usually appear in the spectra of the variable star watching, as is well known to anyone who some photograph of these spectra in hand has had. And further agreement will arise - of that I am sure - if it is possible will be the investigation of the finer structure of these to make lines.

So, I can say that the foregoing analysis gives us the key an observed and not yet explained gives fact in hand, that is I can say that my theory, far from in line with the facts controversy, also in this area authentic success![3])

As for the other serious allegation that Prof. *de Sitter* objects to my theory that it namely in contrast to the general theory of gravitation asked, I must sincerely declare that I really cannot understand how such a misunderstanding could arise. A contrast of this kind is not only

[1]) This point will be dealt with in more detail shortly.

[2]) These distances depend both on the differences between the individual velocities and on the decomposition capability the spectral apparatus. The latter is not yet large enough to allow analysis of the finer structure of the lines, which we here recognize as necessary.

[3]) Anyone who wants to take the trouble to read my treatise will find all this and will also see how it allows me to do so has to bring the following two facts closer: the non-existence of "star systems" that present themselves to us as "variables" could show, with periods longer than 550-600 days, and the presence of many non-varying stars with spectra with greatly broadened lines and a common explanation of this by considering them as systems in which the size *kb* exceeds a certain limit, which cannot be much larger than 5.

not present but cannot be present because of the express and direct purpose of the ballistic postulate is to keep the whole edifice of classical mechanics intact received, then that branch of our science, which the simplest and the most advanced, and the conceptual basics of optics and electromagnetism, the much younger, more complex and darker branches are to renew[4]).

However, I want from these general considerations foresee and on the humble ground of what concerns me. If you stay and draw attention to it - like me have already said above – that the first essential the hypothesis of my theory is that the "variable stars" consist of two or more stars that surround the circling the common center of mass, the laws of mechanics, i.e. that is obeying *Newton*'s laws.

In the end, all that's left for me are the allegations to examine, which Prof. *de Sitter* in the first part set up his writing. But although I about the acceptability of the law of proportionality between changes of frequency and changes in luminous intensity, one proportionality, in my view, not even on the bottom of the elastic and electromagnetic theory can be said to make the most extensive reservations is sufficient I forgive myself to list the express ones which he in his criticism of the basic problems of renewal of our ideas in this area.

He must have seen that the new facts which the physics has gradually accumulated, a profound transformation in our ideas about the nature of have prepared light; he must have seen that through the astronomical phenomena examined by me so well-supported ballistic theory demands that immediately hand to the work of renewal, since they with the classical notion of a perturbation "sui generis" of a universal medium is incompatible.

The ballistic hypothesis necessarily guides us far from the imagination of this continuous medium away; it urges us on that so strange and yet so fertile and suggestive path, already through the facts instructed and divined by a strong spirit: that of a discontinuous mechanism of emission, a quantum-like constitution of radiant primordial energy.

Yet, this is not the opportunity on this seductive subject to enter[1]). I hope very soon to be able to deal with it in the future.

1924 Oct. 26 M. La Rosa.

[4]) I take the opportunity to correct an oversight that the author of the note concerning me in No. **2867** p. 550, 1924 Oct. 1 1 by Nature, while at the same time I thank him most vividly for the attention he has given me gave work. He believes that the interpretation of the Michelson and Morley experiment is an obstacle to ballistic can form theory. This is not the case, because the hypothesis assumes that for the one from the earth together with the light source continued observer the propagation of the rays must take place with the same speed in all directions.