# About the empirical basis of the ballistic principle of light propagation.

(Reply to Prof. H. Thirring.)

By **M. La Rosa** in Palermo.

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This work contains a brief response to two of Prof. Thirring's objections against the ballistic principle of light propagation and mine from it derived theory of variable stars. - In the first part it is shown that the application of the Doppler principle to thermal motion of the emitting particles not only the ballistic principle too absurd consequences but leads us to the existence of a weak continuous background in each line spectrum can be foreseen, what with the ordinary one's observations are in full agreement. - In the second part, the impossibility of a quantitative proof of the variable ballistic theory stars because of the tremendous uncertainty of the required astronomical data, especially the one about the parallax proved.

In a communication published in this journal[1]), Prof. H. Thirring two objections to my more recent work: one more general Nature that justifies the application of the ballistic principle wants to attack at the speed of light; the other, from special nature, should a quantitative non-conformity with the astronomical observations in the right light, that of mine "Variable Star Theory" based on this principle would meet.

Let us first examine the first objection.

Referring to the already between Prof. de Sitter and me discussed question of the Doppler effect, Prof. Thirring recognizes that the movement of the light source does not lead to any further shifts in the spectral lines, other than those foreseen by the ordinary theory of that effect, can give cause, but he emphasizes that the new on the acceleration receding link that enters the ballistic theory calculation introduces, must inevitably make oneself felt when one takes into account the thermal motion of the emitting particles, namely because of the significantly greater value that the acceleration reached in this case.

For greater clarity, Prof. Thirring's calculation is to be found here are played back:

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[1]) H. Thirring, ZS. F. Phys. 31, 133-138, 1925.

We are looking, he writes, at a luminous atom, the one accelerated movement in the direction of the vision radius. It emits a coherent one between the time instants $t$ and $t + dt$ wave train. The speed of the atom relative to the observer have the value $u$ at time $t$ and the value $u + du$ at time $t + dt$ we calculate the distance light source - observer with $\Delta$, so are the arrival times of the beginning and end of the wave train, $T$ and $T + dT$, according to the ballistic hypothesis given by:

$$T = t + \frac{\Delta}{c + u}; \quad T + dT = t + dt + \frac{\Delta}{c + u + du}.$$

From these equations, by taking $\Delta$ as very large compared to $u\,dt$ assumes, and neglecting the members of higher order:

$$dT = dt - \frac{\Delta\, du}{c^2}.$$

Assuming this, Prof. Thirring recognizes, taking into account the smallness of the coherence time $dt$ indicates that the term $\Delta/c^2\ du$ in the movements of the "binary stars" can be neglected, i.e., he recognizes (contrary to the view of Prof. de Sitter and in agreement with mine) that the Doppler effect of the "double stars" as a result of this new link introducing the ballistic hypothesis, must not exhibit any anomalies. However, based on the consideration that the thermal motion of the emitting atom due to the collisions subjected to much much larger changes in speed is, he sees the occurrence of extraordinary, practical unacceptable line shifts ahead.

By in fact relating the result of the calculation to an "emitting atom" on the Sun (i.e., for $\Delta$ the distance to Earth-Sun sets) it shows that one emitted at the moment of the collision visible wave train overturn at the earthly observer (i.e., rear end first and front end behind) and with must reach a wavelength of a few centimeters, and comes then to the following conclusion:

"The ballistic hypothesis is thus presented in its logical form already refuted by the fact that solar radiation a visible spectrum with sharp spectral lines owns."

I do not want here those of mine elsewhere [1]) for revision and specification of the basis for calculating the Doppler effect on the repeat arguments developed from the bottom of the ballistic hypothesis. I confine myself to the remark that the

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[1]) .Astron. Nachr. 222, Sept. 1924, Nr. 5319.

"Coherent wave train", which he considers, as a result of the hypothesis, its coherence and thus the loses value and meaning that Prof. Thirring envisages. This is proved by the result he found himself: that the group of oscillations it adopts during reproduction is profoundly disturbed because the various elements are temporal and spatially get a different distance, overlap and roll over. But apart from all that, here must decide be asserted that these conclusions of Thirring, himself suppose they are undeniable, the basics of "ballistic theory of light" not in the least shake.

It is well known that the knowledge to which we the emission mechanism, allow us to use it as independently of the impact of the emitting atom against any present an obstacle. While therefore nothing deny us can to think that an atom emits at the same moment in which it suffers a thermal collision, so we will be in equal wise by nothing empowered to consider that all atoms emit only at the moment of collision can and must. With the immeasurably large number of atoms of which the sun consists, like any source of light, it becomes certain happen that some at the moment of the collision itself emit; but since the atoms at the moment of collision have velocities possess in all directions, only one becomes small fraction of this number velocities slightly inclined against the vision radius *r* have to for the production of Thirring required effect sufficiently strong components ($du_2/dt$) cause give. And all this leads - if you always do your own calculation Thirrings remains - to no other consistent result as the following: that a small fraction of that of one - also assumed to be completely monochromatic - light source emitted light at a suitable distance standing observer under all possible frequencies got to. This conclusion is fundamentally different from the Thirrings on the basis of considering only one colliding atoms! It is such that it tells us about the possibility we have to observe sharp lines in the solar spectrum - and which doesn't affect my theory at all - more than unconcerned not enough, but it is also such that it gives us one wide possibility of assuming the occurrence of line spectra earthly and heavenly origin. Because everything they us what is new is this: the need to assume that if the distance of the light source from the observer or the du/dt over the measures are large - like those which under certain circumstances can occur during the thermal collisions - the line spectrum of a more or less intense continuous spectral background must be accompanied.

Whether this conclusion by the simplest and most immediate spectral investigation is refuted, or rather confirmed, brilliantly confirmed, everyone will be able to judge!

So, from the objection of a physical nature, that goes ballistic principle strengthened. Now let's examine it objection of astronomical Nature.

After that, not the ballistic principle, but its application on the theory of "variable stars" by the present existing astronomical material "conclusively" refuted! In support of this assertion, Prof. Thirring cites some in "Third Catalog of Spectroscopic Binary Stars" by Lick [1]) results. It would be about multiple double stars for which, although they are variable, the product $Kb > 1$, for some even is slightly greater than 10, while my theory envisages that product of limitation

$$0.02 < Kb < 5$$

suffice and must be close to ½ π if the change amplitude is very big.

Of course, I got hold of this newer catalogue, but I did not find in it those elements that Prof. Whirring allowed to speak of a "striking" refutation.

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1) Lick Obs. Bull., Nr. 355.

First, I note that the five stars he discusses (R. Z. Cass.; W. W. Aur.; S. Ant.; W. U. Ma.; u. Herc.), are of the algol type, that as variable from discountable type, for which the explanation of the eclipse has been developed, an explanation which, like me clear in my reply to a recent criticism of Mr. Salet [1]) have said, I don't want to and I can't switch off my theory. And in this my writing I have made it clear that the phenomenon of Eclipse remains independent of the ballistic hypothesis and thus completely free from any condition as to the value of *Kb* is, and therefore also from being bound to the path speed.

The occurrence of the phenomenon of "variability" in the examples given prove nothing against the ballistic hypothesis.

What remains to be investigated is the behavior of the spectral lines in relation to their state of widening and their movement. In this regard but suffice it to draw the attention of physicists to one extreme precarious and yet essential in the calculations of the numerical values of *Kb* dominant element: the stellar parallax, from which the value of $\Delta$ and thus of *K*

$$\left(K = \frac{propagation\ time\ of\ the\ rays}{rotation\ period\ of\ the\ star}\right)$$

must be derived.

Lick's catalog mentioned above does not contain any information on this all-important element, and Prof. Thirring has omitted to cite the sources from which he obtained his has created numbers that I want to list here :

| Stars | R. Z. Cass. | W. W. Aur. | S. Ant. | W. U. Ma. | u. Herc. |
|---|---|---|---|---|---|
| Parallax | 0.029" | 0.012" | 0.07" | 0.010” | -0.023” |

I have therefore tried to check them for my part, and I managed to get the W. U. Ma. specified parallax in a collection of astronomical data on radial velocities [2]) to find. While, however, this simple transcription really does nothing said, the stage of any good work proves over later ones Parallax measurements as very instructive.

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1) C.R. 180, 1925, No. 9.

2) First Catal. of Rad. Veloc. by J. Voflte- Bosscha Sternw. Lemgang (Java).

The publication I had in hand is a beautiful one Work of the Yerkes Observatory and "Stellar paratlaxes derived from photographs made with the forty-inch refractor"[1]). It is i.e., measurements according to the best method and with one of the best instruments of the world!

In this work I have only used those based on W. U. Ma. Regarding measurements can be found. The result there of becomes as follows given:

$$\pi = 0{,}008'' \pm 0{,}010'',$$

i.e., a value of 8 thousandths of an arc second [2]), afflicted with a probable error that is greater than the measured value!!

And one should not think that this is an exceptional case, since the are analogous in all respects to other listed measurements.

Just to the non-expert about the difficulties and the to clarify uncertainties that prevail in this field of measurements, I take the results from the work in question, which after the different methods for the parallax of the star of Argelander- Oeltzen were found:

| Parallax | Probable Errors | Observer |
|---|---|---|
| 0.247” | 0.021” | Krueger |
| 0.111” | 0.027” | Schweizer-Soeoloff |
| 0.191” | 0.030” | “ “ |
| 0.147” | 0.020” | “ “ |
| 0.22” | 0.050” | Flint |
| 0.35” | 0.051” | “ |
| 0.269” | 0.012” | Davidson |
| 0.217” | 0.006” | Lic and van Biesbroeck |

It is almost superfluous for the reader to get to the bottom of the choice of this example: the magnitude of the numbers in the first column, which is tenfold and more of the greatest of the parallaxes given by Prof. Thirring is, and draw attention to the deviations between the individual values to make those that much larger than those in the second column listed probable errors are!!

Committed to making a final judgment of acceptability base a theory on measurements of this type committed to making a final judgment of acceptability base a theory on measurements of this type committed to making a final judgment of acceptability base a theory on measurements of this type to want now seems

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[1]) Public. of the Yerkes Obs., vol. IV, part I, Nov. 1917.

[2]) It is good to keep in mind that in the reviewed by me work of the Yerkes Observatory an angle at each interval of the scale of 1/4 mm of 2.66", i.e., 1 μ corresponds to an angle of 0.0106".

very daring to me; considering that pushes this judgment against a most simple and most solid building, in which the diverse (photometric, spectroscopic, statistical), facts observed in thousands of stars for the first time have found order and light; against a building that has scarcely arisen, the luck of the most brilliant confirmation in the discovery of a companion and the periodic motion of Mira's spectral lines Ceti had!

I close, not without another moment on this alleged Opportunity to undertake a quantitative review. She will, however only in a few cases, for stars with large parallax and after a long and complete line of dedicated employees observations can be made. The immense insecurity that in parallax measurements does not in fact disappear at those of speeds where until a few months ago excellent observer the presence of larger periodic Changes in the speed of Mira excluded, and even throws cast a shadow on the lightest and most immediate measurements: those the period of light change. In view of this passed until recently there were differences of opinion precisely in relation to that Stars S. Ant. and W. U. Ma [1]), on which Prof. Thirring draws so many supports.

Phys. Institute of the University of Palermo, April 1925.

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[1]) In the masterful work of Müller and Hartwig: History and Literature of the light changes, are found for the periods of these stars from the deviating values were recorded in the Lick catalogue.