

## Questions about the Speed of Light

by P. Lenard

from "Fragen der Lichtgeschwindigkeit" (1921)  
in *Astronomische Nachrichten*, **213**(5079), columns 303-308.  
(originally submitted 18 April 1921)

Translation: © R.R.Traill (2002, 2005):  
consult CAL: [info@copyright.com.au](mailto:info@copyright.com.au) — all rights reserved

---

### Translator's Preface

Criticism of *Relativity* is not new. It was thriving back in the 1920s, though naturally such early debate was largely forgotten after World War II. Philipp Lenard (1862-1947, a former student of Hertz) was one such critic. He had won the Physics Nobel-Prize in 1905 for his work on cathode rays, and of course that granted some prestige to his views. Against that "plus" however there were at least two serious "minuses" which must have diminished his chances within the relativity debate: Firstly, his writing style was extraordinarily convoluted (and there is some reason to suspect that this was deliberate, for some misguided reason). I have tried to remedy that problem within the present text.

Secondly he became an enthusiastic Nazi, espousing a "*proper German physics*" which ignored or indiscriminately belittled opposing views as "Jewish science". To say the least, such racist nonsense does not inspire confidence in Lenard's position. However, to judge scientific issues on such politics-based grounds would leave us partly playing the Nazis' own irrational and self-destructive game, which mindlessly tends to throw the baby out with the bathwater. — Instead it seems more helpful to judge such debates on their own scientific merits-and-failings, and not be distracted by poor presentation or distressing-but-irrelevant side-issues.

Clearly much of the 1920s relativity debate was in German, but there was also some in English which might now also be worth re-assessing belatedly. E.g. T.J.J. See published a series of five long papers on the subject, of which the third (See, 1921) is probably the most relevant.

Translator's comments are indicated in three ways, often in combination: •violet colour, •square brackets "[.]", and as footnotes which are marked alphabetically: •(<sup>A,B,C,...</sup>). Lenard's own footnotes are marked by "1,2,3,...".

For convenience, I have offered references both in their original location (footnote, or text) and also as an alphabetical list in the now-usual "epilogue" format. I have also added titles etc., where appropriate.

Lenard's excessively lengthy sentences and paragraphs have been subdivided, but the original 17 paragraphs are here labelled "[1...]" to "[17...]".

R.R.T. — Melbourne, May 2005

---

[1a] The *Astronomische Nachrichten* journal has taken a renewed interest in relativity theory, mostly in connection with certain pronouncements of this theory, whose investigation is partly an astronomical concern. However the main question must always be, whether the construction of the theory is from an empirical foundation which is faultless and sufficiently free from arbitrary caprice. One could also draw conclusions from falsely constructed theory — conclusions which seem valid within some limited context. Moreover with today's methods, one can have only a barely accurate test of the [logical] correctness of the conclusions; and the theory cannot support itself that way without a clear connection to the empirical foundations which is as direct as possible.

[1b] I would therefore like to communicate here briefly, the results of each unnecessary equivocation from investigations which shun mathematics — equivocation which I have previously imputed to the aether-related deliberations<sup>1</sup>. From this

we get a new theoretical model, which is also particularly fitting as a means for mastery over those earlier findings and phenomena, (especially those of an optical and electrical nature), whose hitherto incomprehensibility was a joint cause for the rise of relativity theory.

[Footnote 1:](#) See "[Über Äther und Materie](#)" Winter: Heidelberg, 2<sup>nd</sup> edition 1911; and "[Über Relativitätsprincip, Äther, Gravitation](#)" Hirzel: Leipzig, 3<sup>rd</sup> edition 1921.

[1c] Into this category comes e.g. the Michelson experiment, which in the simplest interpretation tells us that the Earth drags the aether along with it — while the aberration of light, also in its simplest interpretation, seems to indicate the contrary.

[1d] We most feasibly get rid of the average incomprehensibilities directly through observable facts, plus already established results of suitable concepts; and by that means we manage to quite do without "relativity" of space and time, and particularly do without the special trappings of relativity.

[1e] In any case, in this way we find some home truths about the "benefit" of this relativity theory — given that this "benefit" has hitherto been taken as a principal item of practical evidence in support of the theory (e.g. the speed of light as limiting velocity for cathode rays; mass as a function of velocity; and the inertia of energy). In fact we find that such "benefits of the theory" are *no benefits of the theory at all* — and also that they themselves do not tally with experience and cannot play a supportive role. Indeed we discover that it is only for want of sufficiently precise observation that we have hitherto retained them as "benefit and support".

[1f] Thus relativity, even Special<sup>2</sup> Relativity, is deprived of the physical basis on which it has hitherto depended, and one no longer needs to take it so seriously as hitherto when it could appear as the single attainable solution in the face of enigmas which set us against nature — and thus as the fully predestined route to further progress.

[Footnote 2:](#) That the *general* relativity in its basic conceptualization is inconsistent with everyday phenomena, and is not beyond objection in its thought-experiments, are points which I have thoroughly explained in the above-cited paper "[Über Relativitätsprincip, Äther, Gravitation](#)". Also cf. the remarks by *T. Wulf* in the AN 5084. [[Astronomische Nachrichten](#) 212(5084), 377-380.]

[1g] It was necessary to remark on this, to counter today's prejudice in this theory which has already become almost dominant. The criticism was needed in order to retrieve a freedom of perspective, without which probably the following account would hardly seem worthy of our attention.

[2] Our new-style solution, which I would like to discuss here<sup>3</sup>, leads likewise to questions of an astronomical nature. It uses the normal familiar notion of space and time; but makes special assumptions in connection with the space-filling medium which one has hitherto simply named as "*aether*". We assume the following, and come to the following results and questions.

[Footnote 3:](#) In particular there should be reference to the full account, due to appear next in the book-trade, and to a short summary containing all that is physically significant — in J.Stark's *Jahrbuch der Radioaktivität und Elektronik* [[see Epilogue References](#)] (in press under the title "Über Äther und Uräther"). In the present account, the astronomical perspective is given prominence.

[3] Each body — e.g. the Earth — has *its own local-aether*<sup>A</sup> which it carries along with itself, so that this local-aether (as a total mass, and sufficiently close to the body) is at rest relative to that body. The spatial density of the local-aether belonging to a body will diminish with increasing distance away from the body.

[Footnote A:](#) As we shall see, Lenard distinguishes two different types of aether, using the terms "*Äther*" and "*Uräther*" — but then leaving no separate term to cover both cases. In an attempt to rectify this mildly confusing point, it seems helpful to translate these terms as "*Local-aether*" and "*Cosmic-aether*" respectively — thus leaving the unqualified single word "aether" available to apply generally to either-or-both. (The German prefix "*Ur-*" usually implies something particularly ancient or fundamental or basic, and that fits in with Lenard's usage implying the situation throughout the most of space — here translated as "*cosmic*").

Regarding the various local aethers, Malmström (1917) also discussed such a notion. See translator's References-"epilogue", which also adds a reference to another relativity-critic: E.Gehrke (1918).

[4] The local aether is freely penetrable, (i.e. local-aether components from various bodies do not disturb each other).

[5] As well as the local-aether (here taken as heterogeneous, and distributed in space along with matter), there also exists a universally available *cosmic-aether*.

[6] Light emission consists of the ejection of *light quanta*<sup>4</sup>, of which each is an electromagnetic wave-train of specific energy content. We think of this wave-train as a structure consisting of aether, which before the quantum-ejection belonged to the light-emitting matter (e.g. the Sun), and endowed with a mass corresponding to its energy content<sup>5</sup>. The speed which the light quanta achieve through their emission, is the speed of light relative to the local-aether from which they come; i.e. to the local-aether of the light-source — and hence, for example, with the speed of sunlight relative to the Sun, or with earthly light-sources relative to the Earth.

Footnote 4: The postulate of the quantum-based constitution of light, introduced by Max Planck, has already been very widely verified.

Footnote 5: The mass (inertia) of the energy, and thus also the mass of the light-quanta as already remarked above, is quite out of agreement with the relativity theory. It follows then that one can also, quite without use of the theory, deduce a *bending of light by the Sun* (other than refraction in the Sun's atmosphere). One need only extend the assumption of mass-proportional gravitation so that it also includes light quanta (which naturally requires no sort of special theory at all). The path of the light-quanta would then be like a mass projected at the speed of light, and according to a calculation by Herr von Libotzky (*Physikalische Zeitschrift*, **22**, 69-(1921) [where his name is actually spelt "Lihotzky"; RRT] ), this tallies with the declarations of the "relativity theory" over light-bending by the Sun. If such bending of light rays does actually become proven, then it would be just as little a piece of evidence for relativity, as are the above-mentioned observations of the cathode rays — since all these solutions are only cultivated under a quite arbitrary and superfluous approach to the theory, and actually have nothing to do with it.

One will notice, that I have likewise not been able to agree to the usual assertion, that the relativity theory "at last explains" the mass-proportionality of gravity. This proportionality is just simply assumed by the theory (and thereby deprived of the overlooked scrutiny). However it is not beyond reproach when assessed against comprehensive fact-ensembles; yet it is this last which would most have worth as a scientific explanation.

[7] This initial speed of the light quanta does not however remain fixed for all time, but gradually re-adjusts into the speed of light relative to the cosmic aether whenever the light quantum is sufficiently far from the source of light. And so, for example, the speed of light from the fixed-stars, in free space it is no longer relative to the light-source, to the fixed star, but absolute instead. Therefore, at a sufficient distance from the star, its motions will no longer influence the speed of the light-quanta emitted from it — quanta which are now propagating on their own trajectory.

[8] Next, without any further additions, these assumptions make sense of the customary facts of aberration — since for the light coming here from outside, the cosmic-aether appropriates the role of the otherwise unpromising local-aether which moves with the Earth.

[9] Also moreover, there is no contradiction with the double-star observations.<sup>6</sup> Thus for each separate moving component of the double star, consider its local-aether with its effective range, and its alternating effect on the speed of light-quanta within that range. In any case, these distances are very small in comparison with the total distance from the star to the Earth.

Footnote 6: W. de Sitter (1913), *Koninklijke Akademie van Wetenschappen te Amsterdam: Proceedings of the Section of Sciences*, **15**(2), 1297-1298; P. Guthnick (1913), *Astronomische Nachrichten*, **195**, 265-270.

A train of thought contributed by W. Zuhellen (1914), ["The question of astronomic criteria for the constancy of 'c'" (in German)] *A.N.*, **198**, 1-10 would raise an objection to our

suggestion if the starlight consisted of coherent wave-trains of any wavelength. However that condition is not met. Instead, as far as is known, reality corresponds much more closely to our model of the light-quanta. And we have to conclude (in the sense of Herr Zurhellen's train of thought) that, shortly after it has been emitted, each separate light-quantum also then forms a wave-train of *uniform* velocity, even if the emitting atom was moving irregularly during the emission-time.

[10a] The optical and electrical trials which one has employed for perhaps-possible proof of the absolute motion of the Earth, and which have all produced negative results (e.g. the Michelson experiments), are now *a priori* expected to be nothing other than negative. In such cases they occur entirely in the Earth's local-aether, e.g. within the laboratory in which the light-source is also situated, and this local-aether goes along with the Earth. Hence all that could have been demonstrated in the tests was again only the relative motion of the Earth to the local-aether surrounding it.

[10b] It would be otherwise if one conducted the Michelson test *with light from the fixed stars* — something which, from our viewpoint, seems urgently required. Here a new question emerges. In this case the light-quanta of the fixed-stars have not arisen in the Earth's local-aether, but instead they come in from outside — from the cosmic-aether into the Earth's local-aether. Through carrying out the tests, one would experience how the light-quanta behave in those conditions — namely how far their velocity would be influenced by penetration into the Earth's local-aether.

[10c] By this account, the aberration gives information only to the extent that it indicates, (through their occurrence in the corresponding magnitude, of the usual calculation) that, whenever the light-quanta reach the local-aether in which they have not originated, they take up no velocity-components perpendicular to their own established direction.

[10d] If also they take up no velocity component in their own direction, they will then remain quite uninfluenced — what the simplest possibility would be. Then that must manifest itself through *positive* result of the Michelson experiment with fixed-star light. At the same time this experiment would then give the means for measuring the relative motion of the Earth with respect to the cosmic-aether, i.e. absolute motion.

[11] One may remark that in our interpretation, the question of finding the absolute motion is not excluded *a priori* — something already implied by the introduction of cosmic-aether.

[12a] Other means must also be attempted, to get at the question opened here. One of them has recently been discussed in this journal by Herr K.F.Bottlinger: It consists of the most practicable varied measurement of the speed of light, after O.Römer's method.<sup>7</sup> It must be taken as very useful, if the data over the transits of the Jupiter and Saturn satellites — designated by Herr Bottlinger as richly present — were to be critically studied from the viewpoints explained here.

[Footnote 7](#): K.F.Bottlinger (1920), ["On the possibility of an astronomical proof of the relativity principle" (in German)], *Astronomische Nachrichten*, **211**, 239-240. Incidentally, the thought of being able to ascertain such perhaps-absolute motion, turns out to be as already declared much earlier: (*Encyclopaedia Britannica*, article on "Ether") by J.C.Maxwell. [1879 edition, at least]

[12b] If this fails to produce any decision criteria over absolute motion, it could be that the Sun's light, within the planetary system, is perhaps still totally travelling within the local-aether of the Sun. So one would still in any case receive important information concerning the related questions of the velocity of light in its dependence or independence from the motions of the large masses, Sun and planets, in the vicinity of the light ray — in particular over the questions: •Up to what distance from the Sun is the velocity of its emitted light held relative to its own local-aether? And related to this: •What is the influence on light-speed of a foreign local-aether, into which light penetrates from outside (such as sunlight into the local-aether of a planet)?

[13a]<sup>B</sup> Going further, on observations: Established treatment of these questions will also have to lead us nearer to the deciding of the deeper question: •Whether our postulated cosmic-aether should be viewed as a medium whose collective mass is at rest. This is intimately connected to the question •whether absolute motion has a well-defined meaning, or whether [we would have to invoke the following considerations] using our model:

[Footnote B](#): For this paragraph [13], it has been necessary to translate rather more freely than elsewhere. Readers might therefore like ready access to the original, so I append it

herewith:-

*Eingehende, auf Beobachtungen gestützte Behandlung dieser Fragen wird der Entscheidung der tieferen Frage näher führen müssen; Ob der von uns eingeführte Uräther als ein in seiner Gesamtmasse ruhendes Medium anzusehen ist, was zusammenfällt mit der Frage, ob Absolutbewegung wohldefinierter Sinn hat, oder ob in denjenigene von materiellen Massen fernen Teilen des Himmelraumes, in welchem in unserer Vorstellung das Gemisch der einzelnen geringen Äthermengen vorhanden ist, die zu den einzelnen fernabliegenden Massen gehören, keine einheitliche, von den Bewegungen der nächstbenachbarten Massen unabhängige Licht-geschwindigkeit herrscht, in welchem Falle der Uräther nicht als in seiner Gesamtmasse ruhend anzusehen wäre, was zusammenfiel mit dem Nachweis tatsächlicher Sinnlosigkeit der Frage nach Absolutgeschwindigkeiten.*

[13b] Consider those parts of space, remote from material masses, but where there is at hand the cumulative effect of the individual trace-quantities of local-aether.<sup>C</sup> These traces belonging to the far-away masses, do not control any centralized-uniform light velocity independently of the motions of the next nearest masses. In that case the cosmic-aether would not be seen as at rest in its collective mass. What would collapse with the proof would be the real absurdity of the question as to absolute velocity.

Footnote C: Such local aether is only local to those remote sites, even though it may also have some effect elsewhere. According to Lenard's theory it is at those remote sites that it has its anchor-reference and most of its potential effect. With increasing distance, such effects would individually fade away towards zero; and at remote sites, the effect of any individual source would presumably be negligible if taken alone. Here however we are contemplating the cumulative effect of vast numbers of such influences. [RRT]

[14a] I thought to make astronomy aware that it should direct attention to the here-presented important questions — to the feasibility of their answer, and to models which can lead pertinent deliberation.

[14b] The relativity theory is not appropriate here; it diverts our attention from the happenings in space, in that it deprives us of these happenings themselves and of the time of the activity. Also they do that on ground of totally false positive experience-support, and so in quite capricious (and thus perhaps on seemingly mathematically confirmed) paths into the error-leading path.

[14c] On the question about the velocity of light, this theory proclaims the answer, that one would find this velocity as taking the vacuum as its medium for steady constancy. Likewise it proclaims not only how, but also where and under what circumstances might one measure this velocity. However this answer teaches (assuming it is correct) nothing directly useful, because along with the measurements, "Lorentz-contraction of length" and "Einstein-dilation of time" also creep in, which in their turn surely depend on the movements of masses; and that all makes the measuring-rods and clocks — fundamentals of each velocity-measurement — relatively worthless.

[15a] Consider the attempts, hitherto conducted in Earthly domains, to discover the influence on the velocity of light through the motion of material masses (the "optical drag" tests). Through our assumptions about local and cosmic aethers, these drag-findings become quantitatively understandable — altogether excellently and in the simplest way.

[15b] Thus: The negative aether-drag experiments of O.Lodge<sup>D</sup>, the positive results of Fizeau<sup>E</sup>, Zeeman<sup>F</sup> and the just as positive experiments of Sagnac<sup>G</sup> and Harress<sup>H</sup>, overall very diverse evidence — our account-confirming tests. On the other hand these experiments give no support to the occurrence of the "Lorentz-Contraction" ingredient of the relativity theory.

Footnote D: O.Lodge (1897-Mar). "Experiments on the absence of mechanical connexion between ether and matter". *Transactions of the Royal Society (A)*, **189**, 149-166.

Footnote E: H.Fizeau (1859-Dec) *Annales de Chimie et de Physique*. — English translation which also includes an editorial account of a second experiment: (1860). "On the effect of the motion of a body upon the velocity with which it is traversed by light". *Philosophical Magazine (4)*, **19**, 245-260.

Footnote F: P. Zeeman (1915?) — [mystery reference, suggestions welcome!]



Footnote G: M.G.Sagnac (1914). "Effet tourbillonnaire optique. La circulation de l'éther lumineux dans un interférographe tournant". *Journal de Physique* (5), 4, 177-195.

Footnote H: Harress's experiments date from 1911. The accounts were given posthumously:  
O.Knopf (1920). "Die Versuche von F.Harreß über die Geschwindigkeit des Lichtes in bewegten Körpern" *Annalen der Physik* (4), 62, 389-447.  
M von Laue (1920). "Zum Versuch von F.Harreß". *Annalen der Physik* (4), 62, 448-463

[16a] Quite independently of that theory and from the notion of local-and-cosmic aethers, one can accept the questions of light-velocity in the simplest interpretation of the following: The Michelson test shows that, for light-sources on the Earth within Earthly space, it is light-velocity relative to the Earth which applies. Likewise probably the velocity which applies to the light of the Sun is relative to it; and so too for the light of other fixed stars within their own vicinity.

[16b] The double-star observations show further that, for by far the greatest part of the journey from these stars to us, a uniform light-velocity rules independently of the alternating motions of the star-components. That means that it is to be assumed that the light-velocity (initially in the vicinity of the star and reckoned relative to it) would, at a sufficient distance, change over into absolute light-velocity.

[16c] In short, aberration teaches us that the starlight, whenever it reaches the Earth, will not thereby take on any transverse velocity components from the Earth's motion. This leaves open the question: whether the starlight coming to the Earth takes on an axial velocity component from the Earth's velocity; and so whether perhaps the velocity of this light in the vicinity of the Earth may then be reckoned just as relative to this terrestrial frame as with light from Earthly sources. And this question would need to be answered through performing the Michelson test with fixed-star light.

[16d] Moreover there is also an open question about the distance-law for the changing-over from relative to absolute light-velocity. Or taking a wider view, it is the general question about the lawfulness of the change-over of the light-velocities, obviously occurring on sufficiently great light-paths. And all these questions are to be answered only through systematic work to procure observations concerning light-events within deep space, aberration, astronomical transits and other light-signal observations in space.

[17] When our experience in all these matters has been sufficiently expounded, then the questions of the local-and-cosmic aethers will also be ripe for new decisions; and then, better than now, one will be able to see how a mathematical theory of light's dissemination through space — universal electrodynamics of moving bodies — might be set up.

*P. Lenard* — Radiolog. Institut Heidelberg, 1921 April 18.

---

## REFERENCES

### (Translator's "Epilogue")

{...} = location of reference within text

•• = added references of likely interest

*Fizeau, H. (1859-Dec) Annales de Chimie et de Physique; — and English translation which also includes an editorial account of a second experiment: (1860-Apr). "On the effect of the motion of a body upon the velocity with which it is traversed by light". Philosophical Magazine (4), 19, 245-260. [Originally presented to the Parisian Academy of Sciences, 29 Sep 1851]{from E:\**

*Maxwell, J.C. (1879) "Ether", Encyclopaedia Britannica. {from 7:\**

*Lodge, O. (1897-Mar). "Experiments on the absence of mechanical connexion between ether and matter". Transactions of the Royal Society (A), 189, 149-166. {from D:\**

*Lenard, P. (1911: 2<sup>nd</sup> edition) "Über Äther und Materie" Winter: Heidelberg. {from 1:\**

*de Sitter, W. (1913), "A proof of the constancy of the velocity of light" Koninklijke Akademie van*

*Wetenschappen te Amsterdam: Proceedings of the Section of Sciences*, **15**(2), 1297-1298. {from 6:.\*}

Guthnick, P. (1913), "Astronomische Kriterien für die Unabhängigkeit der Fortpflanzungsgeschwindigkeit des Lichtes von Bewegung der Lichtwelle", *Astronomische Nachrichten*, **195**, 265-270. {from 5:.\*}

Sagnac, M.G. (1914). "Effet tourbillonnaire optique. La circulation de l'éther lumineux dans un interférographe tournant". *Journal de Physique* (5), **4**, 177-195. {from G:.\*}

Zurhellen, W. (1914), "Zur Frage der astronomische Kriterien für die Konstanz der Lichtgeschwindigkeit", *Astronomische Nachrichten*, **198**, 1-10. {from 6:.\*}

Zeeman, P. (1915?) {from F:.\* — details missing. Suggestions welcome}

Malmström, R. (1917). "On the theory of electrodynamics" *Physikalische Zeitschrift*, **18**, 454-456. {from A:.\*}\*

Gehrke, E. (1918). "Über den Äther" *Verhandlungen der Deutschen Physiker Gesellschaft*, **20**, 165-169. {from A:.\*}\*\* — [I am preparing an English translation of this paper. RRT].

Bottlinger, K.F. (1920), "Über eine astronomische Prüfungsmöglichkeit des Relativitätsprinzips", *Astronomische Nachrichten*, **211**, col.239-240. {from 7:.\*}

Knopf, O. (1920). "Die Versuche von F.Harreß über die Geschwindigkeit des Lichtes in bewegten Körpern" *Annalen der Physik* (4), **62**, 389-447. {from H:.\*}

Laue, M. von (1920). "Zum Versuch von F.Harreß". *Annalen der Physik* (4), **62**, 448-463. {from H:.\*}

Lenard, P. (1921)<sup>J</sup> "Über Äther und Uräther", *Jahrbuch der Radioaktivität und Elektronik*, **17**, 307-356. — [A longer explication of the topic discussed here] — {from 3:.\* — "in press"}.

Lenard, P. (1921: 3<sup>rd</sup> edition) "Über Relativitätsprincip, Äther, Gravitation" Hirzel: {from 1:.\*}

See, T.J.J. (1921-Jan) "New Theory of the Aether (Third Paper)". *Astronomische Nachrichten*, **212**(5079), col.233-304. {from Translator's Preface}\*\*

Lihotzky, E. (1921-Feb) "Zur Frage der Verschiebung der scheinbaren Fixsternorte in Sonnennähe" *Physikalische Zeitschrift*, **22**, 69-71. {from 5:.\*}

Wulf, T. (1921) "Tatsachen zur allgemeinen Relativitätstheorie", *Astronomische Nachrichten*, **212**(5084), col.377-380. {from 2:.\*}

**Footnote J:** In the heading above this other 1921 Lenard paper, the year is given as "1920". This is evidently a printers' error as (amongst other things) the paper itself was submitted "6. April 1921" (see its last page).