Home | Up one level | Previous | Next

A Shade Tree Physics *on-line* reprint of an article originally published in *Physics Essays* (1990) 3, 371-374. Used with permission.

This material is based on an article titled :
Zum gegenwärtigen Stand des Strahlungsproblems
(On the Current State of the Radiation Problem)
by
Walter Ritz and Albert Einstein
in
Physikalische Zeitschrift, 10, 323-324 (1909).

Latest update, 22 Sep 2017.
Changes/additions are in bold.

The Ritz-Einstein Agreement to Disagree

Robert S. Fritzius

Abstract

During 1908 and 1909 Ritz and Einstein battled over what we now call the time arrows of electrodynamics and entropy. Ritz argued that electrodynamic irreversibility was one of the roots of the second law of thermodynamics, while Einstein defended Maxwell-Lorentz electromagnetic time symmetry. Microscopic reversibility remains a cornerstone of our current paradigm, yet we are finding more and more evidence that experimentally discerned time arrows are asymmetrical and that they all point from past to future. This paper furnishes some comments about events leading up to the Ritz-Einstein confrontation, some subsequent developments, and an English translation of their agreement to disagree. A side by side comparison of two recent summaries of their battle communiques is included to provide an overview of what they had to say about this current issue.

Key words: arrow of time, reversibility, electrodynamics, entropy, emission theory, elementary actions, ultraviolet catastrophe

1. INTRODUCTION

Maxwell built his electromagnetic field theory on ideas derived from classical mechanics, which was considered to be time reversible, but Poincaré, mentor to Swiss physicist Walther Ritz, observed that "...treatises on mechanics do not clearly distinguish between what is experiment, what is mathematical reasoning, what is convention, and what is hypothesis."(1)

This paper is written from the viewpoint that microscopic time symmetry is an *unproven* convention that is still accepted as established fact and that we might find it beneficial to look under some old stones, one of which seems to have been buried.

In 1908 Ritz, who is well known for his work in spectral physics (the Rayleigh-Ritz perturbation theory and the Ritz combination principle) and his still widely referenced works on the mechanical vibrations of plates, produced a monumental, but not nearly as well known, criticism of electromagnetic field theory.(2a) Even though Ritz acknowledged that the Maxwell-Lorentz equations are elegant and are here to stay, his blockbuster conclusion (which was based, largely, on the inseparable ties of electromagnetic field theory to the discredited *solid* ether continuum), was this: "The partial differential equations and the notion of ether are fundamentally inappropriate to express the comprehensive laws for the propagation of electrodynamic interactions." (2b)

Ritz then enunciated his own *preliminary* time-asymmetric emission theory of electrodynamics (Part II of his work). He hypothesized that charged bodies continuously emit fluxes of fictitious particles, which travel at the speed of light with respect to their emission sources. These emission particles constituted a kinetic electrodynamic intermediate for retarded elementary interactions. He did not address absorption or scattering of his emission particles by other charged bodies, or even specify if he considered there to be more than one type of them, but he did indicate the need to account for their interactions with ponderable matter. For example, he admitted that this preliminary hypothesis was *not* compatible with Fizeau's experiment on the entrainment of electromagnetic waves.(2c) According to Ritz, the Coulomb field is not a static state of space, but rather a kinetic particulate process, taking place in an otherwise empty space that has no properties of its own. His coulomb "interaction" could be characterized as a revised form of the vector potential.

The incompatibility of Ritz's theory with the *entrainment* of waves was probably due to Ritz's strict observance of the superposition principle (a problem which he intended to remedy). The bottom line to superposition seems to be *action without reaction.* My personal conviction is that our adherence to the superposition principle, in electrodynamics, is what prevents the merger of gravitation and electrodynamics. The idea that charges can exert limitless coulomb forces on remote charges (where the field's flux of virtual photons is not thinned out by interactions with intervening charges) is what creates the need for gravity, as a different kind of interaction, with different kinds of particles (gravitons) to balance the books.

Ritz does have his present-day proponents but his theory is outside the vale of the geometrodynamic paradigm and is not always accurately represented

371

in the English speaking world. This is due, in part, to his works being generally inaccessible in English. For example, Waldron keeps the fire going, but his one-time claim that if you have a high enough potential, particles can be accelerated to any speed(3) is not compatible with Ritz's theory. Ritz hypothesized that electrodynamic accelerating influences approach zero, rather than masses increasing to infinity, as bodies approach the speed of light with respect to any given accelerator. (2d) Waldron acknowledges (in private correspondence) that his "unlimited speed" proposition is his own and not Ritz's.

In Ritz's day Einstein was a staunch defender of the time symmetry of the space-time continuum. Indeed he should have been. In 1921 he stated, "The space-time theory and the kinetics of the special theory of relativity were modelled on the Maxwell-Lorentz theory of the electromagnetic field.(4)

The world of science has become polarized on the speed of light issue, and the dividing line has been Einstein versus Ritz. Ritz's theory held to Galilean relativity, i.e., $c + v$ for electrodynamic processes, including optics, whereas Einstein assumed the velocity of light is independent of the motion of the source.

In 1963 Fox added Tolman's *extinction theorem* to Ritz's electrodynamic theory. (Charges in a transparent medium absorb and reradiate transient oscillatory electromagnetic energy. The secondary radiation travels at the speed of light with respect to the medium. The incident energy becomes absorbed and extinguished in the process.) Fox reckons one extinction length , i.e., the distance into a medium for the incident energy to be attenuated to $1/e$ times its original amplitude, at sea level conditions in the Earth's atmosphere, is 0.2 cm. In interstellar space, removed from regions of appreciable stellar gases as in that surrounding binary stars, it is calculated to be one light-year. By making this adjustment to Ritz's theory (which is a superposition principle fix), Fox claims to have invalidated the majority, if not all, of the speed-of-light experiments (including binary star observations) that have been conducted to help us choose between Ritz and Einstein. Based on the long lifetimes of fast muons (which are taken as evidence for time dilation) and the speed-of-light gamma rays from rapidly moving sources, Fox gave a decision in favor of Einstein, but did so in a manner that seems to suggest that the final verdict is not in.(5a) In private correspondence Fox says:

...it is of interest for the general philosophy of science that Ritz's theory, so different in structure from that of Maxwell, Lorentz and Einstein, could come so close to describing correctly the vast quantity of phenomena described today by relativistic electromagnetic theory.(6)

2. THE LORD GIVETH, THE LORD TAKETH AWAY

It may be ironic that Eddington played such a central role in the solar eclipse expeditions of 1919, the results of which brought world acclaim to Einstein's general theory of relativity. Eddington was also the first to coin the phrase "time arrow"(7) and is known as the father of the time arrow concept. Actually, he popularized Helmholtz's earlier ideas about monotonically increasing entropy in a universe that was considered to be microscopically reversible.

According to Roger Penrose, we now have up to seven perceivable, or deducible, *arrows of time,* all asymmetrical, and all pointing from past to future.(8) Arrow No. 2 on Penrose's list is none other that Ritz's restriction to retarded electrodynamic actions. Cramer(9) ponders which comes first, the electromagnetic arrow or the entropy arrow, which is No. 7 on Penrose's list. According to Ritz, the electromagnetic arrow has priority. He has a finite (flat space) universe in which electrodynamic emissions escape at the periphery, so that the universe has to be running down.

Top

3. THE WAR

During 1908 and 1909 Ritz and Einstein had a war that started over the failure of Maxwell-Lorentz electromagnetic theory to handle blackbody radiation, i.e., the ultraviolet catastrophe.(10),(11) Ritz took to the offensive, arguing from his 1908 theory, which he claimed allowed us to hold on to our hard-won ideas about space and time, while Einstein defended the new ideas that eventually overthrew classical physics and banished physical intuition in the relativistic arena. Ritz claimed in the third paper of the series,(12) that by mathematically reversing the direction of time, i.e., by switching to the advanced potential, you actually invoke a different kind of physical process and do not simply arrive at the equivalent of the retarded potential acting in reverse

time sequence. The same argument, in quantum mechanical notation, has been recently revoiced by Leiter.(13)

Ritz and Einstein's final written communication in this battle was a joint paper (14) that has the appearance of having been forced upon them by the editorial staff of *Physikalische Zeitschrift*. The paper is their *agreement to disagree*.

The appendix to the present paper is a translation of the Ritz-Einstein paper so English-speaking readers can study a unique memento from a critical turning point in the world of science. One point of ambiguity in the paper needs comment. It is not clear, based on the terse German text, to which case Einstein is saying one can restrict oneself. It appears to be either: using both retarded and advanced potentials on equal footing or restricting our considerations to electromagnetic processes confined to a finite space. My sketchy peek at the earlier papers (through a translator) favors the first case.

372

The series of exchanges, including this paper, has been summarized by Fox(5b) and Lanczos.(15) Table 1 shows, side by side, their thumbnail abstracts of the series. Note that [...] Lanczos curiously misrepresents the import of the joint paper. He has Einstein apparently admitting that he had been wrong to defend the use of advanced potentials. Actually, although neither author admitted any mistake, many present-day authors are expressing the idea that the *viewpoint* that Einstein defended is becoming untenable.(13), (16) - (22)

Table 1: Ritz-Einstein Exchanges of the Ultraviolet Catastrophe

J.G. Fox	*C. Lanzcos*
	Phys. Z. 9, 903 (1908)
Ritz claimed that the ultraviolet catastrophe in the classical Rayleigh-Jeans law had as its fundamental reason the implicit and improper use of advanced potentials.	Ritz argued that the solution of the wave equation in terms of the retarded (versus advanced) potential established a genuine difference between past and future and may be the real source of the irreversibility of the radiation phenomenoa and the second law of thermodynamics.
	Phys. Z. 10, 185 (1909)
Einstein disagreed.	Einstein maintains that instead of solving the wave equation in terms of intial state, one can, in principle, equally as well use the end state and operate with the help of the advanced potential.
	Phys. Z. 10, 224 (1909)
Ritz replied.	Ritz took strong exception to this view.
	Phys. Z. 10, 323 (1909)
and the series ended with the appearance of a brief, joint publication in which each stated his position.	and Einstein admitted his mistake.

4. SECOND THOUGHTS?

Einstein, in later years, may have had second thoughts about irreversiblity, but because of his revered position with respect to the geometrodynamic paradigm was probably prevented from expressing them publicly. We do have three glimpses into his private leanings on the subject. In 1941 he called Wheeler and Feynman's attention to Ritz's (1908) and Tetrode's (1921) time asymmetric electrodynamic theories. [This was while Wheeler and Feynman were laying the groundwork for their less than successful (1945) time-symmetric *absorber theory*, (23) which was really *emission*/absorber theory, with a lot of help from the future. They could not embrace time asymmetry, but Gill(24) now proposes to revitalize absorber theory by creating a generalized version *without* advanced interactions.] Two pieces of Einstein's private correspondence touch indirectly on the subject of time asymmetry.(25) In these letters Einstein expresses his growing doubts about the validity of the field theory space continuum hypothesis and all that goes with it.

Since time symmetry is intimately tied to the space continuum, if the latter falls, the former may well follow. Lanczos's slip of the pen may be accidental but, nevertheless, could be indicative of Einstein's feelings on this subject in his final years.

5. CONCLUSIONS

Except for the growing consensus about the asymmetry of the arrows of time, we might have concluded that the battle between Ritz and Einstein was a moot point and should be forgotten. The current paradigm says that Einstein prevailed, but many of us never heard of the battle, nor of Ritz's electrodynamics. If an earlier court gave the decision to Einstein, it did so by default. Ritz, at age 31, died 7 July 1909, two months after the joint paper was published.

The world of science of Ritz's day seems to have been so grateful to Maxwell, Lorentz and Hertz for rescuing it from the clutches of instantaneous action-at-a-distance (through empty space) that it couldn't bring itself to entertain any hypothesis that sounded even remotely like the "old" action-at-a-distance. Thus Ritz's electrodynamic theory was bundled up and tucked away after a short but respectful period following his death.

If science cannot prove the existence of a microscopic symmetrical time arrow (Heisenberg's uncertainty principle says we cannot do it), then we may eventually find ourselves using more and more of Ritz's conceptions and giving credit where credit is due. As a minimum, Ritz's (1908) criticism of electromagnetic field theory needs to be subjected to a modern reevaluation.

Acknowledgement

My thanks to Bryan G. Wallace of St. Petersburg, Florida, for calling my attention to the Einstein letters in Pais's book, *Subtle is the Lord ...* [*The Science and **the** Life of Albert Einstein*]

APPENDIX: ENGLISH TRANSLATION OF AGREEMENT TO DISAGREE(14)

In order to clarify the difference in opinion that has arisen in our separate publications ([26]) we present the following.

In the special cases in which an electromagnetic process *stays confined in a finite space*, it is possible to represent the process not only in the form

$$f = f_1 = \frac{1}{4\pi}\int\frac{\varphi(x', y', z', t - r/c)}{r}dx'dy'dz'$$

but likewise in the form

$$f = f_2 = \frac{1}{4\pi}\int\frac{\varphi(x', y', z', t + r/c)}{r}dx'dy'dz'$$

and in other forms.

While Einstein believes it to be possible to restrict oneself to this case [both forms] without *essentially* limiting the generality of the consideration, Ritz considers this restriction as *in principle* not allowed. If one takes the position that experience compels the representation with aid of the retarded potential as the only possibility to consider, and supposing one is inclined to the view that the fact of irreversibility of the radiation process is already in the basic laws, its expression has to be found. Ritz considers the restriction to the form of the retarded potential as one of the roots of the second law [of thermodynamics] while Einstein believes that irreversibility depends exclusively upon reasons of probability.

Zurich, April 1909

Received on 10 August 1989.

373

Résumé

En 1908 et 1909 Ritz et Einstein se querellaient sure ce que nous appelons maintenant les flèches de temps d'électrodynamique et

entropie. Ritz soutenait que l'rréresibilitié électrodynamique était à la racine de la deuxième loi de la thermodynamique tandis qu'Einstein defendait la symmetrie de temps de l'électromagnetisme de Maxwell-Lorentz. La microréversibilité demeure un fondement de notre paradigme courant, toutefois nous trouvons de plus en plus des preuves que les flèches de temps mises en évidence expérimentalement sont asymmetriques et toujours du passé vers le futur. Cet article fournit quelques commentaires sure les évenements qui menèrent à la querelle susdite, quelques développements ultérieures et une traduction en anglais de leur accord sur le désaccord. Une comparaison directe de deux sommaires récents de leur bulletins de bataille est inclus afin que le lecteur puisse avoir un aperçu de ce qu'ils avaient à dire à ce sujet toujours actuel.

References

1. H. Poincaré, *Science and Hypothesis* (1905) (Dover, 1952) p. 89.
2. (a) W. Ritz, Ann. Chim. Phys. 13, 145 (1908). [For an English translation of Part I of this paper, see W. Ritz, *Critical Researches on General Electrodynamics, Introduction and First part* (R.S. Fritzius, Starkville, MS 1980)] (b) *ibid*. 172; (c) *ibid*. 151; (d) *ibid*. 194.
3. R.A. Waldron, Spec. Sci. Tech. 3, 399 (1980).
4. A. Einstein, *Sidelights on Relativity*, G.B. Jeffery and W. Perrett, translators (Methuen & Co., London, 1922). p. 11.
5. (a) J.G. Fox, Am J. Phys. 33, 1, 16 (1965); (b) *ibid.* 3.
6. *Idem*, private correspondence.
7. A.S. Eddington, *The Nature of the Physical World* (MacMillan, NY, Cambridge, 1929), p.68.
8. T. Rothman, Discover 1987 (Feb) 62.
9. J.G. Cramer, Found. Phys. 18, 1205 (1988).
10. H.A. Lorentz, Phys. Z. 9, 562 (1908).
11. J.H. Jeans, *ibid*. 853.
12. W. Ritz, *ibid*. 10, 224 (1909).
13. D. Leiter, Found. Phys. 14, 857 (1983).
14. W. Ritz and A. Einstein, Phys. Z. 10, 323 (1909).
15. C. Lanczos, *The Einstein Decade* (1905-1915) Academic, NY, London, 1974) p. 161.
16. B. Gal-Or, Found. Phys. 5, 50 (1977).
17. D. Leiter, Nuovo Cimento 44, 665 (1985).
18. L.D. Landau and E.M. Lifshitz, *Statistical Physics* (Addison-Wesley, Reading, MA, 1969), pp. 13, 29.
19. T. Futamase and T. Matsuda, Nuovo Cimento B 100, 277 (1987).
20. E. Joos, J. Non-Equilibrium Thermodyn. 12, 27 (1987).
21. W. Schommers, Int. J. Mod. Phys. B (Singapore) 3, 1 (1989).
22. D. Leiter, Nucl. Phys. B. Proc. Suppl. 6, 337 (1989).
23. 23. J.A. Wheeler and R.P. Feynman, Rev. Mod. Phys. 17, 157 (1945).
24. T.L. Gill, Hadronic J. 7, 1224 (1984).
25. A. Pais, *Subtle is the Lord ... The Science and **the** Life of Albert Einstein*, Oxford, 1982), p.467.
26. W. Ritz, Phys. Z. 9, 903 (1908); A. Einstein, *ibid*. 10, 185 (1909).

Robert S. Fritzius

305 Hillside Drive
Starkville, Mississippi 39759 U.S.A.

Links to related articles:

Kevin Brown, Advanced and Retarded Potential - Math Pages: Physics

John D. Norton, Einstein's Investigations of Galilean Covariant Electrodynamics prior to 1905 [PDF]

J.G. Cramer, The Arrow of Electromagnetic Time and Generalized Absorber Theory -

Walter Ritz, Das Prinzip der Relativität in der Optik, (Antrittsrede zur Habilitation am 5. Mai 1908) Entnommen aus dem Buch: *Theorien über Äther, Gravitation, Relativität und Elektrodynamik* - Herausgegeben und mit einem Nachwort versehen von Dr. Karl Dürr, Schritt-Verlag, Bern und Badisch-Rheinfelden 2. Auflg. (1965), S. 5 - 14. Courtesy, Ekkehard-Friebe

Mathias Frisch, Wolfgang Pietsch, Reassessing the Ritz-Einstein debate on the radiation asymmetry in classical electrodynamics, *Studies in History and Philosophy of Science - Part B: Studies in History and Philosophy of Modern Physics.* 55, 13-23, (2016). [Added 19 Sep 2017.]

Send comments/enquiries to Robert Fritzius at
fritzius@bellsouth.net
Home | Up one level | Previous | Next
00953159
Top