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titled :

Zum gegenwärtigen Stand des
Strahlungsproblems
(On the Current State of the
Radiation Problem)

by

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The Ritz-Einstein Agreement to Disagree

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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 vane of the geometrodynamics paradigm and is not always accurately represented

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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 the 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 than 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.

Table 1: Ritz-Einstein Exchanges on the Ultraviolet Catastrophe

J.G. Fox

C. Lanczos

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 phenomena and the second law of thermodynamics.

Phyz. Z. 10, 185 (1909)

Einstein disagreed,

Einstein maintains that instead of solving the wave equation in terms of initial state, one can, in principle, equally as well use the end state and operate with the help of the advanced potential.

Ritz replied
Phys. Z. 10, 224 (1909)
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 opinion.
and Einstein admitted his mistake.

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