Experimental Verification of the Relationship between Diffusion Constant and Mobility of Electrons and Holes

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The relationship between diffusion constant and mobility, called the Einstein relationship, has been experimentally verified for electrons and holes in germanium. This has been accomplished by measuring the rate of increase in half concentration width of a pulse of minority carriers moving in an electric field.

According to theory, the ratio of the diffusion constant $D$ to the mobility $\mu$ of charged particles is

$$D/\mu = kT/q,$$

where $T$ is the absolute temperature, $k$ the Boltzmann constant, and $q$ is the magnitude of the charge.$^1$


Gravitation and Electrodynamics

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In this paper Einstein's unified field theory is modified, and some of the physical implications of the new theory are examined. It entails: (1) a restriction of 4-current distribution, (2) an electromagnetic field consisting of short- and long-range parts, (3) a finite self-energy for the electron, (4) a classical description of pair production and annihilation as discussed by Feynman in his electrodynamics, (5) the Lorentz-force law for a charged particle moving in an external electromagnetic field, (6) the bending of light grazing the surface of the sun—the same as given by the general theory of relativity.

1. INTRODUCTION

The arguments for the necessity of a unified field theory are well known, and therefore they will not be elaborated at length. The author believes that a correct and unified quantum theory of fields, without the need of the so-called renormalization of some physical constants, can be reached only through a complete classical field theory that does not exclude gravitational phenomena. It is true that one cannot feel very optimistic about the quantization of a non-linear classical field theory. But one hopes that this difficulty may be overcome, partly, by starting the quantization procedure with a Lagrangian formulation of the quantum field theory.

In this paper we propose a new version of Einstein's latest unified field theory.1 The reasons for this modification will be made clear in the following. The same formalism and notation of Einstein's theory are used. The total field is described by a Hermitian tensor $g_{αβ}$ given as

$$g_{αβ} = a_{αβ} + i ϕ_{αβ},$$

where $a_{αβ} = g_{αβ}$ and $ϕ_{αβ} = g_{αβ}$, $i = (-1)^{i}$, so that we have

$$(g_{αβ})^{i} = (g_{αβ}).$$

The dagger ($†$) stands for Hermitian conjugate operation. We also have the general affine connection $Γ^γ_{αβ}$ given by

$$Γ^γ_{αβ} = Γ^γ_{βα} + iΓ^γ_{αβ}.$$  (1.3)

The Hermitian property of $Γ^γ_{αβ}$ in the covariant indices $α$ and $β$ is obvious.

Now, if we define $a^{αβ}$ as the normalized minors of $Det a_{αβ} = a$, then we have

$$a_{αβ}a^{γε} = δ_{α}^{γ}.$$  (1.4)

The determinant of $g_{αβ}$, because of (1.2), is real and can be expressed as

$$g = a(1 - Ω - Λ^{2}),$$

where

$$Ω = \frac{1}{4} ϕ_{μν}ϕ^{μν}$$

is an invariant,

$$Λ = \frac{1}{4} f^{αεν}ϕ_{αεν}$$

is a pseudoscalar,

and

$$f^{αεν} = \frac{1}{2(- a)^{3}} e^{ενσμ}ϕ_{σμ},$$

where $e^{ενσμ}$ is zero whenever any two indices are equal and is ±1 for even and odd permutations. All indices are raised by $g_{αβ}$.

We also have the contravariant tensor $g^{αβ}$ given by

$$g^{αβ}g^{γε} = δ_{α}^{γ}.$$