A Reply to V.V. Dvoeglazov

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It is proved that Dvoeglazov's attempt to rectify Evans' $\mathbf{B}^{(3)}$ longitudinal phaseless magnetic field theory is erroneous.

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In recent years, M. W. Evans claimed time and again that a circularly polarized electromagnetic radiation is characterized, besides the transverse, phase dependent fields, by a real, phaseless longitudinal magnetic field. A long but incomplete list of Evans' publications on this topic can be found in [1]. The fundamental expression of Evans' theory states

$$\mathbf{B}^{(1)} \times \mathbf{B}^{(2)} = iB^{(0)}\mathbf{B}^{(3)*} \tag{1}$$

where $\mathbf{B}^{(1)}$and $\mathbf{B}^{(2)}$ are the ordinary complex transverse magnetic field and its complex conjugate, respectively and $\mathbf{B}^{(3)}$ is a longitudinal phaseless magnetic field. The meaning of $B^{(0)}$ is discussed below.

Evans' theory has raised objections[1-9]. Attempts to rectify Evans' theory have been carried out recently by V. V. Dvoeglazov[10,11]. The present Reply proves that these attempts fail because they are based on erroneous arguments.

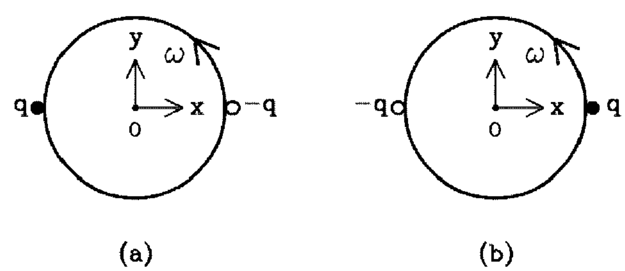

Fig. 1. - A disk whose radius $r = 1$ rotates in the (x,y) plane around its center O. Two charges $\pm q$ are attached to two antipodal points on its circumference.
(A) The system at time T.
(B) The system at time $T + \pi/\omega$ *and* the system obtained from the operation of $\hat{C}$ on the state depicted in (A). (This figure was originally published in [3]).

The device described in Fig. 1 is analyzed in [1]. The radiation at a point on the z-axis is circularly polarized. The integral illustrated in fig. 2 is used as a counterexample. It is proved in [1] that Evans' longitudinal magnetic field of circularly polarized electromagnetic radiation $\mathbf{B}^{(3)}$ does not satisfy the Maxwell equation in the vacuum $\nabla \times \mathbf{B} = \partial \mathbf{E}/\partial t$. Hence, it is claimed there that Evans' $\mathbf{B}^{(3)}$ is not a magnetic field.

One of Dvoeglazov's arguments suggests a modification of Evans' theory. This modification states that *linearly* polarized radiation has, like the circular one, a longitudinal magnetic field (see [11], few lines after (3), the text that starts with the statement "I agree"). Dvoeglazov also assumes that the *strength* of $\mathbf{B}^{(3)}$ at a point on the *z*-axis is the same as that which is found at a corresponding point on the *x*-axis. This argument, which obviously lacks a physical basis (note, for example, that the radiation intensity at a point on the *z*-axis is twice as strong as that which is found at a corresponding point on the *x*-axis), does not remove the contradictions from Evans' theory which are demonstrated in [1]. Indeed, for the purpose of the discussion, let us assume the existence of Dvoeglazov's field at a point on the *x*-axis and examine a modification of the experiment described in [1]. In the modified experiment, the charges rotate in the opposite direction. It follows that, in the modified experiment, the circular polarization of the radiation seen at a point on the z-axis takes the opposite sign with respect to that of the original experiment. It follows that, in the present case, Evans' longitudinal field at points on the *z*-axis must also change sign. On the other hand Dvoeglazov's field remains as before, because the linear polarization at points on the *x*-axis is the same as before. It follows that, if Dvoeglazov's field yields a null integral in the original experiment, then, in the present case, the integral is twice as large and the contradictions of Evans' theory hold.

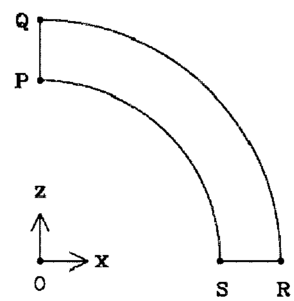

Fig. 2. - The integral $\int \mathbf{B} \cdot d\mathbf{l}$ is evaluated along the closed path *PQRSP*. (This figure was originally published in [1]).

In [10] and [11], Dvoeglazov attempts to restore covariance of Evans' fundamental relation (1). This attempt is based on a definitions of $B^{(0)}$ and $\mathbf{B}^{(3)}$ as entries of a new kind of a 4-vector

$$\left(B^{(0)}, \mathbf{B}^{(3)}\right) \tag{2}$$

(see [10], text after (11b) and [11], text preceding (11a)). This new quantity clearly does not deny my claim that Evans longitudinal *magnetic* field violates covariance[4]. Indeed, if $B^{(0)}$ and $\mathbf{B}^{(3)}$ are entries of a 4-vector then they *cannot* be components of a magnetic field because the latter transforms like components of a second rank antisymmetric tensor[12,13]. It follows that the usage of the letter *B* for the entries of Dvoeglazov's 4-vector (2) is a *misleading notation* because a quantity which is not a magnetic field should not be denoted by the letter *B* in an expression pertaining to electrodynamics.

In the rest of this Reply it is proved that, in spite of Dvoeglazov's 4-vector (2), Evans' fundamental relation (1) is wrong. To this end, let us examine again a system of two rotating charges (see Fig. 1). For the simplicity of the discussion, it is assumed that the charges move nonrelativistically. It follows that in the present experiment $\omega \ll 1$ (units where $c = 1$ are used) and dipole radiation is dominant.

As seen if Fig. 1, the state at time $T + \pi/\omega$ is obtained from that of *T* by a multiplication of the two charges by –1. Therefore, all quantities which are *proportional* to the charge must change sight when a time interval of π/ω elapses. Maxwellian fields, like the transverse electric and magnetic fields, are proportional to a phase factor $\sin(\omega t + \delta)$ and satisfy this requirement. Evans' longitudinal *phaseless* magnetic field clearly violates it. It follows that Evans' magnetic field as well as the entries of Dvoeglazov's 4-vector (2) are *not* proportional to the charge.

Now let us examine the interaction part of the electromagnetic Lagrangian (see [12], p. 71; [13], p. 596)

$$L_{\text{int}} = -j^{\mu} A_{\mu} \tag{3}$$

where j^{μ} denotes the current of the charged matter and A_{μ} denotes the electromagnetic 4-potential. The summation convention of pair of indices is used. As is well known, j^{μ} is proportional to the charge density (see [12], p 70; [13], p. 549). Relation (3) yields Maxwell equations (see [12], pp. 73,74; [13], pp. 596,597) where the overall electromagnetic field is a superposition of field quantities, each of which is proportional to a specific charge (see [12] p. 162; [13], p.657) which is regarded as a source. It is shown above that the Evans-Dvoeglazov $\mathbf{B}^{(3)}$ field is *not* proportional to the charge at the source. Therefore, it should not be regarded as a magnetic field.

The following argument proves unphysical properties of the Evans-Dvoeglazov $B^{(0)}$ and $\mathbf{B}^{(3)}$ fields. Let us examine a system S which consists of one charge q which moves uniformly along a circle in the (x,y) plane and its position $\mathbf{r}(t)$ is

$$x = R\cos\omega t, \quad y = R\sin\omega, \quad z = 0 \tag{4}$$

The radiation emitted by this charge is circularly polarized along the z-axis. Introducing the magnetic field of this radiation into the left hand side of Evans' fundamental relation (1), one finds that this side is proportional to q^2. Hence, the right hand side of (1) must also be proportional to q^2. Now, $B^{(0)}$ and $\mathbf{B}^{(3)}$ are entries of Dvoeglazov's 4-vector (2). Hence, they have the same dependence on q. As explained above, $B^{(0)}$ and $\mathbf{B}^{(3)}$ are *not* proportional to q. Therefore, they must be proportional to the *absolute value* of q. This result means that the dependence of the Evans-Dvoeglazov $B^{(0)}$, $\mathbf{B}^{(3)}$ fields on the charge cannot be described by an analytic function.

Another unphysical aspect of the $B^{(0)}$ and $\mathbf{B}^{(3)}$ fields is as follows. Consider another system S' which is very similar to S. The difference between the systems is that in S', the position of the charge q' ($q' = q$), is

$$x' = -R\cos\omega t, \quad y' = -R\sin\omega t, \quad z' - 0. \tag{5}$$

Obviously, in S', the intensity of the radiation is the same as that of S. It follows that for S and S', Evans' field $\mathbf{B}^{(3)}$ field at a point on the z-axis satisfies

$$\mathbf{B}^{(3)} = \mathbf{B}'^{(3)}. \tag{6}$$

Now, let us examine a third system S'' which is a union of S and S'. In S'', the two charges, q and q' are at two antipodal points $\mathbf{r}(t) = -\mathbf{r}'(t)$. Hence, in S'', transverse components of the electric field at a point on the z-axis vanish. It means that, in S'', there is *no radiation* along this axis. Therefore, due to (1), the Evans-Dvoeglazov $B^{(0)}$ and $\mathbf{B}^{(3)}$ fields of the S'' system must vanish too. Relying on (6), one concludes that Evans-Dvoeglazov $\mathbf{B}^{(3)}$ field does not satisfy the principle of superposition (see [13], p. 10) which is a characteristic property of electromagnetic fields.

The analysis carried out above substantiates the claim that the longitudinal phaseless magnetic field ascribed by Evans to a circularly polarized radiation is inherently wrong and that Dvoeglazov's attempt to rectify it has no basis.

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