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Photon Rest Frames and Null Geodesics

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Abstract

A stationary spatial model for electromagnetic waves has the useful feature that it provides a means for characterizing discrete field distributions. Such a distribution may then be mapped to spherical particlelike entities, so that it then corresponds to a particle (photon) in its own rest frame.

It is possible to define a rest frame that travels at the velocity of light, c, but is conceptual in nature and nevertheless can be useful. This is primarily for providing a stationary spatial model for electromagnetic waves. Such rest frames provide a way of characterizing electromagnetic $\frac{1}{2}\lambda$ dipole field distributions that are discrete and that may be used, in addition, to characterize photons (Honig, 1974, 1976, 1977).

This consists of using the Hertzian electromagnetic dipole field distribution pictures (see Figure 1) in a more literal sense than has heretofore been the case. Their connection with the electron, as shown in Figure 1a, assumes an electron at O, the origin, in rectilinear acceleration in the positive and negative z direction. The electron is taken as the spherical entity localized about O. The $\frac{1}{2}\lambda$ field patterns are shown for E, the electric field, for the right hemisphere. The physical and conceptual similarities between these $\frac{1}{2}\lambda$ electromagnetic dipole field distributions and hydrodynamical toroidal vortices has been pointed out (Honig, 1973). That is, initially each $\frac{1}{2}\lambda$ dipole electromagnetic field distribution appears as a toroidal vortex of circular cross section that girdles the electron equator and then moves out in the radial direction but deforms itself continuously into the well-known kidney-shaped field patterns (see Figure 1). The continuous deformation of each such $\frac{1}{2}\lambda$ field distribution makes it evident that, first, there should be an isomorphism between all $\frac{1}{2}\lambda$ field distributions at all subsequent times after its formation; and, second,

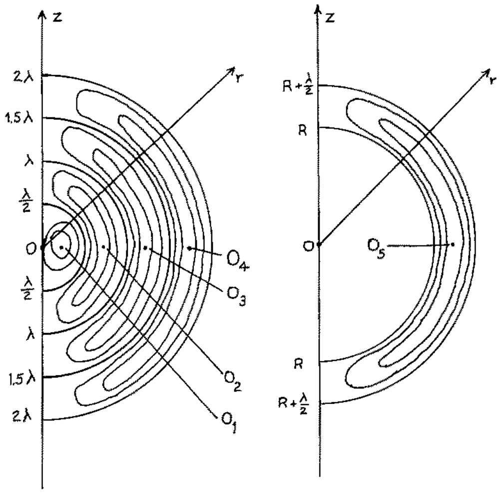

Figure 1. (a) Hertzian dipole radiation fields. (b) Single $\frac{1}{2}\lambda$ "vortex photon" field.

that each $\frac{1}{2}\lambda$ field distribution ought to be considered as a separate entity, which is as shown in Figure 1b.

This requires that a physical model for free space be used consisting of continuous charged fluids out of which such entities can be constructed (Honig, 1974, 1976). When no electromagnetic waves are present two such oppositely charged superposable fluids would cause a net neutrality for the vacuum space. Differences, however, in their densities and their velocity fields can then be used for the construction of toroidal and vortical field distributions. The toroidal vortex, therefore—which, as is well known, is a discontinuous phenomenon in single-fluid hydrodynamics (Lamb, 1945; Milne-Thomson, 1961)—is here considered as a toroidal flow of charge imbalance of the above two-fluid model. The single toroidal entity shown in Figure 1b is the basic element out of which all electromagnetic wave trains can be constructed.

Now the accepted definition of the photon is that it is given by the discrete energy, E, defined by

$$E = hf \tag{1}$$

where f is cycles per second, and h is Planck's constant in erg seconds, and E is in ergs; this where f is continuous in nature. If, however, a finite wave train is considered as a contiguous sequence of the $\frac{1}{2}\lambda$ field distributions shown in Figure 1a and 1b, then for an arbitrary frequency the photon defined above may be considered as equal to the (even) number of such entities, $2n$, which pass a point in space per second. The Planck energy relation becomes, for the vortical entities considered and because of relativistic considerations (Honig, 1974, 1976), equal to

$$E = (h/2)(2n) \tag{2}$$

but now h = ergs, *not* erg seconds, i.e., action for physical rest frames corresponds to energy in photon rest frames, with a minimum value of energy corresponding to a mass equivalent of 3.68×10^{-48} g (see Honig, 1974).

These vortical entities are called "vortex photons" because they are the discrete entities from which electromagnetic wave trains can be constructed and for other reasons as given in the reference above.

The purpose of this note is to call attention to how the notion of a localized particle can be extended to the $\frac{1}{2}\lambda$ field distribution of Figure 1b in a similar manner to the particle treatment of the electron. It is based on the fact that the electron is treated as an entity localized about the origin O of Figure 1. The $\frac{1}{2}\lambda$ field distributions (these "vortex photons") also have a center of symmetry; this is shown in cross section as O_1, O_2, O_3, O_4, and O_5 in Figure 1. *This is not a point, however: It is a ring.* If one treats this ring as the origin of the toroidal (doubly-connected) space of *each* "vortex photon," then it is not possible to treat these "vortex photons" as particles, i.e., as points about which something is localized in a Euclidean flat space. It is clear, however, that the "vortex photon" can indeed be treated in such a manner if the ring origin could be mapped to a point origin of a singly connected space, with the simultaneous mapping of the field distribution to a sphere about that point origin. In such a case the "vortex photon" will map to an entity that is similar to that of the "sphere" electron of Figure 1. Under such a mapping the "vortex photon" will be a localized entity about a point origin of a Euclidean space, and therefore, quite particlelike. Such a mapping or transformation need not be Lorentzian, and the radial velocity of the ring origin with respect to the origin O of Figure 1 will still be equal to c, although the final space where the ring is a point and the "vortex photon" is a stationary sphere is not representable in Figure 1.

It is, of course, well known that the mapping from a doubly to a singly connected space is not isomorphic. If such a mapping is considered from a more physical (and fluidic) point of view, this will not be a serious problem. One considers the "vortex photon" as a fluid dynamical entity (somewhat like a "smoke ring"); then the following conceptual mapping may be made, assuming that this entity has a finite energy that is to be preserved (invariant) in the mappings (Honig, 1977).

The ring is cut open (see Figure 2) and projected to a shape where it is a right circular cylinder of finite length whose axis is the previous ring origin. The positive and negative extensions of this axis are the infinite extensions of the Reimannian surface, which in Figure 1 extends beyond the 2π radian angular range of the original "vortex photon." The other two dimensions of this 3-space may be easily brought into correspondence with the y' and z' of an x', y', z' space. If now the original finite axis of the cylinder is shrunk, i.e., mapped to a point, subject to the condition that the distance of points inside the cylinder to the axis be kept constant, then the cylindrical volume will map to a spherical volume about the new point origin. In this x', y', z' space the "vortex photon" will look like the electron of Figure 1. The singularities of the mapping, S and S', will in a physical sense map to a vanishingly small

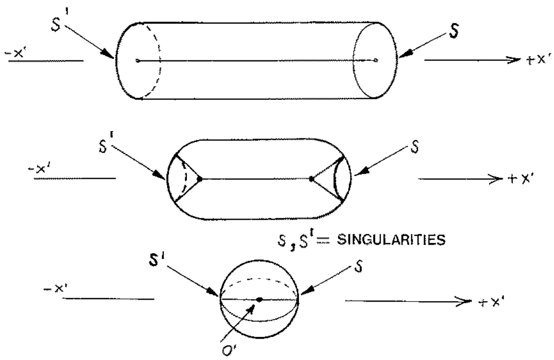

Figure 2. Mapping of a cut toroid to a sphere.

volume and have a vanishingly small contribution to the energy of the spherical droplet into which the toroid has been mapped. Thus the singularities still exist but the energy in those regions is negligible. For such a spherical droplet one may take the local or global geodesics in the x', y', z' space as

$$dx'_u \, dx'_u = 0 \tag{3}$$

$$x'_u x'_u = 0 \tag{4}$$

respectively, where the summation convention is used and u takes the values $1, 2, 3, 4$ for $x_u = x', y', z', ict'$, in that order. In a Cartesian flat space, where a localized entity (a particle) is situated about the origin of that space, and where each of the dimensions are orthogonal, each x_u is separately zero as is each dx_u since they refer to the fact that the entity is at the origin. Furthermore, it is at rest there so that (with no summation convention)

$$\text{globally: } x_u = 0 \text{ (separately)} \tag{5}$$

$$\text{locally: } dx_u = 0 \text{ (separately)} \tag{6}$$

This may be understood as referring to the fact that the "photon vortex" is at rest in its own space. The meaning for the null geodesic forms, equations (3) and (4), is this fact, which is quite obvious in the $x'y'z'$ space where the "vortex photon" is the localized entity at the bottom of Figure 2. This also implies that the spatial transformations from the $x'y'z'$ space back to the xyz space of Figure 1 will result in the transformation of the equations (3) and (4) into the usual null geodesic forms for x, y, z, and t.

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