ELECTROMAGNETISM EXPLAINED BY THE THEORY OF INFORMATONS

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ABSTRACT

The "*theory of informatons"* explains the electromagnetic interactions by the hypothesis that "*e-information*" is the substance of electromagnetic fields. The constituent element of that substance is called "*an informaton*".

The theory starts from the idea that any material object manifests itself in space by the emission of informatons: granular mass and energy less entities rushing away with the speed of light and carrying information about the position, about the velocity and about the electrical status of the emitter.

In this article the electromagnetic field in a point is characterised as the macroscopic manifestation of the presence of a cloud of informatons near that point; Maxwell's laws are mathematically deduced from the dynamics of the informatons; the electromagnetic interactions are explained as the effect of the trend of an electrically charged object to become blind for flows of e-information generated by other charged objects; and photons are identified as informatons carrying a quantum of energy, what allows us to understand the strange behaviour of light as described by QEM .

Key words: electromagnetism, gravito-electromagnetism, informatons.

INTRODUCTION

In this paper we show that the theoretical model that we have introduced in the article "Gravitation explained by the theory of informatons"(1) not only is suitable to explain gravitation, but also provides a framework to understand the phenomena and to deduce the laws of electromagnetism. Furthermore, we discuss the generation of electromagnetic energy by an oscillating point charge and the transport of that energy by an electromagnetic wave. In particular we focus on the role of photons in that process.

When we say that it is the *substance* of gravitational and electromagnetic fields, we mean that "information carried by informatons" makes these fields what they are: not just mathematical constructions but elements of the natural world. We call the constituent element of that substance an "informaton".

The theory of informatons starts from the hypothesis that any material object manifests itself in space by emitting informatons at a rate that is proportional to its rest mass: *the rest*

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mass is the only factor that determines the rate at which an object emits informatons. Informatons run through space with the speed of light.
The *fundamental attribute* of an informaton is called its "g-spin". The g-spin of an informaton refers to information about the position of its emitter and equals the elementary quantity of "g-information", this is information in relation with gravity. The g-spin is the only attribute of an informaton emitted by an electrically neutral object at rest. It is represented by a vectorial quantity $\vec{s}_g$ that points to the emitter.

Informatons emitted by an electrically charged object at rest have moreover an *attribute that refers to information about the electrical status* of their emitter. This attribute is called the "e-spin". The e-spin of an informaton refers to information about the sign of the charge, about the position and about the ratio of the quantity of charge *Q* to the mass *m* of its emitter. The e-spin is represented by a vectorial quantity $\vec{s}_e$ that is on the line connecting the informaton with its source, the magnitude of $\vec{s}_e$ is proportional to $\frac{Q}{m}$.

An object at rest emits informatons whose g-spin-vector $\vec{s}_g$ and - if it is electrically charged - whose e-spin-vector $\vec{s}_e$ have the same direction as their velocity $\vec{c}$. This is no longer the case when the emitter is moving. How greater the speed of the emitter, how greater the deviation of $\vec{s}_g$ and of $\vec{s}_e$ relative to $\vec{c}$. This deviation is characteristic for the speed of the emitter. In relation to gravitation the *additional attribute of an informaton referring to information about the status of motion* of its emitter is called the "β-index", and in relation to electromagnetism it is called the "b-index". The β- and the b-index of an informaton is respectively represented by the vectorial quantities $\vec{s}_\beta$ and $\vec{s}_b$ whose magnitudes are proportional to the component of the velocity of the emitter that is perpendicular to the velocity of the informaton.

The theory of informatons explains gravitational and electromagnetic forces as the reaction of a material object on the disturbance of the characteristic symmetry of its "own" cloud of g/e-information by the flux of g/e-information emitted by other objects. *There is no mechanical interaction between informatons and matter*: informatons are mass and energy less entities.

The theory of informatons explains why gravitational and electromagnetic fields are *isomorphic*. From its starting points it follows that its scope is limited to the spacetime of the SRT and that its results are in line with this theory.

I. The Postulate of the Emission of Informatons

The emission of informatons by a point mass with rest mass *m* and carrying a charge *q*[•], that is anchored in an inertial reference frame ***O***, is governed by the *postulate of the emission of informatons*:

[•] A point mass carrying an electrical charge is called a "point charge".

A. *The emission* is governed by the following rules:

1. *The emission is uniform in all directions of space, and the informatons diverge with the speed of light (c = 3.10⁸* m/s) *along radial trajectories relative to the location of the emitter.*

2. $\dot{N} = \frac{dN}{dt}$*, the rate at which a point-mass emits informatons•, is time independent and proportional to its rest mass m. So, there is a constant K so that:*

$$\dot{N} = K.m$$

3. *The constant K is equal to the ratio of the square of the speed of light (c) to the Planck constant (h):*

$$K = \frac{c^2}{h} = 1{,}36.10^{50}\, kg^{-1}.s^{-1}$$

B. We call the essential attribute of an informaton its *g-spin.* The g-spin of an informaton refers to information about the position of its emitter and equals the elementary quantity of g-information. It is represented by a vectorial quantity $\vec{s}_g$, the "*g-spin vector*":

1. $\vec{s}_g$ *is points to the position of the emitter.*

2. *All g-spin vectors have the same magnitude, namely:*

$$s_g = \frac{1}{K.\eta_0} = 6{,}18.10^{-60}\, m^3.s^{-1}$$

($\eta_0 = \frac{1}{4.\pi.G} = 1{,}19.10^9\, kg.s^2.m^{-3}$ with *G* the gravitational constant)

C. Informatons emitted by an electrically charged point mass *m* carrying an electric charge *q* have a second attribute, namely the *e-spin*. The e-spin of an informaton refers to the electrical status of its emitter and is represented by the vectorial quantity $\vec{s}_e$:

1. *The e-spin vectors are radial relative to the position of the emitter. They are centrifugal when the emitter carries a positive charge (q = +Q) and centripetal when the charge of the emitter is negative (q = -Q).*

2. s_e*, the magnitude of an e-spin vector depends on Q/m, the charge per unit of mass of its emitter.* s_e *is defined by:*

• We neglect the possible stochastic nature of the emission, that is responsible for noise on the quantities that characterize the gravitational field. So, $\dot{N}$ is the average emission rate.

$$s_e = \frac{1}{K.\varepsilon_0}.\frac{Q}{m} = 8{,}32.10^{-40}.\frac{Q}{m} N.m^2.s.C^{-1}$$

($\varepsilon_0 = 8{,}85.10^{-12} F/m$ is the permittivity constant).

So, according to *the postulate of the emission of informatons*, an electrically charged point mass (*a point charge*) that is anchored in an inertial reference frame ***O*** is an emitter of informatons. The emission rate only depends on its mass *m* and is defined in section *A* of the postulate. The informatons carry two attributes: the g-spin (defined in section *B*) and the e-spin (defined in section *C*), which are respectively at the base of the gravitational and the electromagnetic interactions. In what follows, we study the electromagnetic phenomena. For the study of gravitation, we refer to "Gravitation explained by the theory of informatons"(1).

II. The electric Field of electrically charged Objects at rest•

2.1. The electric field of a point charge at rest

In fig 1 we consider a point charge, with mass *m* and (algebraic) charge *q*, that is anchored in the origin of an inertial reference frame ***O***.

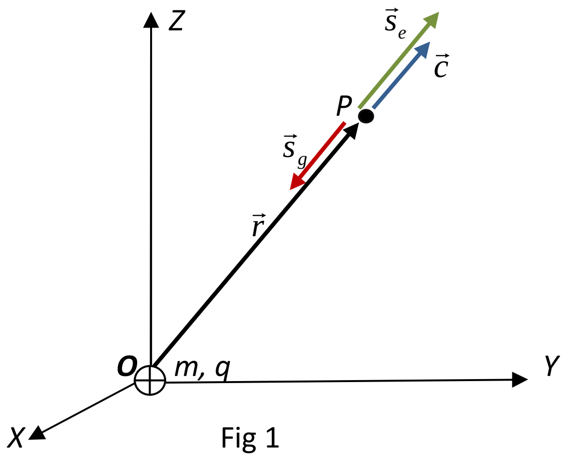


Fig 1

From the postulate of the emission of informatons it follows that the informatons, emitted by this point charge at a rate $\dot{N} = \frac{dN}{dt} = K.m$, are carriers of both g- and e-information. The informatons passing - with velocity $\vec{c} = c.\frac{\vec{r}}{r} = c.\vec{e}_r$ - near the fixed point *P* - defined by the position vector $\vec{r}$ - have two attributes: their g-spin vector $\vec{s}_g$ and their e-spin vector $\vec{s}_e$:

$$\vec{s}_g = -\frac{1}{K.\eta_0}.\frac{\vec{r}}{r} = -\frac{1}{K.\eta_0}.\vec{e}_r \qquad \vec{s}_e = \frac{q}{m}.\frac{1}{K.\varepsilon_0}.\frac{\vec{r}}{r} = \frac{q}{m}.\frac{1}{K.\varepsilon_0}.\vec{e}_r$$

• In this and in the following sections, we restrict our considerations to the field in free space. For the effects of dielectric and magnetic materials see "Gravitatie en Electromagnetisme"(4).

The gravitational field of the point charge is the macroscopic manifestation of the g-spin vectors. In an arbitrary point *P,* it is characterized by the vectorial quantity $\vec{E}_g$, the density of *the g-information flow* or *the g-field*. In the paper "Gravitation explained by the Theory of Informatons" [(1)], it was shown that:

$$\vec{E}_g = \frac{\dot{N}}{4.\pi.r^2}.\vec{s}_g = -\frac{m}{4.\pi.\eta_0.r^2}.\vec{e}_r = -\frac{m}{4.\pi.\eta_0.r^3}.\vec{r}$$

In an analogous manner, it can be shown that the e-spin vectors of the informatons emitted by the point charge, manifest themselves macroscopically as its *electric field* or its *e-field*, and that the e-field in a point *P* is characterised by the *density of the e-information flow*.

Indeed, the rate at which the point charge *q* emits e-information is the product of the rate at which it emits informatons with the elementary e-information quantity carried by the emitted informatons:

$$\dot{N}.s_e = K.m.\frac{1}{K.\varepsilon_0}.\frac{Q}{m} = \frac{Q}{\varepsilon_0}$$

Of course, this is also the rate at which it sends e-information through any closed surface that spans *q.*

The emission of informatons fills the space around *q* with an expanding cloud of e-information. This cloud has the shape of a sphere whose surface goes away from the centre *O* - the position of the point charge - with the speed of light.

- Within the cloud is a *stationary state*: because the inflow equals the outflow, each spatial region contains an unchanging number of informatons and thus a constant quantity of e-information. Moreover, the orientation of the e-spin vectors of the informatons passing near a fixed point is always the same.

- The cloud can be identified with a *continuum*: each spatial region contains a very large number of informatons: the e-information is like continuously spread over the volume of the region.

That cloud of e-information surrounding *O* constitutes the *electric field* or the *e-field* of the point charge *q.*

Without interruption "countless" informatons are rushing through any - even very small - surface in the electric field: we can describe the motion of e-information through a surface as a *continuous flow* of e-information.

We know already that the intensity of the flow of e-information through a closed surface that spans *O* is expressed as:

$$\dot{N}.s_e = \frac{Q}{\varepsilon_0}$$

If the closed surface is a sphere with radius *r*, the *intensity of the flow per unit area* is given by:

$$\frac{Q}{4.\pi.r^2.\varepsilon_0}$$

This is the *density* of the flow of e-information in any point *P* at a distance *r* from *q* (fig 1). This quantity is, together with the orientation of the e-spin vectors of the informatons that are passing near *P,* characteristic for the electric field in that point. Consequently, in a point *P*, the electric field of the point charge *q* is defined by the vectorial quantity $\vec{E}$:

$$\boxed{\vec{E} = \frac{\dot{N}}{4.\pi.r^2}.\vec{s}_e = \frac{q}{4.\pi.\varepsilon_0.r^2}.\vec{e}_r = \frac{q}{4.\pi.\varepsilon_0.r^3}.\vec{r}}$$

This quantity is the *electric field strength* or the *e-field strength* or the *e-field*. In any point of the electric field of the point charge *q*, the orientation of $\vec{E}$ corresponds to the orientation of the e-spin-vectors of the informatons who are passing near that point. If the emitter is positively charged this is also the direction in which the informatons are moving. And the magnitude of $\vec{E}$ is the *density of the e-information flow* in that point. Let us note that the role played by the factor $(-\frac{m}{\eta_0})$ in the definition of $\vec{E}_g$ is taken over by the factor $(\frac{q}{\varepsilon_0})$ in het definition of $\vec{E}$.

Let us consider a surface-element *dS* in *P* (fig 2,a). Its orientation and magnitude are completely determined by the surface-vector $\overrightarrow{dS}$ (fig 2,b)

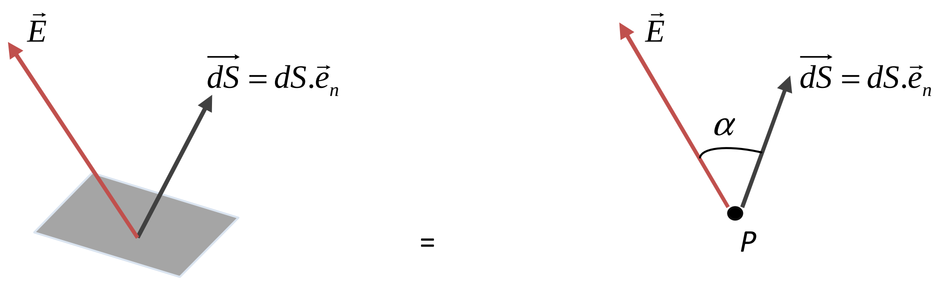


Fig 2,a Fig 2,b

We define $d\Phi_e$, the *elementary e-flux through dS* as:

$$d\Phi_e = \vec{E}.\overrightarrow{dS} = E.dS.\cos\alpha$$

The magnitude of this scalar quantity equals the rate at which e-information flows through *dS* in the sense of the positive normal. The sign is related to the direction of the e-spin-vectors of the informatons passing near *P*: in the case of a positive emitter is this also the direction in which the informatons are moving.

For an arbitrary closed surface *S* that spans *q*, the outward flux (which we obtain by integrating the elementary contributions $d\Phi_e$ over *S*) must be equal to the rate at which the charge emits e-information. Thus:

$$\Phi_e = \oiint \vec{E}.\overrightarrow{dS} = \frac{q}{\varepsilon_0}$$

This relation is the expression of *the conservation of e-information* in the case of a point charge at rest.

2.2. The electric field of a set of point-charges at rest

We consider a set of point charges $q_1,...,q_i,...q_n$ that are anchored in an inertial reference frame ***O***.

In an arbitrary point *P*, the flows of e-information who are emitted by the distinct masses are defined by the gravitational fields $\vec{E}_1,..., \vec{E}_i,..., \vec{E}_n$.

$d\Phi_e$, the rate at which e-information flows through a surface-element *dS* in *P* in the sense of the positive normal, is the sum of the contributions of the distinct charges:

$$d\Phi_e = \sum_{i=1}^{n}(\vec{E}_i.\overrightarrow{dS}) = (\sum_{i=1}^{n}\vec{E}_i).\overrightarrow{dS} = \vec{E}.\overrightarrow{dS}$$

So, the *effective density of the flow of e-information in P* (the effective e-field) is completely defined by:

$$\boxed{\vec{E} = \sum_{i=1}^{n}\vec{E}_i}$$

We conclude: *The e-field of a set of point charges at rest is in any point of space completely defined by the vectorial sum of the e-fields caused by the distinct charges.*

Let us note that the orientation of the effective e-field has no longer a relation with the direction in which the passing informatons are moving.

One shows easily that the outward e-flux through a closed surface in the e-field of a set of anchored point charges only depends on the enclosed masses q_{in}:

$$\Phi_e = \oiint \vec{E}.\overrightarrow{dS} = \frac{q_{in}}{\varepsilon_0}$$

This relation is the expression of *the conservation of e-information* in the case of a set of point charges at rest.

2.3. The electric field of a charge continuum at rest

We call an object in which the charge is spread over the occupied volume in a time independent manner, a *charge continuum*.

In each point M of such a continuum, the accumulation of charge is defined by the *charge-density* ρ_E . To define this scalar quantity one considers a volume element dV that contains M, and one determines the enclosed charge dq. The accumulation of charge near M is defined by:

$$\rho_E = \frac{dq}{dV}$$

A charge continuum - anchored in an inertial reference frame - is equivalent to a set of infinitely many infinitesimal charge elements dq. The contribution of each of them to the electric field in an arbitrary point P is $d\vec{E}$. $\vec{E}$, the effective electric field in P, is the result of the integration over the volume of the continuum of all these contributions.

It is evident that the outward e-flux through a closed surface S only depends on the mass enclosed by the surface (the enclosed volume is V):

$$\oiint_S \vec{E}.\overrightarrow{dS} = \frac{1}{\varepsilon_0}.\iiint_V \rho_E .dV$$

That is equivalent with (theorem of Ostrogradsky)[(2)]:

$$div\vec{E} = \frac{\rho_E}{\varepsilon_0}$$

These relations are the expression of *the conservation of e-information* in the case of a charge contiuum at rest.

Furthermore, one can show[(4] that: $rot\vec{E} = 0$, what implies the existence of *a electrical potential function V* for which: $\vec{E} = -gradV$.

III. The electric Field of moving Charges - The electromagnetic Field

3.1. The emission of informatons by a moving point charge

In fig 3, we consider an electrically charged point mass that moves with constant velocity $\vec{v} = v.\vec{e}_z$ along the Z-axis of an inertial reference frame ***O*** . At the moment *t = 0,* it passes through the origin O and at the moment *t = t* through the point P_1.

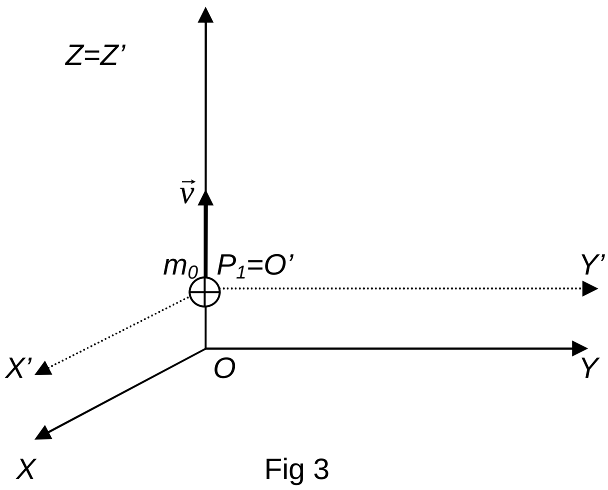


Fig 3

*We posit that $\dot{N}$ - the rate at which a point mass emits informatons in the space connected to **O** - is determined by its rest mass m_0 and is independent of its motion:*

$$\dot{N} = \frac{dN}{dt} = K.m_0$$

Furthermore, we posit also that the charge q is independent of the motion of its carrier.

This implies that(1), if the time is read on a standard clock that is moving with the same velocity as the point mass, the emission rate is proportional to the relativistic mass *m*:

$$\frac{dN}{dt'} = \frac{\dot{N}}{\sqrt{1-\beta^2}} = K.\frac{m_0}{\sqrt{1-\beta^2}} = K.m \qquad \text{with} \qquad \beta = \frac{v}{c}$$

3.2. The electric field caused by a uniform rectilinear moving point charge

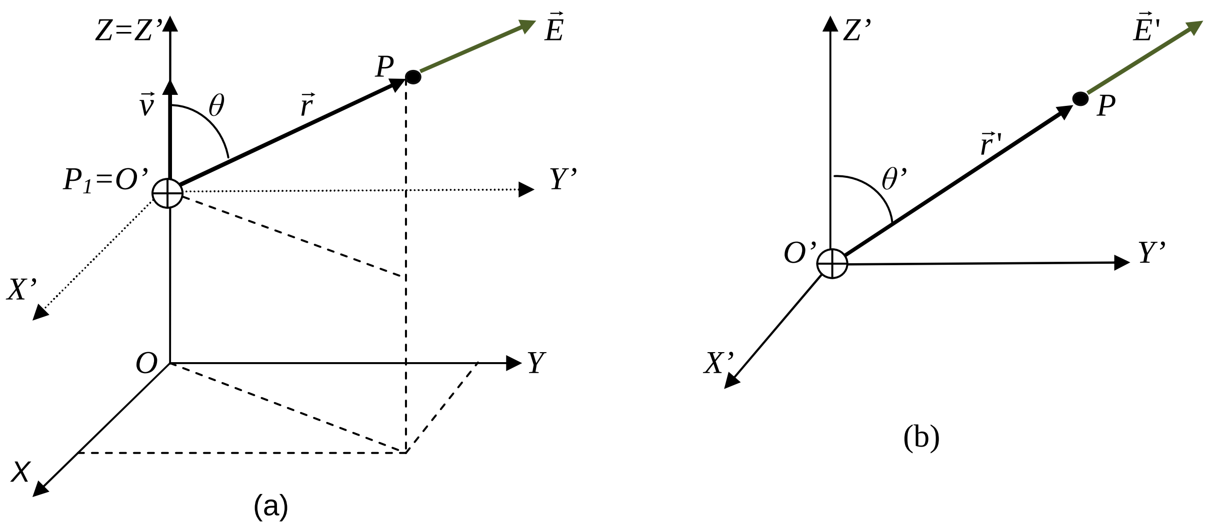


Fig. 4

In fig 4,a, we consider a charged point mass with rest mass m_0 that carries an electrical charge q and that is moving with constant velocity $\vec{v} = v.\vec{e}_z$ along the *Z*-axis of an inertial reference frame ***O***. At the moment *t = 0*, it passes through the origin *O* and at the moment *t = t* through the point P_1. It is evident that:

$$OP_1 = z_{P_1} = v.t$$

m_0 continuously emits informatons that, with the speed of light, rush away relative to the point where the mass is at the moment of emission. We wish to determine the density of the flow of e-information - this is the e-field - in a fixed point *P*. The position of *P* relative to the reference frame ***O*** is determined by the time independent Cartesian coordinates (*x, y, z*), or by the time dependent position vector $\vec{r} = \overrightarrow{P_1P}$. θ is the angle between $\vec{r}$ and the *Z*-axis.

Relative to the inertial reference frame ***O'***, that is anchored to the moving charge and that at the moment *t = t' = 0*, coincides with ***O*** (fig 4,b), the instantaneous value of the density of the flow of e-information in *P* is determined by:

$$\vec{E}' = \frac{q}{4\pi\varepsilon_0 r'^3}.\vec{r}'$$

Indeed, relative to ***O'*** the point charge is at rest and he position of *P* is determined by the time dependant position vector $\vec{r}'$ or by the Cartesian coordinates (*x', y', z'*). So, the e-field generated by the mass is determined by 2.1.

The components of $\vec{E}'$ in *O'X'Y'Z'*, namely:

$$E'_{x'} = \frac{q}{4\pi\varepsilon_0 r'^3}.x' \qquad E'_{y'} = \frac{q}{4\pi\varepsilon_0 r'^3}.y' \qquad E'_{z'} = \frac{q}{4\pi\varepsilon_0 r'^3}.z'$$

determine in *P* the densities of the flows of e-information respectively through a surface element *dy'.dz'* perpendicular to the *X'*-axis, through a surface element *dz'.dx'* perpendicular to the *Y'*-axis and through a surface element *dx'.dy'* perpendicular to the *Z'*-axis.

The e-fluxes through these different surface elements in *P*, or the rates at which e-information flows through it are:

$$E'_{x'}.dy'.dz' = \frac{q.x'}{4\pi\varepsilon_0 r'^3}.dy'.dz'$$

$$E'_{y'}.dz'.dx' = \frac{q.y'}{4\pi\varepsilon_0 r'^3}.dz'.dx'$$

$$E'_{z'}.dx'.dy' = \frac{q.z'}{4\pi\varepsilon_0 r'^3}.dx'.dy'$$

The Cartesian coordinates of *P* in the frames ***O*** and ***O'*** are connected by[(3)]:

$x' = x$ $y' = y$ $z' = \frac{z - v.t}{\sqrt{1-\beta^2}} = \frac{z - z_{P_1}}{\sqrt{1-\beta^2}}$

And the line elements by: $dx' = dx$ $dy' = dy$ $dz' = \frac{dz}{\sqrt{1-\beta^2}}$

Further[•]: $r' = r.\frac{\sqrt{1-\beta^2.\sin^2\theta}}{\sqrt{1-\beta^2}}$

So relative to ***O***, the g-information fluxes that the moving charge sends - in the positive direction - through the surface elements *dy.dz*, *dz.dx* and *dx.dy* in *P* are:

$$\frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.x.dy.dz$$
$$\frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.y.dz.dx$$
$$\frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(z-z_{P_1}).dx.dy$$

Since the densities in *P* of the flows of e-information in the direction of the *X*-, the *Y*- and the *Z*-axis are the components of the e-field caused by the moving point charge *q* in *P*, we find:

$$E_x = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.x$$
$$E_y = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.y$$
$$E_z = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(z-z_{P_1})$$

[•] In ***O***: $r = \sqrt{x^2 + y^2 + (z - z_{P_1})^2}$, $\sin\theta = \frac{\sqrt{x^2+y^2}}{r}$ and $\cos\theta = \frac{z - z_{P_1}}{r}$.

And in ***O'***: $r' = \sqrt{x'^2 + y'^2 + z'^2}$ and $\sin\theta' = \frac{\sqrt{x'^2+y'^2}}{r'}$.

We express *r'* in function of *x, y* and *z*:

$$r' = \sqrt{x^2 + y^2 + \frac{(z-z_{P1})^2}{(1-\beta^2)}} = \sqrt{r^2.\sin^2\theta + \frac{(z-z_{P1})^2}{1-\beta^2}} = \frac{\sqrt{r^2.\sin^2\theta.(1-\beta^2) + r^2.\cos^2\theta}}{\sqrt{1-\beta^2}} = r\frac{\sqrt{1-\beta^2.\sin^2\theta}}{\sqrt{1-\beta^2}}$$

So, the g-field caused by the moving point charge in the fixed point *P* is:

$$\boxed{\vec{E} = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.\vec{r} = \frac{q}{4\pi\varepsilon_0 r^2}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.\vec{e}_r}$$

We conclude: *A charged point mass describing - relative to an inertial reference frame **O** - a uniform rectilinear movement creates in the space linked to that frame a time dependent electric field.* $\vec{E}$*, the e-field in an arbitrary point P, is at any time on the line connecting P to the position of the charge at that moment; and its magnitude is:*

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}$$

If the speed of the charge is much smaller than the speed of light, this expression reduces itself to that valid in the case of a charge at rest. This non-relativistic result could also been obtained if one assumes that the displacement of the point charge during the time interval that the informatons need to move from the emitter to *P* can be neglected compared to the distance they travel during that period.

The orientation of the e-field implies that the spin vectors of the informatons that at a certain moment pass through P, have the same direction as the line that connects P to the position of the emitting mass at that moment.

Let us note that the above expression for the electric field immediately could be found by replacing the factor $(-\frac{m_0}{\eta_0})$ in the formula for $\vec{E}_g$ by the factor $(\frac{q}{\varepsilon_0})$.

3.3. The emission of informatons by a point charge describing a uniform rectilinear motion

In fig 5 we consider a point charge *q* that moves with a constant velocity $\vec{v}$ along the *Z*-axis of an inertial reference frame. Its instantaneous position (at the arbitrary moment *t*) is P_1.

The position of *P*, an arbitrary fixed point in space, is defined by the vector $\vec{r} = \overrightarrow{P_1P}$. The position vector $\vec{r}$ - just like the distance *r* and the angle θ - is time dependent because the position of P_1 is constantly changing.

The informatons that - with the speed of light - at the moment *t* are passing near *P*, are emitted when *q* was at P_0. Bridging the distance $P_0P = r_0$ took the time interval Δt:

$$\Delta t = \frac{r_0}{c}$$

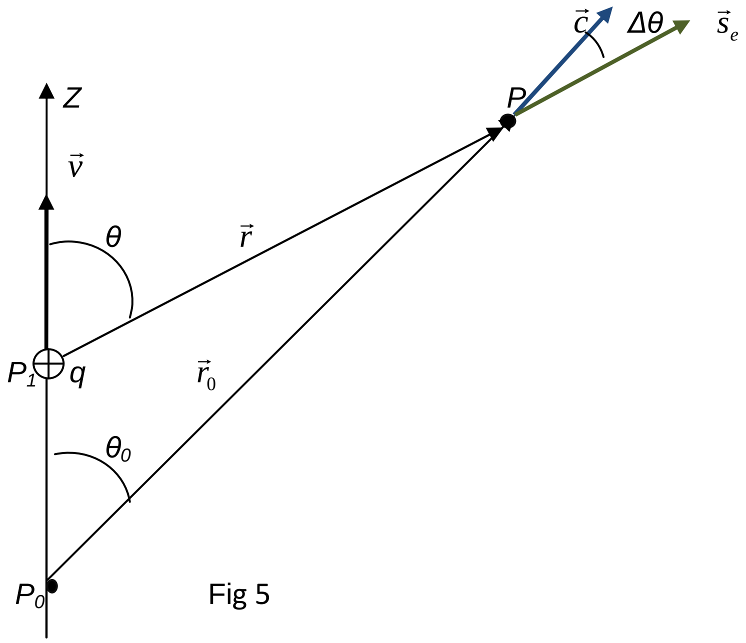


Fig 5

During their rush from P_0 to P, the mass moved from P_0 to P_1:

$$P_0P_1 = v.\Delta t$$

- $\vec{c}$, the velocity of the informatons, points in the direction of their movement, thus along the radius P_0P.

- $\vec{s}_e$, their e-spin vector, has the direction of the line P_1P, the position of q at the moment t. This is an implication of rule B.1 of the postulate of the emission of informatons and confirmed by the conclusion of §3.2.

The lines carrying $\vec{s}_e$ and $\vec{c}$ form an angle $\Delta\theta$. We call this angle the "*characteristic angle*" or the "*characteristic deviation*" because it is characteristic for the speed of the point charge. The quantity $s_b = s_e.\sin(\Delta\theta)$ is called the "*characteristic e-information*" or the "*magnetic* information" or the "*b-information*" of an informaton. It refers to the speed of its emitter.

We conclude that an informaton emitted by a moving point charge, is transporting information referring to the velocity of that charge. This information is represented by its "*electrical characteristic vector*" or the "*b-index*" $\vec{s}_b$ that is defined by:

$$\boxed{\vec{s}_b = \frac{\vec{c} \times \vec{s}_e}{c}}$$

- The b-index is perpendicular to the plane formed by the path of the informaton and the straight line that carries the e-spin vector, thus perpendicular to the plane formed by the point P and the path of the emitter.

- Its orientation relative to that plane is defined by the "rule of the corkscrew": in the case of fig 5 (positive charge) the orientation of the b-indices is opposite to the orientation of the positive *X*-axis.

- Its magnitude is: $s_b = s_e.\sin(\Delta\theta)$, the *b-information* of the informaton.

We apply the sine rule to the triangle P_0P_1P: $\frac{\sin(\Delta\theta)}{v.\Delta t} = \frac{\sin\theta}{c.\Delta t}$

It follows:

$$s_b = s_e.\frac{v}{c}.\sin\theta = s_e.\beta.\sin\theta = s_e.\beta_\perp$$

$\beta_\perp$ is the component of the dimensionless velocity $\vec{\beta} = \frac{\vec{v}}{c}$ perpendicular to $\vec{s}_e$.

Taking into account the orientation of the different vectors, the b-index of an informaton emitted by a point mass moving with constant velocity, can also be expressed as:

$$\vec{s}_b = \frac{\vec{v} \times \vec{s}_e}{c}$$

3.4. The magnetic induction of a point charge describing a uniform rectilinear motion

We consider again the situation of fig 5. All informatons in *dV* - the volume element in *P* - carry both e-information and b-information. The b-information refers to the velocity of the emitting mass and is represented by the b-indices $\vec{s}_b$:

$$\vec{s}_b = \frac{\vec{c} \times \vec{s}_e}{c} = \frac{\vec{v} \times \vec{s}_e}{c}$$

If *n* is the density in *P* of the cloud of informatons (number of informatons per unit volume) at the moment *t*, the amount of b-information in *dV* is determined by the magnitude of the vector:

$$n.dV.\vec{s}_b = n.\frac{\vec{c} \times \vec{s}_e}{c}.dV = n.\frac{\vec{v} \times \vec{s}_e}{c}.dV$$

And the density of the b-information cloud (characteristic information per unit volume) in *P* is determined by:

$$n.\vec{s}_b = n.\frac{\vec{c} \times \vec{s}_e}{c} = n.\frac{\vec{v} \times \vec{s}_e}{c}$$

We call this (time dependent) vectorial quantity - that will be represented by $\vec{B}$ - the "*magnetic induction*" or the "*b-induction*" in *P:*

- Its magnitude B determines the density of the b-information in *P.*
- Its orientation determines the orientation of the b-indices $\vec{s}_b$ of the informatons passing near that point.

So, the magnetic induction caused in *P* by the moving charge *q* (fig 5) is:

$$\vec{B} = n.\frac{\vec{v}\times\vec{s}_e}{c} = \frac{\vec{v}}{c}\times(n.\vec{s}_e)$$

N - the density of the flow of informatons in *P* (the rate per unit area at which the informatons cross an elementary surface perpendicular to the direction of movement) - and *n* - the density of the cloud of informatons in *P* (number of informatons per unit volume) - are connected by the relation:

$$n = \frac{N}{c}$$

With $\vec{E} = N.\vec{s}_e$, we can express the gravitational induction in *P* as:

$$\vec{B} = \frac{\vec{v}}{c^2}\times(N.\vec{s}_e) = \frac{\vec{v}\times\vec{E}}{c^2}$$

Taking into account (3.2): $\vec{E} = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.\vec{r}$

We find:

$$\vec{B} = \frac{q}{4\pi\varepsilon_0 c^2.r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\vec{v}\times\vec{r})$$

We define the constant $\mu_0 = 1{,}26.10^{-6}\,H/m$ as: $\mu_0 = \frac{1}{\varepsilon_0.c^2}$

And finally, we obtain:

$$\boxed{\vec{B} = \frac{\mu_0.q}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\vec{v}\times\vec{r})}$$

$\vec{B}$ in *P* is perpendicular to the plane formed by *P* and the path of the point charge; its orientation is defined by the rule of the corkscrew; and its magnitude is:

$$B = \frac{\mu_0.q}{4\pi r^2}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.v.\sin\theta$$

If the speed of the charge is much smaller than the speed of light, this expression reduces itself to:

$$\vec{B} = \frac{\mu_0 .q}{4\pi r^3}.(\vec{v} \times \vec{r})$$

This non-relativistic result could also be obtained if one assumes that the displacement of the point charge during the time interval that the informatons need to move from the emitter to *P* can be neglected compared to the distance they travel during that period.

Let us note that the above expression for the magnetic induction immediately could be found by replacing the factor $(-\nu_0.m_0)$ in the formula for $\vec{B}_g$ by the factor $(\mu_0.q)$.

3.5. The electromagnetic field of a point charge describing a uniform rectilinear motion

A point charge *q*, moving with constant velocity $\vec{v} = v.\vec{e}_z$ along the *Z*-axis of an inertial reference frame, creates and maintains a cloud of informatons that are carrying both e- and b-information. That cloud can be identified with a time dependent continuum. That continuum is called the *electromagnetic field* of the point charge. It is characterized by two time dependent vectorial quantities: the electric field (short: *e-field*) $\vec{E}$ and the magnetic induction (short*: b-induction*) $\vec{B}$.

- With *N* the density of the flow of informatons in *P* (the rate per unit area at which the informatons cross an elementary surface perpendicular to the direction of movement), the e-field in that point is:

$$\vec{E} = N.\vec{s}_e = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.\vec{r}$$

  The orientation of $\vec{E}$ learns that the direction of the flow of g-information in *P* is not the same as the direction of the flow of informatons.

- With *n,* the density of the cloud of informatons in *P* (number of informatons per unit volume), the magnetic induction in that point is:

$$\vec{B} = n.\vec{s}_b = \frac{\mu_0 .q}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\vec{v} \times \vec{r})$$

One can verify that:

1. $div\vec{E} = 0$
2. $div\vec{B} = 0$
3. $rot\vec{E} = -\frac{\partial \vec{B}}{\partial t}$
4. $rot\vec{B} = \frac{1}{c^2}.\frac{\partial \vec{E}}{\partial t}$

These relations are Maxwell's laws in the case of an electromagnetic field of a point charge describing a uniform rectilinear motion.

If $v << c$, the expressions for the electric field and for the magnetic induction reduce to:

$$\vec{E} = -\frac{q}{4\pi\varepsilon_0 r^3}.\vec{r} \qquad \text{and} \qquad \vec{B} = \frac{\mu_0 . q}{4\pi r^3}.(\vec{v} \times \vec{r})$$

3.6. The electromagnetic field of a set of point charges describing uniform rectilinear motions

We consider a set of point charges $q_1,\ldots,q_i,\ldots q_n$ that move with constant velocities $\vec{v}_1,\ldots,\vec{v}_i,\ldots,\vec{v}_n$ in an inertial reference frame ***O***. This set creates and maintains an electromagnetic field that in each point of the space linked to ***O***, is characterised by the vector pair ($\vec{E}$, $\vec{B}$) .

- Each charge q_i continuously emits e-information and contributes to the e-field in an arbitrary point *P* with an amount $\vec{E}_i$. As in 2.2 we conclude that the effective e-field $\vec{E}$ in *P* is defined as:

$$\boxed{\vec{E} = \sum \vec{E}_i}$$

- If it is moving, each charge q_i emits also b-information, contributing to the magnetic induction in *P* with an amount $\vec{B}_i$. It is evident that the b-information in the volume element *dV* in *P* at each moment *t* is expressed by:

$$\sum(\vec{B}_i.dV) = (\sum \vec{B}_i).dV$$

Thus, the effective magnetic induction $\vec{B}$ in *P* is:

$$\boxed{\vec{B} = \sum \vec{B}_i}$$

Maxwell's laws mentioned in the previous section remain valid for the effective electric field and the effective magnetic induction in the case of the electromagnetic field of a set op point charges describing a uniform rectilinear motion.

3.7. The electromagnetic field of a stationary charge flow

3.7.1. The magnetic induction of a line current.

With the term "line current", we refer to a stationary charge flow through a - whether or not straight - electrical conductor. If *dq* is the elementary quantity of charge that during the elementary time interval dt flows through *ΔS* - an arbitrary section of the conductor - the rate at which charge is transported through the conductor, is

$$i = \frac{dq}{dt}$$

This - time and position independent - algebraic• quantity is called the *electric current through the conductor.* In the case of a cylindrical conductor, the charge elements *dq* that constitute the current are moving parallel to the axis with speed *v*.

We can identify a cylindrical conductor with a string through which a current *i* flows. Each moving charge element is contained in a line element $\overrightarrow{dl}$ of the string†. The quantities that are relevant for the electric current in the string are related by[(4)]:

$$\vec{v}.dq = i.\overrightarrow{dl}$$

$i.\overrightarrow{dl}$ is called a *current element*.

The magnetic induction $d\vec{B}$, caused in a point *P* by a current element is found by substituting $\vec{v}.dq$ by $i.\overrightarrow{dl}$ in the formula that we derived for a moving point charge. ($\vec{r}$ defines the position of P relative to the current element). So:

$$d\vec{B} = \frac{\mu_0.i}{4\pi r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\overrightarrow{dl}\times\vec{r})$$

The fact that the speed of the charge carriers that constitute the current *i* is very small relative to the speed of light, implies that *β<<1* and that $\vec{dB}$ can be expressed as:

$$d\vec{B} = \frac{\mu_0.i}{4.\pi.r^3}.(\overrightarrow{dl}\times\vec{r})$$

This is the mathematical formulation of Laplace's law.

We can understand the current in a conductor as the drift movement of fictive positive charge carriers through a lattice of immobile negative charged entities. *A conductor in which an electric current flows causes a magnetic field, but not an electric one.* Indeed, the current is a stationary charge flow and thus the cause of a stationary magnetic field composed by contributions defined by Laplace's law. It doesn't cause an electric field, because the e-spin vectors of the informatons emitted by the moving charge carriers are neutralized by the e-spin vectors of the informatons emitted by the lattice.

Unlike a β-field - that never exists without a g-field - a magnetic field can exist without an electric field, *what implies that a magnetic field is not necessarily masked in every day circumstances.*

• *I > 0* if the current is transporting positive charge in the sense of an a priori chosen reference direction.

† The reference direction is identified with the orientation of the vector $\overrightarrow{dl}$

One can show that[4] $\oint_L \vec{B}.\overrightarrow{dl}$ calculated along a closed path *L* is only depending on the electric current ($\sum i_{in}$) encircled by this path (*Ampère's law*):

$$\oint_L B.\overrightarrow{dl} = \mu_0.\sum i_{in}$$

3.7.2. The magnetic induction of a charge flow

The term "stationary charge flow" indicates the movement of an homogeneous and incompressible charged fluid that, in an invariable way, flows relative to an inertial reference frame.

The intensity of the charge flow in an arbitrary point *P* is characterised by the flow density $\vec{J}_E$. The magnitude of this vectorial quantity equals the rate per unit area at which the charge flows through a surface element that is perpendicular to the flow in *P.* The orientation of $\vec{J}_E$ corresponds to the direction of the movement of positive charge. If $\vec{v}$ is the velocity of the charge element $\rho_E.dV$ that at the moment *t* flows through *P*, then:

$$\vec{J}_E = \rho_E.\vec{v}$$

So, the rate at which the flow transports charge - in the positive sense - through an arbitrary surface *ΔS,* is:

$$i = \iint_{\Delta S} \vec{J}_E.\overrightarrow{dS}$$

i is the *intensity of the charge flow through ΔS* or *the electric current through ΔS.*

Since a stationary charge flow is the macroscopic manifestation of moving charge elements $\rho_E.dV$, it creates and maintains an electromagnetic field. And since the velocity $\vec{v}$ of the charge element in each point is time independent, *the electromagnetic field of a stationary charge flow will be time independent*.

It is evident that the rules of 2.3 also apply for the time independent e-field:

1. $div\vec{E} = \dfrac{\rho_E}{\varepsilon_0}$ and 2. $rot\vec{E} = 0$ what implies: $\vec{E} = -gradV$

For the time independent magnetic induction, the following rules apply:

3. $div\vec{B} = 0$ what implies $\vec{B} = rot\vec{A}$ and 4. $rot\vec{B} = \mu_0.\vec{J}_E$

Indeed, it follows from the fact that the b-index of an informaton is always perpendicular to its velocity, that for any closed surface S: $\oiint_S \vec{B}.\overrightarrow{dS} = 0$, what implies[2]: $div\vec{B} = 0$. And from

Ampère's law one can conclude that the following relation exists between $\oint_L \vec{B}.\vec{dl}$ calculated for a closed line *L* and $\iint_{\Delta S} \vec{J}_E.\vec{dS}$ calculated over a surface *ΔS* bounded by that line: $\oint_L \vec{B}.\vec{dl} = \mu_0.\iint_{\Delta S} \vec{J}_E.\vec{dS}$

what implies[(2)]: $rot\vec{B} = \mu_0.\vec{J}_E$

3.8. The electromagnetic field of an accelerated point charge.

3.8.1. The e-spinvector of an informaton emitted by an accelerated point charge

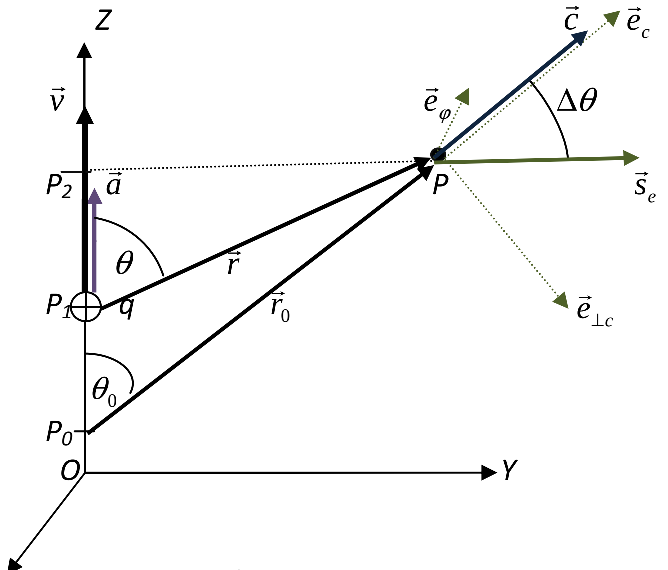


Fig 6

In fig 6 we consider a point charge *q* that, during a finite time interval, moves with constant acceleration $\vec{a} = a.\vec{e}_z$ relative to the inertial reference frame *OXYZ*. At the moment *t = 0*, *q* starts - from rest - in the origin *O*, and at the moment *t = t* it passes in the point P_1. Its velocity is there defined by $\vec{v} = v.\vec{e}_z = a.t.\vec{e}_z$, and its position by $z = \frac{1}{2}.a.t^2 = \frac{1}{2}.v.t$. We suppose that the speed *v* remains much smaller than the speed of light: $\frac{v}{c} << 1$.

The informatons that during the infinitesimal time interval (*t, t+dt*) pass near the fixed point *P* (whose position relative to the moving charge *q* is defined by the time dependant position vector $\vec{r}$) have been emitted at the moment $t_0 = t - \Delta t$, when *q* - with velocity $\vec{v}_0 = v_0.\vec{e}_z = v(t-\Delta t).\vec{e}_z$ - passed through P_0 (whose position is defined by the time dependant position vector $\vec{r}_0 = \vec{r}(t-\Delta t)$). *Δt*, the time interval during which *q* moves from P_0 to P_1 is the time that the informatons need to move - with the speed of light (*c*) - from P_0 to *P* . We can conclude that $\Delta t = \frac{r_0}{c}$, and that $v_0 = v(t-\Delta t) = v(t - \frac{r_0}{c}) = v - a.\frac{r_0}{c}$.

Between the moments $t = t_0$ and $t = t_0 + \Delta t$, *q* moves from P_0 to P_1. That movement can be considered as the resultant of

1. a uniform movement with constant speed $v_0 = v(t - \Delta t)$ and
2. a uniformly accelerated movement with constant acceleration a.

1. In fig. 6,a, we consider the case of the point charge q moving with constant speed v_0 along the *Z*-axis. At the moment $t_0 = t - \Delta t$ q passes in *P₀* and at the moment *t* in $P_1^{'}$: $P_0 P_1^{'} = v_0 . \Delta t$

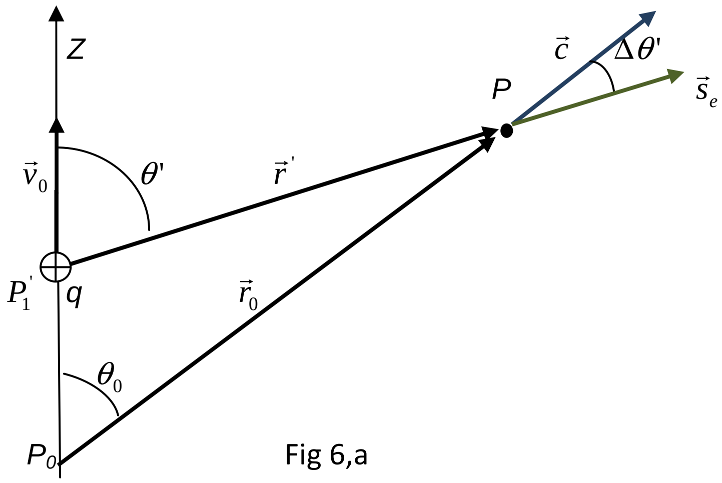


Fig 6,a

The informatons that, during the infinitesimal time interval (*t, t + dt*), pass near the point *P* - whose position relative to the uniformly moving charge *q* is defined, at the moment *t*, by the position vector $\vec{r}^{\,'}$ - have been emitted at the moment t_0 when *q* passed in P_0. Their velocity vector $\vec{c}$ is on the line $P_0 P$ and their spin vector $\vec{s}_e$ on the line $P_1^{'} P$.

2.

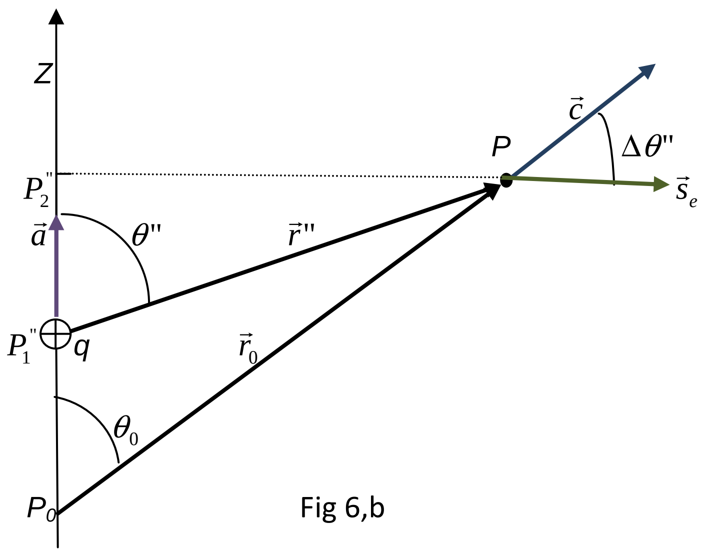


Fig 6,b

In fig 6,b we consider the case of the point charge *q* starting at rest in P_0 and moving with constant acceleration a along the *Z*-axis. At the moment $t_0 = t - \Delta t$ it is in P_0 and at the moment t in $P_1^{''}$: $P_0 P_1^{''} = \frac{1}{2} . a . (\Delta t)^2$

The informatons that during the infinitesimal time interval (*t, t + dt*) pass near the point *P* (whose position relative to the uniformly accelerated charge *q* is - at the moment *t* - defined by the position vector $\vec{r}''$) have been emitted at the moment t_0 when *q* was in P_0. Their velocity vector $\vec{c}$ is on the line P_0P , their e-spinvector $\vec{s}_e$ on the line $P_2''P$.

To determine the position of P_2'', we consider the trajectories of the informatons that at the moment t_0 are emitted in the direction of *P*, relative to the accelerated reference frame *OX'Y'Z'* that is anchored to *q*. (fig 6,c; $\alpha = \frac{\pi}{2} - \theta_0$)

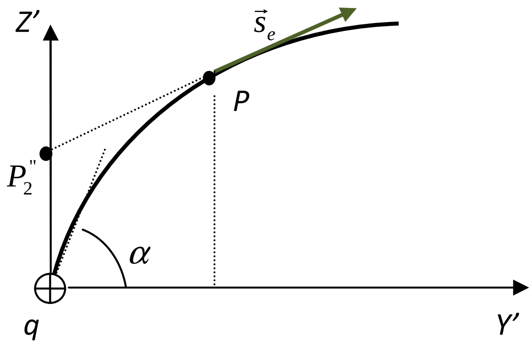


Fig. 6,c

Relative to *OX'Y'Z'* these informatons are accelerated with an amount $-\vec{a}$: they follow a parabolic trajectory defined by the equation:

$$z' = tg\alpha.y' - \frac{1}{2}.\frac{a}{c^2.\cos^2\alpha}.y'^2$$

At the moment $t = t_0 + \Delta t$, when they pass in *P* where the tangent line to that trajectory cuts the *Z'*-axis in the point P_2'', that is defined by:

$$z'_{P_2''} = \frac{1}{2}.a.(\Delta t)^2 = \frac{1}{2}.a.\frac{r_0^2}{c^2}$$

That means that the spinvectors of the informatons that at the moment *t* pass in *P*, are on the line $P_2''P$; P_2'' is a point on the *Z*-axis that has a lead of

$$P_1''P_2'' = \frac{1}{2}.a.(\Delta t)^2 = \frac{1}{2}.a.\frac{r_0^2}{c^2}$$

on P_1'', the actual position of the point charge *q*.

And since $P_0P_1'' = P_0P_1'' + P_1''P_2''$, we conclude that: $P_0P_2'' = a.\frac{r_0^2}{c^2}$

In the inertial reference frame *OXYZ* (fig 6), $\vec{s}_e$ is on the line P_2P. *The* point P_2 is on the *Z*-axis and determined by the superposition of the effect of the velocity (1) and the effect of the acceleration (2):

$$P_0P_2 = P_0P_1' + P_0P_2'' = \frac{v_0}{c}.r_0 + \frac{a}{c^2}.r_0^2$$

The carrier line of the e-spinvector $\vec{s}_e$ of an informaton that - relative to het inertial frame *OXYZ* - at the moment *t* passes near *P* forms a "characteristic angle" $\Delta\theta$ with the carrier line of its velocity vector $\vec{c}$, that can be deduced by application of the sine-rule in triangle P_0P_2P (fig 6):

$$\frac{\sin(\Delta\theta)}{P_0P_2} = \frac{\sin(\theta_0 + \Delta\theta)}{r_0}$$

We conclude: $$\sin(\Delta\theta) = \frac{v_0}{c}.\sin(\theta_0 + \Delta\theta) + \frac{a}{c^2}.r_0.\sin(\theta_0 + \Delta\theta)$$

From the fact that P_0P_1 - the distance travelled by *q* during the time interval *Δt* - can be neglected relative to P_0P - the distance travelled by light in the same interval - it follows that $\theta_0 \approx \theta_0 + \Delta\theta \approx \theta$ and that $r_0 \approx r$. So:

$$\boxed{\sin(\Delta\theta) \approx \frac{v_0}{c}.\sin\theta + \frac{a}{c^2}.r.\sin\theta}$$

We can conclude that the e-spinvector $\vec{s}_e$ of an informaton that at the moment *t* passes near *P*, has a component in the direction of $\vec{c}$ - its velocity vector - and a component perpendicular to that direction. It is evident that:

$$\vec{s}_e = \frac{q}{|q|}.[s_e.\cos(\Delta\theta).\vec{e}_c + s_e.\sin(\Delta\theta).\vec{e}_{\perp c}] \approx \frac{q}{|q|}.\left[s_e.\vec{e}_c + s_e.(\frac{v_0}{c}.\sin\theta + \frac{a}{c^2}.r.\sin\theta).\vec{e}_{\perp c}\right]$$

3.8.2. The electromagnetic field of an accelerated point charge

The informatons that, at the moment *t,* are rushing near the fixed point *P* - defined by the time dependent position vector $\vec{r}$ - are emitted when *q* was in P_0 (fig 6). Their velocity $\vec{c}$ is on the same carrier line as $\vec{r}_0 = \overrightarrow{P_0P}$. Their g-spin vector is on the carrier line P_2P. According to 3.8.1, the characteristic angle $\Delta\theta$ - this is the angle between the carrying lines of $\vec{s}_g$ and $\vec{c}$ - has two components:

- a component $\Delta\theta'$ related to the velocity of *q* at the moment ($t - \frac{r_0}{c}$) when the considered informatons were emitted. In the framework of our assumptions, this component is:

$$\sin(\Delta\theta') = \frac{v(t - \frac{r}{c})}{c}.\sin\theta$$

- a component $\Delta\theta''$ related to the acceleration of *q* at the moment when they were emitted. This component is, in the framework of our assumptions:

$$\sin(\Delta\theta'') = \frac{a(t-\frac{r}{c}).r}{c^2}.\sin\theta$$

The macroscopic effect of the emission of e-information by the accelerated charge q is an electromagnetic field ($\vec{E},\vec{B}$). We introduce the reference system ($\vec{e}_c,\vec{e}_{\perp c},\vec{e}_{\varphi}$) (fig 6).

1. $\vec{E}$, the electric field in *P*, is defined as the density of the flow of e-information in that point. That density is the rate at which e-information per unit area crosses in *P* the elementary surface perpendicular to the direction of movement of the informatons. So $\vec{E}$ is the product of *N*, the density of the flow of informatons in *P*, with $\vec{s}_e$, their spinvector:

$$\vec{E} = N.\vec{s}_e\,.$$

According to the postulate of the emission of informatons, the magnitude of $\vec{s}_e$ is:

$$s_e = \frac{|q|}{m}.\frac{1}{K.\varepsilon_0}$$

And the density of the flow of informatons in *P* is:

$$N = \frac{\dot{N}}{4.\pi.r_0^2} \approx \frac{\dot{N}}{4.\pi.r^2} = \frac{K.m}{4.\pi.r^2}\,.$$

Taking this into account and knowing that $\frac{1}{\varepsilon_0.c^2} = \mu_0$, we obtain:

$$\boxed{\vec{E} = \frac{q}{4.\pi.\varepsilon_0.r^2}.\vec{e}_c + \{\frac{q}{4.\pi.\varepsilon_0.c.r^2}.v(t-\frac{r}{c}).\sin\theta + \frac{\mu_0.q}{4.\pi.r}.a(t-\frac{r}{c}).\sin\theta\}.\vec{e}_{\perp c}}$$

2. $\vec{B}$, the magnetic induction in *P*, is defined as the density of the cloud of b-information in that point. That density is the product of *n*, the density of the cloud of informations in *P* (number per unit volume) with $\vec{s}_b$, their b-index:

$$\vec{B} = n.\vec{s}_b$$

The b-index of an informaton characterizes the information it carries about the state of motion of its emitter; it is defined as:

$$\vec{s}_b = \frac{\vec{c}\times\vec{s}_e}{c}$$

And the density of the cloud of informatons in *P* is related to *N*, the density of the flow of informatons in that point by: $n = \frac{N}{c}$

So: $$\vec{B} = n.\vec{s}_b = \frac{N}{c}.\frac{\vec{c}\times\vec{s}_e}{c} = \frac{\vec{c}\times(N.\vec{s}_e)}{c^2} = \frac{\vec{c}\times\vec{E}}{c^2}$$

And with: $$\vec{E} = \frac{q}{4.\pi.\varepsilon_0.r^2}.\vec{e}_c + \{\frac{q}{4.\pi.\varepsilon_0.c.r^2}.v(t-\frac{r}{c}).\sin\theta + \frac{\mu_0.q}{4.\pi.r}.a(t-\frac{r}{c}).\sin\theta\}.\vec{e}_{\perp c}$$

we obtain:

$$\boxed{\vec{B} = \{\frac{\mu_0.q}{4.\pi.r^2}.v(t-\frac{r}{c}).\sin\theta + \frac{\mu_0.q}{4.\pi.c.r}.a(t-\frac{r}{c}).\sin\theta\}.\vec{e}_{\varphi}}$$

IV. The Laws of the electromagnetic Field - Maxwell's Laws.

In the space linked to an inertial reference frame ***O***, the electromagnetic field is characterised by two time dependent vectors: the (effective) e-field $\vec{E}$ and the (effective) magnetic induction $\vec{B}$. In an arbitrary point *P*, these vectors are the results of the superposition of the contributions of the various sources of informatons (the electrical charged masses) to respectively the density of the flow of e-information and to the cloud of b-information in *P*:

$$\vec{E} = \sum N.\vec{s}_e \qquad \text{and} \qquad \vec{B} = \sum n.\vec{s}_b$$

The informatons that - at the moment *t* - pass near *P* with velocity $\vec{c}$ contribute with an amount ($N.\vec{s}_e$) to the instantaneous value of the e-field and with an amount ($n.\vec{s}_b$) to the instantaneous value of the magnetic induction in that point.

- $\vec{s}_e$ and $\vec{s}_b$ respectively are their e-spin and their b-index. They are linked by the relationship:

$$\vec{s}_b = \frac{\vec{c}\times\vec{s}_e}{c}$$

- *N* is the instantaneous value of the density of the flow of informatons with velocity $\vec{c}$ in *P* and *n* is the instantaneous value of the density of the cloud of those informatons in that point. *N* and *n* are linked by the relationschip:

$$n = \frac{N}{c}$$

4.1. Relations between $\vec{E}$ and $\vec{B}$ in a matter free point of an electromagnetic Field

In each point where no matter is located - where $\rho_E(x,y,z;t)$ = $\vec{J}_E(x,y,z;t)$ = *0* - the following statements are valid.

1. In a matter free point *P* of an electromagnetic field, the spatial variation of $\vec{E}$ obeys the law:

$$div\vec{E} = 0$$

This statement is the expression of the law of conservation of e-information. The fact that the rate at which e-information flows inside a closed empty space must be equal to the rate at which it flows out, can be expressed as:

$$\boxed{\oiint_S \vec{E}.\overrightarrow{dS} = 0}$$

So (theorem of Ostrogradsky)[(2)]:

$$div\vec{E} = 0$$

2. In a matter free point *P* of an electromagnetic field, the spatial variation of $\vec{B}$ obeys the law:

$$div\vec{B} = 0$$

This statement is the expression of the fact that the b-index of an informaton is always perpendicular to its e-spin vector $\vec{s}_e$ and to its velocity $\vec{c}$.

For the proof of this theorem - and also for that of the theorems 3 and 4 - we refer to the proof of the analogous theorem in *§4* of "Gravitation explained by the Theory of Informatons"[(1)].

The statement $div\vec{B} = 0$ implies (theorem of Ostrogradsky) that for every closed surface *S* in a gravitational field:

$$\boxed{\oiint_S \vec{B}.\overrightarrow{dS} = 0}$$

3. In a matter free point *P* of an electromagnetic field, the spatial variation of $\vec{E}$ and the rate at which $\vec{B}$ is changing are connected by the relation:

$$rot\vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

This statement is the expression of the fact that any change of the product $n.\vec{s}_b$ in a point of an electromagnetic field is related to a variation of the product $N.\vec{s}_e$ in the vicinity of that point.

The relation $rot\vec{E} = -\frac{\partial \vec{B}}{\partial t}$ implies (theorem of Stokes): *In a gravitational field, the rate at which the surface integral of $\vec{B}$ over a surface S changes is equal and opposite to the line integral of $\vec{E}$ over its boundery L:*

$$\boxed{\oint \vec{E}.\overrightarrow{dl} = -\iint_S \frac{\partial \vec{B}}{\partial t}.\overrightarrow{dS} = -\frac{\partial}{\partial t}\iint_S \vec{B}.\overrightarrow{dS} = -\frac{\partial \Phi_b}{\partial t}}$$

The orientation of the surface vector $\overrightarrow{dS}$ is linked to the orientation of the path on *L* by the "rule of the corkscrew". $\Phi_b = \iint_S \vec{B}.\overrightarrow{dS}$ is called the "magnetic flux through *S*".

4. In a matter free point *P* of an electromagnetic field, the spatial variation of $\vec{B}$ and the rate at which $\vec{E}$ is changing are connected by the relation:

$$rot\vec{B} = \frac{1}{c^2}\frac{\partial \vec{E}}{\partial t}$$

This statement is the expression of the fact that any change of the product $N.\vec{s}_e$ in a point of an electromagnetic field is related to a variation of the product $n.\vec{s}_b$ in the vicinity of that point.

This relation implies (theorem of Stokes): In an electromagnetic field, the rate at which the surface integral of $\vec{E}$ over a surface *S* changes is proportional to the line integral of $\vec{B}$ over its boundery *L:*

$$\boxed{\oint \vec{B}.\overrightarrow{dl} = \frac{1}{c^2}\iint_S \frac{\partial \vec{E}}{\partial t}.\overrightarrow{dS} = \frac{1}{c^2}\frac{\partial}{\partial t}\iint_S \vec{E}.\overrightarrow{dS} = \frac{1}{c^2}\frac{\partial \Phi_e}{\partial t}}$$

The orientation of the surface vector $\overrightarrow{dS}$ is linked to the orientation of the path on *L* by the "rule of the corkscrew". $\Phi_e = \iint_S \vec{E}.\overrightarrow{dS}$ is called the "e-flux through *S*".

4.2. Relations between $\vec{E}$ and $\vec{B}$ in a point of an electromagnetic field•

The volume-element in a point *P* inside a charge continuum is in any case an emitter of e-information and, if the charge is in motion, also a source of b-information.

According to 2.3 , the instantenuous value of ρ_E - the charge density in *P* - contributes to the instantaneous value of $div\vec{E}$ in that point with an amount $\frac{\rho_E}{\varepsilon_0}$; and according to 3.7 the instantaneous value of $\vec{J}_E$ - the charge flow density - contributes to the instantaneous value of $rot\vec{B}$ in *P* with an amount $\mu_0.\vec{J}_E$.

Generally, in a point of an electromagnetic field - linked to an inertial reference frame ***O*** - one must take into account the contributions of the local values of $\rho_G(x,y,z;t)$ and of

• For the effects of dielectric and magnetic materials, see "Gravitatie en Electromagnetisme"(4)

$\vec{J}_G(x,y,z;t)$ as sources of respectively the electric field and the magnetic induction. This results in the generalization and expansion of the laws in a mass free point. By superposition we obtain:

1. In a point *P* of an electromagnetic field, the spatial variation of $\vec{E}$ obeys the law:

$$div\vec{E} = \frac{\rho_E}{\varepsilon_0}$$

In integral form: $\Phi_e = \oiint_S \vec{E}.\overrightarrow{dS} = \frac{1}{\varepsilon_0}.\iiint_G \rho_E.dV$

2. In a point *P* of an electromagnetic field, the spatial variation of $\vec{B}$ obeys the law:

$$div\vec{B} = 0$$

In integral form: $\Phi_b = \oiint_S \vec{B}.\overrightarrow{dS} = 0$

3. In a point *P* of an electromagntic field, the spatial variation of $\vec{E}$ and the rate at which $\vec{B}$ is changing are connected by the relation:

$$rot\vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

In integral form: $\oint \vec{E}.\overrightarrow{dl} = -\iint_S \frac{\partial \vec{B}}{\partial t}.\overrightarrow{dS} = -\frac{\partial}{\partial t}\iint_S \vec{B}.\overrightarrow{dS} = -\frac{\partial \Phi_b}{\partial t}$

4. In a point *P* of an electromagnetic field, the spatial variation of $\vec{B}$ and the rate at which $\vec{E}$ is changing are connected by the relation:

$$rot\vec{B} = \frac{1}{c^2}\frac{\partial \vec{E}}{\partial t} + \mu_0.\vec{J}_E$$

In integral form:

$$\oint \vec{B}.\overrightarrow{dl} = \frac{1}{c^2}\iint_S \frac{\partial \vec{E}}{\partial t}.\overrightarrow{dS} + \mu_0.\iint_S \vec{J}_E.\overrightarrow{dS} = \frac{1}{c^2}.\frac{\partial}{\partial t}\iint_S \vec{E}.\overrightarrow{dS} + \mu_0.\iint_S \vec{J}_E.\overrightarrow{dS} = \frac{1}{c^2}.\frac{\partial \Phi_E}{\partial t} + \mu_0.i$$

These are the laws of Maxwell or the laws of electromagnetism.

V. The interaction between charges

5.1. The interaction between charges at rest

We consider a set of point charges anchored in an inertial reference frame ***O***. They create and maintain an electromagnetic field that is, in each point of the space linked to ***O***, completely determined by the vector $\vec{E}$ **.** Each charge is "immersed" in a cloud of e-information. In every point, except its own anchorage, each charge contributes to the construction of that cloud.

Let us consider the point charge *q* carried by the point mass *m* and anchored in *P*. If the other charges were not there, then *q* would be at the centre of a perfectly spherical cloud of e-information. In reality this is not the case: the emission of e-information by the other charges is responsible for the disturbance of that "*characteristic symmetry*". Because $\vec{E}$ in *P* represents the intensity of the flow of e-information send to *P* by the other charges, the extent of disturbance of that characteristic symmetry in the direct vicinity of *q* is determined by $\vec{E}$ in *P*.

If it was free to move, the point charge *q* could restore the characteristic symmetry of the e-information cloud in his direct vicinity: it would suffice to accelerate with an amount $\vec{a} = \frac{q}{m}.\vec{E}$. Accelerating in this way has the effect that the extern field disappears in the origin of the reference frame anchored to *q*. If it accelerates that way, the mass becomes "blind" for the e-information send to *P* by the other masses, it "sees" only its own spherical e-information cloud.

These insights are expressed in the following postulate.

5.1.1. The postulate of the electrical action

A free material point with mass *m* and charge *q* acquires in a point of an electromagnetic field ($\vec{E},\vec{B}$) an acceleration $\vec{a} = \frac{q}{m}.\vec{E}$ so that the characteristic symmetry of the e-information cloud in its direct vicinity is conserved. A point charge anchored in an electromagnetic field cannot accelerate. In that case it *tends* to move. We can conclude that:

> *A point charge, carried by a mass m, anchored in a point of an electromagnetic field ($\vec{E},\vec{B}$) is subjected to a tendency to move in the direction defined by $\vec{E}$, the e-field in that point. Once the anchorage is broken, the charge acquires a vectorial acceleration $\vec{a}$ that equals $\frac{q}{m}.\vec{E}$.*

5.1.2. The electric force

Because an electrically charged point mass *m* carrying a charge *q* and anchored in a point *P* of an electromagnetic field ($\vec{E},\vec{B}$) experiences an action because of that field, the field must - according to §5.1.2 of "Gravitation explained by the Theory of Informatons"(4) - exert an action on that mass. If the anchorage is broken the effect of that action is an acceleration $\vec{a}=\frac{q}{m}.\vec{E}$. Because the cause of an acceleration is defined as a "force", an electromagnetic field exerts a force on a point charge, more specifically an "electric force" $\vec{F}_E$. The relation between that force ($\vec{F}_E$) and its effect ($\vec{a}$) is:

$$\vec{F}_E = m.\vec{a} \ .$$

So, the relation between the electric field in *P* and the force it exerts on a point charge in that point, is:

$$\boxed{\vec{F}_E = q.\vec{E}}$$

5.1.3. Coulomb's law

In fig 7 we consider two point charges q_1 and q_2 anchored in the points P_1 and P_2 of an inertial frame.

q_1 creates and maintains an electric field that in P_2 is defined by:

$$\vec{E}_2 = \frac{q_1}{4.\pi.\varepsilon_0.R^2}.\vec{e}_{12}$$

This field exerts a gravitational force on q_2:

$$\vec{F}_{12} = q_2.\vec{E}_2 = \frac{q_1.q_2}{4.\pi.\varepsilon_0.R^2}.\vec{e}_{12}$$

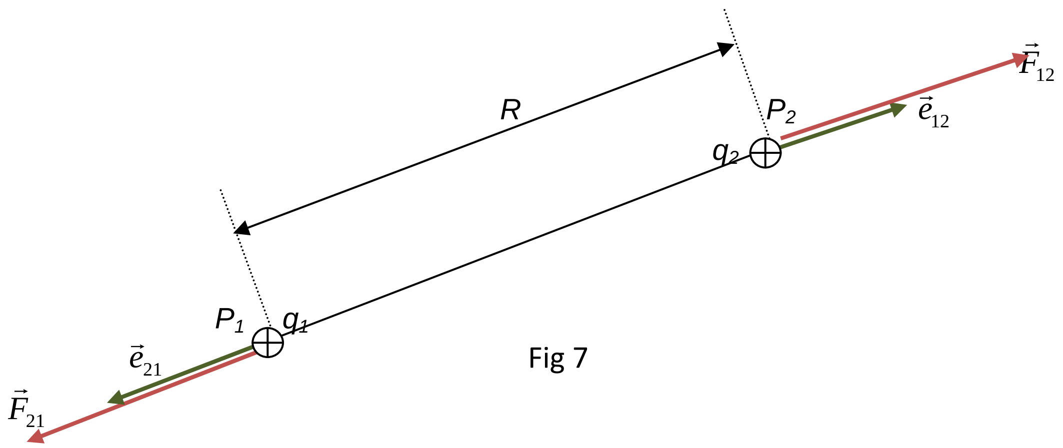


Fig 7

In a similar manner we find $\vec{F}_{21}$:

$$\boxed{\vec{F}_{21} = \frac{q_1.q_2}{4.\pi.\varepsilon_0.R^2}.\vec{e}_{21} = -\vec{F}_{12}}$$

This is the mathematical formulation of *Coulomb's law.*

5.2. The interaction between moving charges

We consider a number of electrically charged point masses (*m, q)* moving relative to an inertial reference frame ***O***. They create and maintain an electromagnetic field that in each point of the space linked to ***O*** is defined by the vectors $\vec{E}$ and $\vec{B}$. Each charge is "immersed" in a cloud of informatons carrying both e- and b-information. In each point, except its own position, each charge contributes to the construction of that cloud. Let us consider the charge *q* that, at the moment *t*, passes in the point *P* with velocity $\vec{v}$.

- If the other charges were not there, the e-field in the vicinity of *q* (the "eigen" e-field of *q*) should be symmetric relative to the carrier line of the vector $\vec{v}$. Indeed, according to 3.3 the e-spin vectors of the informatons emitted by *q* during the interval (*t* - *Δt*, *t* + *Δt*) are all directed to that line. In reality that symmetry is disturbed by the e-information that the other charges send to *P*. $\vec{E}$, the instantaneous value of the e-field in *P,* defines the extent to which this occurs.

- If the other masses were not there, the magnetic induction in the vicinity of *q* (the "eigen" b-field of *q*) should "rotate" around the carrier line of the vector $\vec{v}$. The vectors of the vector-field defined by the vector product of $\vec{v}$ with the magnetic induction that characterizes the "eigen" b-field of *q,* should - as $\vec{E}$ - be symmetric relative to the carrier line of the vector $\vec{v}$. In reality this symmetry is disturbed by the b-information send to *P* by the other charges. The vector product $(\vec{v}\times\vec{B})$ of the instantaneous values of the velocity of *q* and of the magnetic induction in *P*, defines the extent to which this occurs.

So, the *characteristic symmetry* of the cloud of e-information around a moving charge (the "eigen" electromagnetic field) is disturbed by $\vec{E}$ regarding the "eigen" e-field; and by ($\vec{v}\times B$) regarding the "eigen" magnetic field. If it was free to move, the point mass *q* could restore the characteristic symmetry in its direct vicinity by accelerating with an amount $\vec{a}'=\vec{E}+(\vec{v}\times\vec{B})$ relative to its "eigen" inertial reference frame[*] ***O'***. In that manner it would become "blind" for the disturbance of symmetry of the electromagnetic field in its direct vicinity.

These insights form the basis of the following postulate.

[*] The "eigen" inertial reference frame ***O'*** of the point charge *q* is the reference frame that at the moment *t* moves relative to ***O*** with the same velocity as *q*.

5.2.1. The postulate of the electromagnetic action

A point charge q carried by a point mass with rest mass m_0 that is moving in an electromagnetic field ($\vec{E},\vec{B}$) with velocity $\vec{v}$, tends to become blind for the influence of that field on the characteristic symmetry of its "eigen" field. If it is free to move, it will accelerate relative to its "eigen" inertial frame with an amount $\vec{a}'$:

$$\vec{a}' = \frac{q}{m_0}.\{\vec{E} + (\vec{v}\times\vec{B})\}$$

5.2.2. The Lorentz force

Because it is the cause of the acceleration $\vec{a}'$ of the point charge *q* relative to the reference frame that moves with the same velocity $\vec{v}$ as that charge, the force $\vec{F}_{EM}$ exerted on *q* is: $\vec{F}_{EM} = m_0.\vec{a}'$. And with $\vec{a}' = \frac{q}{m_0}.\{\vec{E} + (\vec{v}\times\vec{B})\}$:

$$\boxed{\vec{F}_{EM} = q.(\vec{v}\times\vec{B})}$$

This force is called the *Lorentz force.* It is the superposition of the *electric force* $\vec{F}_E = q.\vec{E}$ and the magnetic force $\vec{F}_B = q.(\vec{v}\times\vec{B})$.

The acceleration $\vec{a}'$ of the point mass relative to the eigen inertial reference frame ***O'*** can be decomposed in a tangential ($\vec{a}_T^{'}$) and a normal component ($\vec{a}_N^{'}$):

$$\vec{a}_T^{'} = a_T^{'}.\vec{e}_T \qquad \text{and} \qquad \vec{a}_N^{'} = a_N^{'}.\vec{e}_N$$

$\vec{e}_T$ and $\vec{e}_N$ are the unit vectors, respectively along the tangent and along the normal to the path of the point mass in ***O'*** (and in ***O***).

We express $a_T^{'}$ en $a_N^{'}$ in function of the characteristics of the motion in the reference system ***O***[(3)]:

$$a_T^{'} = \frac{1}{(1-\beta^2)^{\frac{3}{2}}}.\frac{dv}{dt} \qquad \text{and} \qquad a_N^{'} = \frac{v^2}{R.\sqrt{1-\beta^2}}$$

(If *R* is the curvature of the path in ***O***, the curvature in ***O'*** is $R\sqrt{1-\beta^2}$.)

The Lorentz force is:

$$\vec{F}_{EM} = q.\vec{a}' = q.(a_T^{'}.\vec{e}_T + a_N^{'}.\vec{e}_N) = q.\left[\frac{1}{(1-\beta^2)^{\frac{3}{2}}}.\frac{dv}{dt}.\vec{e}_T + \frac{1}{(1-\beta^2)^{\frac{1}{2}}}.\frac{v^2}{R}.\vec{e}_N\right] = \frac{d}{dt}\left[\frac{m_0}{\sqrt{1-\beta^2}}.\vec{v}\right]$$

Finally, with: $\frac{m_0}{\sqrt{1-\beta^2}}.\vec{v} = \vec{p}$

We obtain: $$\vec{F}_{EM} = \frac{d\vec{p}}{dt}$$

$\vec{p}$ is the linear momentum of the point mass relative to the inertial reference frame ***O***. It is the product of its relativistic mass $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$ with its velocity $\vec{v}$ in ***O***.

The linear momentum of a moving point mass is a measure for its inertia, for its ability to persist in its dynamic state.

5.2.3. The interaction between two uniform linear moving point charges

5.2.3.1. The interaction between two moving point charges according to S.R.T.

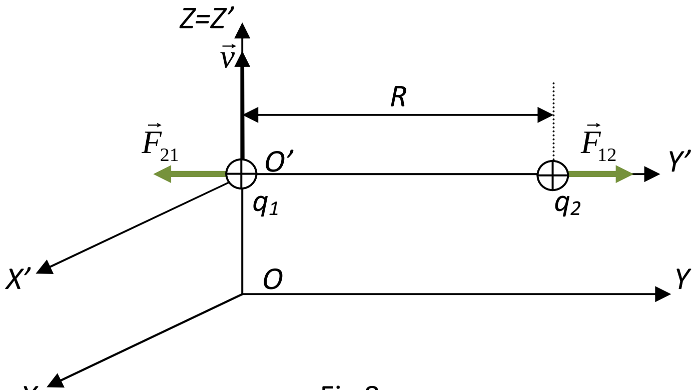


Fig 8

Two point charges, q_1 and q_2 (fig 8) are anchored in the inertial frame ***O'*** that is moving with constant velocity $\vec{v} = v.\vec{e}_z$ relative to the inertial frame ***O***. The distance between the charges is *R.*

In ***O'*** the charges are at rest, they don't move. According to Coulomb's law, they exert on each other forces with equal magnitude:

$$F' = F_{12}^{'} = F_{21}^{'} = \frac{1}{4.\pi.\varepsilon_0}.\frac{q_1.q_2}{R^2}$$

In ***O*** both charges are moving with constant speed v in the direction of the *Z*-axis. From the transformation equations between an inertial frame ***O*** and another inertial frame ***O'***, in which a point charge experiencing a force *F'* is instantaneously at rest[3], we can immediately deduce the force F that the point charges exert on each other in ***O***:

$$F = F_{12} = F_{21} = F'.\sqrt{1-(\frac{v}{c})^2} = F'.\sqrt{1-\beta^2}$$

5.2.3.2. The interaction between two moving point charges according to the theory of informatons

In 3.5, it is shown that the electromagnetic field ($\vec{E},\vec{B}$) of a charged particle q that is moving with constant velocity $\vec{v} = v.\vec{e}_z$ along the *Z*-axis of an inertial frame ***O*** (fig 8) is determined by:

$$\vec{E} = \frac{q}{4\pi\varepsilon_0 r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.\vec{r} = \frac{q}{4\pi\varepsilon_0 r^2}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.\vec{e}_r$$

$$\vec{B} = \frac{q}{4\pi\varepsilon_0 c^2.r^3}.\frac{1-\beta^2}{(1-\beta^2.\sin^2\theta)^{\frac{3}{2}}}.(\vec{v}\times\vec{r})$$

with $\beta = \frac{v}{c}$, the dimensionless speed of *q*. One can verify that these expressions satisfy Maxwell's laws.

In the inertial frame ***O***, the charges q_1 and q_2 are moving in the direction of the *Z*-axis with speed v. q_2 moves through the electromagnetic field generated by q_1, and q_1 moves through that generated by q_2.

According the above formulas, the magnitude of the electromagnetic field created and maintained by q_1 at the position of q_2 is determined by:

$$E_2 = \frac{q_1}{4\pi\varepsilon_0 R^2}.\frac{1}{\sqrt{1-\beta^2}} \quad \text{and} \quad B_2 = \frac{q_1}{4\pi\varepsilon_0 R^2}.\frac{1}{\sqrt{1-\beta^2}}.\frac{v}{c^2}$$

And according to the force law $\vec{F}_{EM} = q.\left[\vec{E} + (\vec{v}\times\vec{B})\right]$, F_{12}, the magnitude of the force exerted by the electromagnetic field ($\vec{E}_2,\vec{B}_2$) on q_2 - this is the repellent force of q_1 on q_2 - is:

$$F_{12} = q_2.(E_2 - v.B_2)$$

After substitution: $$F_{12} = \frac{1}{4\pi\varepsilon_0}.\frac{q_1 q_2}{R^2}.\sqrt{1-\beta^2} = F'_{21}.\sqrt{1-\beta^2}$$

In the same way we find: $$F_{21} = \frac{1}{4\pi\varepsilon_0}.\frac{q_1 q_2}{R^2}.\sqrt{1-\beta^2} = F'_{12}.\sqrt{1-\beta^2}$$

We conclude that the moving charges repel each other with a force:

$$F = F_{12} = F_{21} = F'.\sqrt{1-\beta^2}$$

This result perfectly agrees with that based on S.R.T. (§5.2.3.1).

We can also conclude that the component of the electromagnetic force due to the b-induction is β^2 times smaller than that due to the e-field. *This implies that, for speeds much smaller than the speed of light, the effects of het β-information are masked.*

VI. The electromagnetic field of an harmonically oscillating point charge *q* Electromagnetic waves

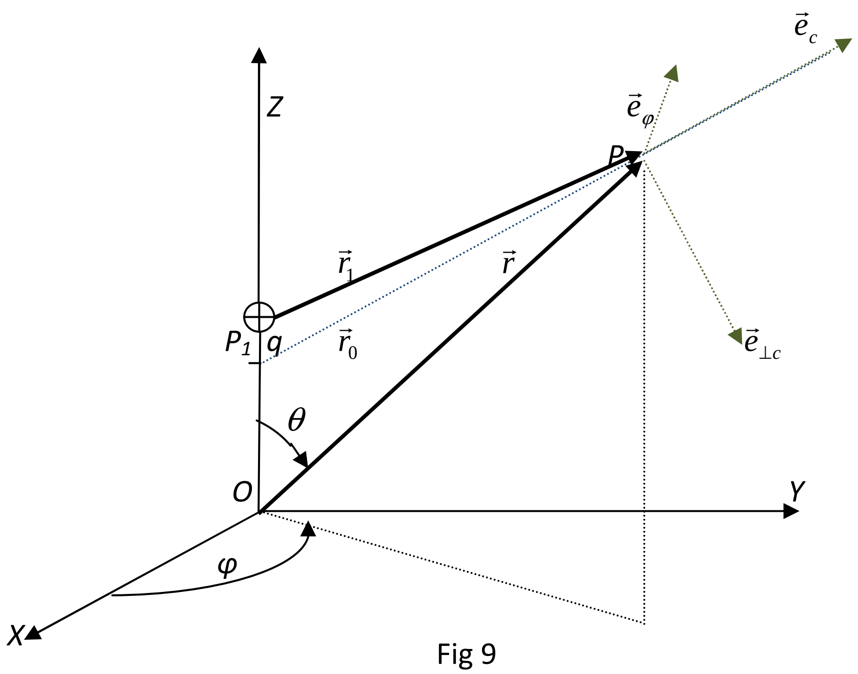


Fig 9

In fig 9 we consider a point charge q that harmonically oscillates around the origin of the inertial reference frame ***O*** with frequency $\nu = \dfrac{\omega}{2.\pi}$. At the moment *t* it passes in P_1. We suppose that the speed of the charge is always much smaller than the speed of light and that it is described by:

$$v(t) = V.\cos\omega t$$

The elongation *z(t)* and the acceleration *a(t)* are than expressed as:

$$z(t) = \frac{V}{\omega}.\cos(\omega t - \frac{\pi}{2}) \qquad \text{and} \qquad a(t) = \omega.V.\cos(\omega t + \frac{\pi}{2})$$

We restrict our considerations about the electromagnetic field of q to points P that are sufficiently far away from the origin O. Under this condition we can posit that the fluctuation of the length of the vector $\overrightarrow{P_1P} = \vec{r}_1$ is very small relative to the length of the time-independent position vector $\vec{r}$, that defines the position of *P* relative to the origin *O.* In other words: we accept that the amplitude of the oscillation is very small relative to the distances between the origin and the points *P* on which we focus.

6.3.1. The transversal electromagnetic field of an harmonically oscillating point charge

Starting from $\overline{V} = V.e^{j.0}$ - the complex quantity representing $v(t)$ - the complex representation $\overline{E}_{\perp c}$ of the time dependant part of the transversal component of $\vec{E}$ and the complex representation $\overline{B}_{\varphi}$ of the time dependant part of $\vec{B}$ in *P* follow immediately from 3.8.2.

$$\overline{E}_{\perp c} = \frac{q.\overline{V}}{4.\pi}.e^{-j.k.r}.(\frac{1}{\varepsilon_0.c.r^2} + \frac{j.\omega.\mu_0}{r}).\sin\theta \quad \text{and} \quad \overline{B}_{\varphi} = \frac{\mu_0.q..\overline{V}}{4.\pi}.e^{-j.k.r}.(\frac{1}{r^2} + \frac{j.k}{r}).\sin\theta$$

Where $k = \frac{\omega}{c}$ is the phase constant. Note that $\overline{B}_{\varphi} = \frac{\overline{E}_{\perp c}}{c}$.

So, an harmonically oscillating point charge emits a transversal electromagnetic wave that - relative to the position of the charge - expands with the speed of light:

$$B_{\varphi}(r,\theta;t) = \frac{E_{\perp c}(r,\theta;t)}{c} = \frac{\mu_0.q.V.\sin\theta.\sqrt{1+k^2r^2}}{4\pi r^2}.\cos(\omega t - kr + \Phi) \quad \text{with} \quad tg\Phi = kr$$

In points at a great distance from the oscillating charge, specifically there were $r >> \frac{1}{k} = \frac{c}{\omega}$, this expression equals asymptotically:

$$B_{\varphi} = \frac{E_{\perp c}}{c} = -\frac{\mu_0.k.q.V.\sin\theta}{4\pi r}.\sin(\omega t - kr) = -\frac{\mu_0.q.\omega.V.\sin\theta}{4\pi cr}.\sin(\omega t - kr) = \frac{\mu_0.q.a_{\theta}(t-\frac{r}{c}).\sin\theta}{4\pi cr}$$

The intensity of the "far field" is inversely proportional to *r*, and is determined by the component of the acceleration of *q*, that is perpendicular to the direction of $\vec{e}_c$.

6.3.2. The longitudinal electromagnetic field of an harmonically oscillating point charge

The oscillation of the point charge *q* along the *Z*-axis is responsible for the existence of a fluctuation of $r_0 = P_1P$ (fig 9), the distance travelled by the informatons that at the moment *t* pass near *P*. Within the framework of our approximations:

$$r_0(t) \approx r - z(t-\frac{r}{c}).\cos\theta = r.\left\{1 - \frac{z(t-\frac{r}{c})}{r}.\cos\theta\right\} \quad \text{and} \quad (\frac{1}{r_0})^2 \approx \frac{1}{r^2}.(1+2.\frac{z(t-\frac{r}{c})}{r}.\cos\theta)$$

From 3.8.2 it follows: $E_c = \frac{q}{4.\pi.\varepsilon_0.r^2} + \frac{q}{4.\pi.\varepsilon_{.0}.r^3}.2.z(t-\frac{r}{c}).\cos\theta$

So $\overline{E}_c$, the complex representation of the time dependant part of the longitudinal electromagnetic field is: $\overline{E}_c = \frac{q.\overline{V}}{4\pi}.e^{-jkr}.\frac{2}{j.\omega.\varepsilon_0.r^3}.\cos\theta$

We conclude that an harmonically oscillating point charge emits a longitudinal electromamgnetic wave that - relative to the position of the mass - expands with the speed of light:

$$E_c(r,\theta;t) = \frac{q.V}{4.\pi.\varepsilon_0.c.k}.\frac{2}{r^3}.\sin(\omega t - kr)$$

In the "far field", it can be neglected relative to the transversal wave.

6.3.3. The energy radiated by an harmonically oscillating point charge

6.3.3.1. Poynting's theorem

In empty space an electromagnectic field is completely defined by the vectorial functions $\vec{E}(x,y,z;t)$ and $\vec{B}(x,y,z;t)$. It can be shown(4) that the spatial area *G* enclosed by the surface *S* contains - at the moment *t* - an amount of electromagnetic energy given by the expression:

$$U = \iiint_G (\frac{\varepsilon_0.E^2}{2} + \frac{B^2}{2\mu_0}).dV$$

The rate at which the energy escapes from *G* is: $-\frac{\partial U}{\partial t} = -\iiint_V (\varepsilon_0.\vec{E}.\frac{\partial \vec{E}}{\partial t} + \frac{1}{\mu_0}.\vec{B}.\frac{\partial \vec{B}}{\partial t}).dV$

According to Maxwell's third law: $rot\vec{E} = -\frac{\partial \vec{B}}{\partial t}$.

And according to the fourth law: $rot\frac{\vec{B}}{\mu_0} = \varepsilon_0.\frac{\partial \vec{E}}{\partial t}$.

So:

$$-\frac{\partial U}{\partial t} = \iiint_G (\frac{\vec{B}}{\mu_0}.rot\vec{E} - \vec{E}.rot\frac{\vec{B}}{\mu_0}).dV = \iiint_G div(\frac{\vec{E}\times\vec{B}}{\mu_0}).dV$$

By application of the theorem of Ostrogradsky(2): $\iiint_G div\vec{F}.dV = \oiint_S \vec{F}.\overrightarrow{dS}$, one can rewrite this as: $-\frac{\partial U}{\partial t} = \oiint_S \frac{\vec{E}\times\vec{B}}{\mu_0}.\overrightarrow{dS}$

One can conclude that the expression $\frac{\vec{E}\times\vec{B}}{\mu_0}.\overrightarrow{dS}$ defines the rate at which energy flows through the surface element *dS* in *P* in the sense of the positive normal. So, the density of the energy flow in *P* is: $\frac{\vec{E}\times\vec{B}}{\mu_0}$. This vectorial quantity is called the "Poynting's vector". It is represented by $\vec{P}$:

$$\vec{P}=\frac{\vec{E}\times\vec{B}}{\mu_0}$$

The amount of energy transported through the surface element *dS* in the sense of the positive normal during the time interval *dt* is:

$$dU=\frac{\vec{E}\times\vec{B}}{\mu_0}.\overrightarrow{dS}.dt$$

6.3.3.2 The energy radiated by an harmonically oscillating point charge - Photons

Under 6.3.1 it is shown that an harmonically oscillating point charge *q* radiates a transversal electromagnetic wave that in a far point *P* is defined by:

$$\vec{E}=E_{\perp c}.\vec{e}_{\perp c}=-\frac{\mu_0.q.\omega.V.\sin\theta}{4\pi r}.\sin(\omega t-kr).\vec{e}_{\perp c}$$

$$\vec{B}=B_{\varphi}.\vec{e}_{\varphi}=-\frac{\mu_0.q.\omega.V.\sin\theta}{4\pi c r}.\sin(\omega t-kr).\vec{e}_{\varphi}$$

The instantaneous value of Poynting's vector in *P* is:

$$\vec{S}=\frac{\mu_0.q^2.\omega^2.V^2.\sin^2\theta}{16.\pi^2.c.r^2}.\sin^2(\omega t-kr).\vec{e}_c$$

The amount of energy that, during one period T, flows through the surface element *dS* that in *P* is perpendicular to direction of of motion of the informatons, is:

$$dU=\int_0^T P.dt.dS=\frac{\mu_0.q^2.\omega^2.V^2.\sin^2\theta}{16.\pi^2.c.r^2}.\frac{T}{2}.dS$$

And with $\omega=\frac{2.\pi}{T}=2.\pi.\nu$:

$$dU=\frac{\mu_0.q^2.V^2.\sin^2\theta}{8c}.\nu.\frac{dS}{r^2}$$

$\frac{dS}{r^2}=d\Omega$ is the solid angle under which *dS* is "seen" from the origin .

So, the oscillating charge radiates, per period, an amount of energy per unit of solid angle in the direction θ :

$$u_{\Omega} = \frac{\mu_0.q^2.V^2.\sin^2\theta}{8c}.\nu$$

The density of the flux of energy is greatest in the direction defined by θ *= 90°*, thus in the direction perpendicular to the movement of the charge. The radiated energy is proportional to the frequency of the wave, thus proportional to the frequency at which the charge oscillates.

We posit that an oscillating charge q loads some of the informatons that it emits with a discrete energy packet hν*. Informatons carrying an energy packet are called photons.*

In other words, we postulate that the electromagnetic energy radiated by an oscillating point charge is transported by informatons. This implies that photons rush through space with the speed of light.

Consequently, the number of photons emitted by an oscillating point charge *q* per period and per unit of solid angle in the direction θ is:

$$N_{f\Omega} = \frac{\mu_0.q^2.V^2.\sin^2\theta}{8hc}$$

It follows that the total number of photons that it emits per period is:

$$N_f = \frac{\mu_0.q^2.V^2}{8hc}.2\pi.\int_0^{\pi}\sin^3\theta.d\theta = \frac{\pi}{3}.\frac{\mu_0}{h.c}.q^2.V^2$$

Let us compare N_f with *N,* the number of informatons that the electrically charged oscillating point mass *m* emits during the same interval:

$$N = \dot{N}.T = \frac{c^2}{h}.m.\frac{1}{\nu} = 1{,}36.10^{50}.\frac{m}{\nu} \qquad \text{and} \qquad N_f = \frac{\pi.\mu_0}{3.h.c}.q^2.V^2 = 6{,}63.10^{18}.q^2.V^2$$

If the oscillating entity is an electron, we obtain:

$$N = \frac{1{,}24.10^{20}}{\nu} \qquad \text{and} \qquad N_f = 1{,}70.10^{-19}.V^2$$

Since the instantaneous speed cannot reach the speed of light, we can find an absolute upper limit for N_f:

$$N_f < 1{,}70.10^{-19}.c^2 = 1{,}53.10^{-2}$$

It is impossible for an oscillating electron to emit more than *1,53.10*$^{-2}$ photons per period.

From the definition of a photon it follows that the number of photons emitted during a period must be smaller than the number of informatons emitted during the same interval:

$$1{,}53.10^{-2} < \frac{1{,}24.10^{20}}{\nu}$$

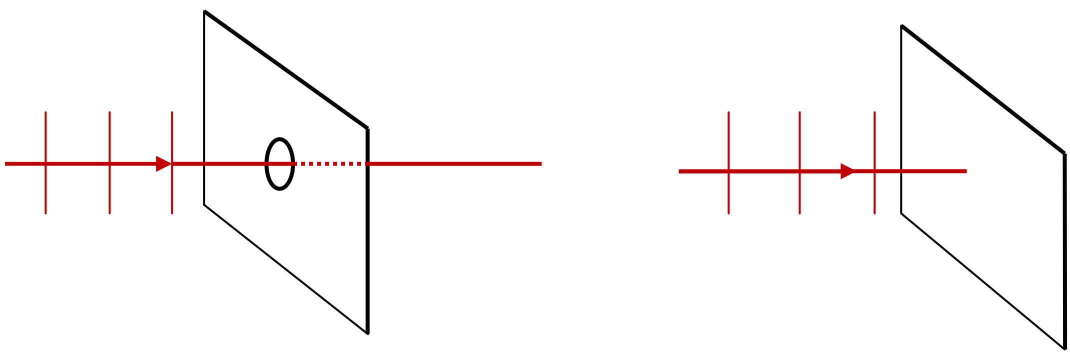
So : $\nu < 8{,}10.10^{21}$ *Hz*.

We conclude that $8{,}10.10^{21}$ *Hz* is an absolute upper limit for the frequency of the electromagnetic waves that can be radiated by an oscillating electron. If the source of radiation is an oscillating proton the frequency of the electromagnetic wave must be smaller than $1{,}50.10^{25}$ *Hz*.

6.3.4. On the dual nature of light

The hypothesis that photons are nothing else than informatons carrying a packet of energy allows us to understand the strange behavior of light as described by QED(6). The wave character of light can be understood as the macroscopic manifestation of the dynamics of the informatons emitted by an oscillating point charge; and the corpuscular character as the manifestation of the fact that some of those informatons are carriers of a quantum of energy. We illustrate this by a short study on the diffraction of light.

6.3.4.1 . Babinet's theorem - The Huygens-Fresnel principle(5)



(a) (b)

Fig 10

In fig 10,a a perfectly opaque flat plate with an opening in it is shown. A plane electromagnetic wave *G* (a light wave) with frequency ν is send to the opening. The "wave fronts" are parallel to the plate. *G* is constituted by a flow of informatons that are transporting e- and b-information, some of them also are carrying a package of energy. In fig 10,b the same plate is shown but now the opening is filled with a perfectly opaque plug.

In each point where it passes the wave maintains an electromagnetic field characterized by the time dependant vector pair ($\vec{E}_0 = \vec{E}_{\perp c}, \vec{B}$). *For the existence of that field it doesn't matter whether or not the informatons are carriers of energy.*

For the expansion of *G* in the space beyond the plate, nor the magnitude or the form of the opening, neither the presence of the plug matters. Indeed, the plate as well as the plug are transparent for the wave since it is constituted by a flow of mass- and energy less entities.

Some of the informatons transport an energy packet. When such an informaton (a "photon") is penetrating the plate (or the plug) its energy package will be absorbed by an atom in the plate (or the plug). That atom will be forced to emit a secondary electromagnetic wave with the same frequency as the incident. The movement of the informaton has not been disturbed by this phenomenon.

So, in the situation of fig 10,a the electric field in a point beyond the plate is composed by the superposition of the original plane wave *G* with the secondary waves that are emitted by the atoms in the plate. $\vec{E}$ - the electric field in a point *P* beyond the plate - is the sum of $\vec{E}_0$ - the electric field in *P* due to the passage of the plane wave *G* - and $\vec{E}_{pl}$ - the electric field due to the passage of the secondary waves generated by the atoms in the plate:

$$\vec{E} = \vec{E}_0 + \vec{E}_{pl}$$

In the situation of fig 10,b, three sources of radiation contribute to the construction of the field beyond the plate:

- the plane wave *G* whose contribution to the field in *P* is $\vec{E}_0$,
- the part of the plate that is hit by *G*; this contributes with an amount $\vec{E}_{pl}$ to the field in *P*,
- the plug that, in this condition, also is a source of radiation. Indeed, since it is absorbing the energy packets that *G* sends in its direction, some of its atoms function as emitters of electromagnetic radiation. The contribution of these waves to the field in *P* is: $\vec{E}_{plug}$.

Naturally, in this situation - where the full plate is opaque - there cannot exist a field in *P*. So:

$$\vec{E}_0 + \vec{E}_{pl} + \vec{E}_{plug} = \vec{E} + \vec{E}_{plug} = 0$$

We conclude: *In the space beyond the plate, the superposition of the field radiated by the plate and that radiated by the plug (the "complement" of the plate) is equal and opposite to the field of the original plane wave.*

$$\vec{E}_{pl} + \vec{E}_{plug} = -\vec{E}_0$$

This is *Babinets theorem.*

An equivalent formulation: *In a point beyond the plate, the plug generates an electromagnetic field that is exactly equal and opposite to the field that there is if the plug is removed;* or *the field in the space beyond the plate without plug is equal and opposite to the field generated by the plug.*

$$\vec{E} = -\vec{E}_{plug}$$

This implies that the field $\vec{E}$ beyond the plate with the opening (situation of fig. 10,a) can be found by considering the opening as the only source of radiation, what can be expressed as:

Each point of the wave front reaching the opening can be regarded as a point source emitting a spherical electromagnetic wave, the effective wave in the region beyond the opening is the superposition of all these waves.

This is the *Huygens-Fresnel principle.*

6.3.4.2. Max Born's interpretation of the diffraction of light

With the Huygens-Fresnel principle as a starting point, we can calculate the strength of the electric field $\vec{E}$ in an arbitrary point in the region beyond the plate of fig 10,a. $\vec{E}$ is an harmonic function of time. E^2 , the square of the effective value of *E(t),* characterizes the intensity of het electromagnetic field (the intensity of light) in *P.*

We know that $\vec{E}$ is a measure of the density of the flow of e-information in *P*: the greater the value of E^2 in *P*, the greater the number of informatons that per unit of time are passing near *P.* Some of these informatons are carriers of an energy packet: it are photons. The denser the cloud of informatons near *P*, the greater the number of photons near that point. So, the density of the cloud of photons near *P* must be proportional to E_P^2.

This explains the *interpretation of Max Born*: *the probability for a photon at a point P is proportional to* E_P^2.

6.3.4.3. Diffraction of light

In fig 11 we consider a plane (light) wave *G* send through a narrow split in a perfectly opaque plate. *a* is the width of the split and *λ* is the wave-length of the wave. The distance *L* between the plate and the screen - that is parallel to the plate - is much larger than *a*.

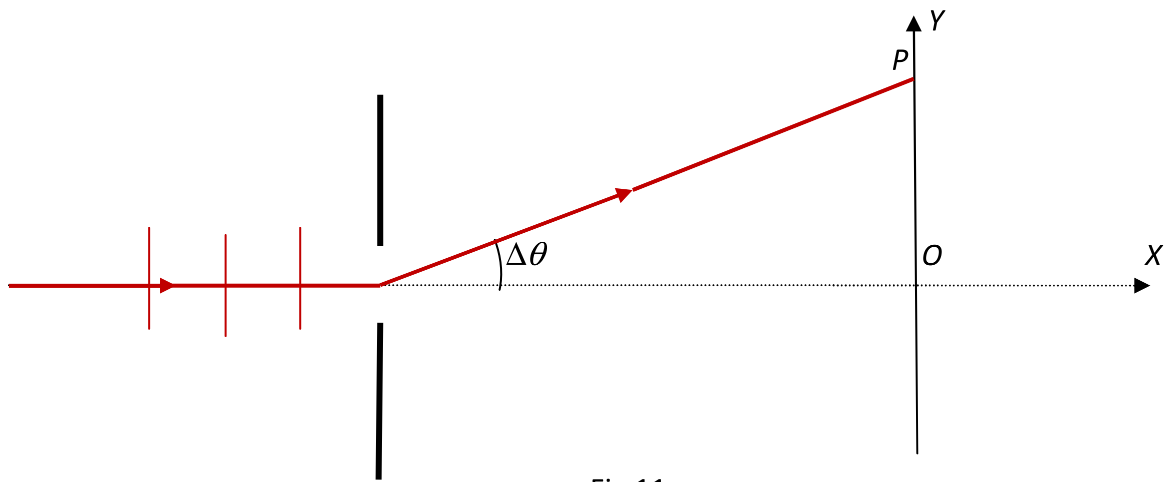


Fig 11

With the Huygens-Fresnel principle as starting point, we can calculate the strength of the (transversal) electric field $\vec{E}$ in an arbitrary point in the region beyond the plate of fig 10,a. $\vec{E}$ is an harmonic function of time. E^2 , the square of the effective value of *E(t),* characterizes the intensity of het electromagnetic field (the intensity of light) in *P*.

The calculation[5] of E_P^2 as a function of $\sin(\Delta\theta)$ learns that E^2 is maximal in the strip of the screen where $\sin(\Delta\theta) \approx 0$ (what corresponds with $y \approx 0$) and gradually decreases to *0* when $\sin(\Delta\theta) = \dfrac{\lambda}{a}$. With a further increase of $\Delta\theta$ corresponds an increase of E_P^2 until a new maximum is reached (a maximum that is smaller than the central one), etc.

Thus, in the centre of the screen (around *y = 0*) is a bright strip whose edges are defined by $\sin(\Delta\theta) = \pm\dfrac{\lambda}{a}$. This bright strip is caught between two dark strips, which are followed by bright strips who are less clear than the central one, etc.

Since the value of E_P^2 is proportional to the number of photons that - per unit of time - goes through *P*, the intensity of light in a point of the screen characterizes the rate at which the screen is hit by photons in that point.

Most of the photons hit the screen in the strip defined by the condition:

$$-\frac{\lambda}{a} < \sin(\Delta\theta) < +\frac{\lambda}{a}$$

The intensity pattern we have found is only possible if the photons that rush through the split can change direction, in other words if they can “deflect”.

Since informatons always move straight away, the deflection of the photon san only be understood as the transition of an energy packet from one informaton to another that crosses its pad.

As explained under 6.3.4.1 two different sources of e-information send informatons through the region between the plate and the screen.

1. Informatons that constitute the incident wave *G* that move in the direction of the *X*-axis.
2. Informatons emitted by the part of the plate that is hit by *G*. They rush through the region beyond the plate in all possible directions.

If informatons of group 1 carrying an energy packet are crossing the path of informatons of group 2, it may happen that they transfer their energy packet. This leads to the substitution of a photon by another. This transfer of an energy packet between two informatons can be interpreted as the deflection of a photon. The deflected photon will hit the screen somewhere where $E^2 \neq 0$, thus in a point of the central strip where $-\frac{\lambda}{a} < \sin(\Delta\theta) < +\frac{\lambda}{a}$, or in another more remote bright strip. One can posit that $|\Delta[\sin(\Delta\theta)]|$ - the uncertainty on the magnitude of the sinus of the angle of deflection - is at least $\frac{\lambda}{a}$:

$$|\Delta[\sin(\Delta\theta)]| \geq \frac{\lambda}{a}$$

6.3.4.4. Heisenberg's uncertainty principle

A photon rushing to the plate has a linear momentum:

$$\vec{p} = \frac{h.\nu}{c}.\vec{e}_x = \frac{h}{\lambda}.\vec{e}_x$$

If it, after been "deflected", hits the screen in the direction $\Delta\theta$, its linear momentum beyond the split has a component parallel to the *Y*-axis:

$$p_y = p.\sin(\Delta\theta) = \frac{h}{\lambda}.\sin(\Delta\theta)$$

The uncertainty on the magnitude of $|\sin(\Delta\theta)|$ corresponds to an uncertainty $|\Delta p_y|$ on the magnitude of p_y:

$$|\Delta p_y| \geq \frac{h}{a}$$

The photon can have gone through each point of the split: so, $a = \Delta y$ is the uncertainty on its position:

$$\Delta y.\Delta p_y \geq h$$

This equation is one of *Heisenberg's uncertainty relations*.

VI. THE NATURE OF THE ELECTROMAGNETIC FIELD•

According to the postulate of the emission of informatons, the electromagnetic field of a charge at rest is characterized by the following statements.

1. ***Electromagnetic phenomena propagate with the speed of light.*** *This is a direct consequence of the fact that - relative to an inertial reference frame - informatons move at the speed of light.*

• We restrict our considerations to electromagnetic fields outside dielectric or magnetic materials.

*2. **The electromagnetic field is granular.** This is evident, because the elementary building blocks - the informatons - are e-information grains. Macroscopically, the granular character of the field can be neglected because of the high density of the cloud of informatons.*

*3. **The electromagnetic field continuously regenerates.** The informatons that constitute the field in ΔV - any volume element of space - are continuously replaced: indeed, they fly through the volume element. So, ΔV contains e-information that is continuously regenerating.*

*4. **The electromagnetic field shows fluctuations.** Because the emission of informatons by a point mass is a stochastic process, the rate at which informatons cross an elementary surface that in P is perpendicular to the direction of movement, fluctuates. This implies that there is noise on the e-field* $\vec{E}$.

*5. **The electromagnetic field expands with the speed of light.** The surface of the spherical cloud of informatons that is generated and maintained by a point mass moves away from the emitter at the speed of light.*

*6. **In an electromagnetic field, there is conservation of e-information.** The source of e-information is the charge of the emitter. In a point P of an inertial reference frame, a charge continuum is macroscopically characterized by the charge density* ρ_E. *The rate at which e-information flows out through a closed surface equals the rate at which e-information is generated in the space enclosed by that surface. Mathematically, this can be expressed as a relation between the spatial variation of the e-field* $\vec{E}$ *and the charge density* ρ_E *in P:*

$$div\vec{E} = \frac{\rho_E}{\varepsilon_0}.$$

Complementary, the following statements are valid for the electromagnetic field of a uniformly moving charge.

*7. **The e-field** $\vec{E}$ **in P of a point charge that is moving with constant velocity is always on the line that connects P with the actual position of that charge.** This is an obvious consequence of the fact that the e-spin vector of the informatons emitted by that charge is always on the line that the informatons connects to the actual position of their emitter. This implies that in a point of an electromagnetic field generated by a moving charge q, the orientation of the e-field is not determined by the direction in which q is seen (that is its light-delayed position) , but by that where q really is.*

*8. **The e-induction** $\vec{B}$ **shows fluctuations**. The reason for this phenomenon is the same as that for the phenomenon mentioned under 4.*

*9. **From the definition of the b-index, it follows**:* $div\vec{B} = 0$. *This relation is the expression of the fact that* $\vec{s}_b$, *the b-index of an informaton is always perpendicular to its velocity* $\vec{c}$.

*10.**The spatial variation of the magnetic induction in a point of an electromagnetic field depends on $\vec{J}_E$, the densitity of the charge flow in that point:** $rot\vec{B} = \mu_0.\vec{J}_E$ with $\mu_0 = \dfrac{1}{\varepsilon_0.c^2}$. The source of b-information is moving charge. In a point of an inertial reference frame, a continuous charge flow is macroscopically characterized by the charge flow density $\vec{J}_E$. The relation $rot\vec{B} = \mu_0.\vec{J}_E$ expresses how the generation of b-information in a point is affecting the magnetic induction in that point.*

The definitions of $\vec{E}$ and of $\vec{B}$ can be extended to the situation where the electromagnetic field is generated by a set of whether or not - uniformly or not uniformly - moving point charges or by a whether or not moving charge continuum. In that general case, the statements 1 - 10 stay valid. In addition:

*11.**From the dynamics of an informaton, it follows that in empty space**:*

- *11,a.* $rot\vec{E} = -\dfrac{\partial\vec{B}}{\partial t}$
- *11,b.* $rot\vec{B} = \dfrac{1}{c^2}.\dfrac{\partial\vec{E}}{\partial t}$

*12.**There is a perfect isomorphism between the gravitational field and the electromagnetic field.** From 6, 9, 10, 11, it follows that in a point P situated in a charge continuum that is characterized by the charge density ρ_E and the charge flow density $\vec{J}_E$, $\vec{E}$ and $\vec{B}$ satisfy the following equations:*

- *12,1.* $div\vec{E} = \dfrac{\rho_E}{\varepsilon_0}$
- *12,2.* $div\vec{B} = 0$
- *12,3.* $rot\vec{E} = -\dfrac{\partial\vec{B}}{\partial t}$
- *12,4.* $rot\vec{B} = \mu_0.\vec{J}_E + \dfrac{1}{c^2}.\dfrac{\partial\vec{E}}{\partial t}$

In an inertial reference system, the interaction between charges is determined by a force law that is analogue to the force law of G.E.M. It is the expression of the fact that a point charge tends to become blind for the flow of e-information generated by other point charges.

*13. **A point charge q that moves with velocity $\vec{v}$ through an electromagnetic field ($\vec{E},\vec{B}$) experiences a force** $\vec{F}_{EM} = q.\left[\vec{E} + (\vec{v}\times\vec{B})\right]$.*

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