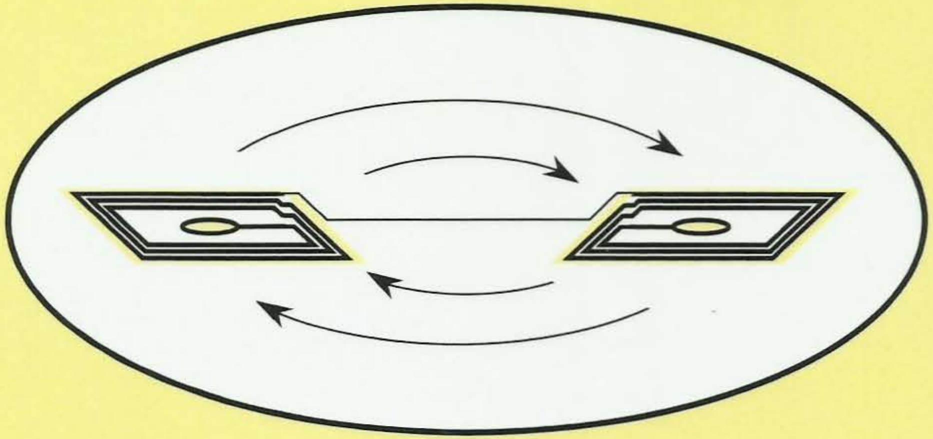
Konstantin Meyl

# Scalar Wave Transponder



Field-physical basis for electrically coupled bi-directional far range transponder

## Scalar Wave Transponder

by

Prof. Dr. Konstantin Meyl

Current RFID technology explains how the transfer of energy takes place on a chip card by means of longitudinal wave components in close range of the transmitting antenna. It is scalar waves which spread towards the electrical or the magnetic field pointer. That provides the better explanation.
Using the wave equation proposed by Maxwell's field equations these wave components were set to zero. Why were only the postulated model computations provided after which the range is limited to the sixth part of the wavelength.
Meyl in this text proposes instead the rationale for scalar wave components in the wave equation of Laplace. Physical conditions for the development of scalar wave transponders become operable well beyond the close range. Scalar wave information and energy is transferred with the same carrier wave and not carried over two separated ways as with RFID systems. Bi-directional signal transmission with energy transfer in both directions is achieved when there is a resonant coupling between transmitter and receiver.
The first far range transponders developed on the basis of the extended field equations are already functional as prototypes. *(Prof. Dr. Ray Turner)*

**Field-physical basis for electrically coupled bi-directional Far range transponder**

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# Scalar Wave Transponder

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## Preface

Before the introduction into the topic, the title of the book should be first explained in more detail. A "**scalar wave**" spreads like every wave directed, but it consists of physical particles or formations, which represent for their part scalar sizes. The name scalar is avoided by some critics or is even disparaged because of the apparent contradiction in the designation which makes believe the wave is not directional, which does not apply.

The term "**scalar wave**" originates from mathematics and is as old as the wave equation itself, which started with the mathematician Laplace. It can be used favorably as a generic term for a large group of wave features, for example for acoustic waves, gravitational waves, or plasma waves.

Seen from the physical characteristics they are longitudinal waves. Contrary to the transverse waves, such as electromagnetic waves, scalar waves carry and transport energy and impulse. Thus one of the tasks of **scalar wave transponders** is fulfilled.

The term "**transponder**" consists of the terms transmitter and responder, describes thus radio devices which receive incoming signals, in order to redirect or answer them. First there were only active transponders, which require a power supply from outside. Next passive systems were developed whose receiver gets the necessary energy at the same time conveyed by the transmitter wirelessly.

After the state of the art several high frequency channels are necessary around the two parts of a transponder system to couple one with another.

The transfer of energy from the fundamental unit to the Transceiver takes place with a low frequency, in order to obtain, as a consequence of the high wavelength, the largest range as possible. The Data flows in the opposite direction and takes place with high frequencies, which usually already lie in the range of the cellular phone network. Additionally, if data is to be conveyed from the fundamental unit to the Transceiver, then a third channel with its own transmitter and receiver is necessary.

Expenditure are drastically reduced to only one channel with a substantially larger range.
Basis is the extended field theory formulated by me, which forms the emphasis in the available paper.

Two co-workers of my institute, the 1. Transfer centre for scalar wave technology (www.etzs.de), have demonstrated 2003 on a congress in the technology park of Villingen Schwenningen for the first time publicly, on the ISM frequency of 6.78 MHz, a scalar wave transponder in function consisting of a bi-directional LAN connection to exchange data between two PC's coupled with a transfer of energy for the passive interface map over a distance of 30 m.

I think, the indeterminable trend required for new technologies and applications for transponders require an extended field theory, to which this paper can give a valuable contribution.

*Konstantin Meyl*

Radolfzell, Germany, June 2005 www.meyl.eu



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# 1. Introduction

## 1.1 Abstract of the practical setting of tasks

Transponders serve the transmission of energy e.g. on a chip card in combination with a transmission of information. The range is with the presently marketable devices (RFID technology) less than one meter [1-1]. The energy receiver must be in close range of the transmitter.

The far range transponders developed by the first transfer centre for scalar wave technology are able to transfer energy beyond close range (10 to 100 m) with fewer losses and/or a higher efficiency. The energy using the same carrier wave is transferred as well as information vs. the RFID technology which uses two separate systems [1-1].

A condition for new technologies is a technical-physical understanding, as well as a mathematically correct and comprehensive field description, which include all well-known effects of the close range of an antenna. We encounter here a central problem of the field theory, which forms the emphasis of this paper and the basis for advancements in transponder technology.

## 1.2 Requirements at transponders

In today's times of Bluetooth and Wireless LAN one quickly becomes accustomed to the amenities of wireless communication. For example garage gates, the barrier of the parking lot, or the car trunk are opened by radio.
However, the limited life span and often polluting batteries used in numerous radio transmitters and remote maintenances create a great disadvantage.

Ever more frequently the developers see themselves confronted with the demand for a wireless transfer of energy. Accumulators are to be reloaded or replaced completely. In entrance control systems (ski elevator, stages, department stores...) these systems are already successfully used. But new areas of application with increased requirements are constantly added apart from the desire for a larger range:

- In telemetry plants rotary sensors are to be supplied with energy (in the car e.g. to control tire-pressure).
- Also with heat meters the energy should come from a central unit and be spread wireless in the whole house to the heating cost meters without the use of batteries.
- In airports contents of freight containers are to be seized, without having been opened (security checks).
- The forwarding trade wants to examine closed truck charges by transponder technology.
- In the robot and handling technique the wirings are to be replaced by a wireless technology due to



wear-out problem.

- Portable radio devices, mobile phones, Notebooks and remote controls working without batteries and Accumulators will reduce the environmental impact.

A technical solution, which is based on pure experimenting and trying, is to be optimised unsatisfactorily and hardly. It should stand rather on a field-theoretically secured foundation, whereby everyone thinks first of Maxwell's field equations. Here however a new hurdle develops itself engaged closely.

## 1.3 Problem of the field theory

In the close range of an antenna, the current level of knowledge is longitudinal based - towards a field pointer portions of the radiated waves present. These are usable in the transponder technology for the wireless transmission of energy. The range amounts to only $\lambda/2\pi$ and that is approximately the sixth part of the wavelength [1-2].

The problem consists now of the fact that the valid field theory from Maxwell, is only able to describe transversal and not longitudinal wave components.
All computations of longitudinal waves or wave components, which run toward the electrical or the magnetic pointer of the field, are based without exception on postulates [1-3].

The near field is not considered in vain as an unresolved problem of the field theory. The experimental proof may succeed, but not the field-theoretical proof.

## 1.4 Field equations according to Maxwell

A short derivation brings it to light. We start with the formulation of Faraday's law of induction according to the textbooks

$$\boxed{\text{curl } \mathbf{E} = -\partial \mathbf{B}/\partial t} \qquad (1.1)$$

with the electric field strength $\mathbf{E} = \mathbf{E}(\mathbf{x},t)$
and the magnetic field strength $\mathbf{H} = \mathbf{H}(\mathbf{x},t)$, with $\mathbf{x} = \mathbf{r}(t)$

and: $\mathbf{B} = \mu \cdot \mathbf{H}$ (1. relation of material), (1.2)

apply the curl-operation to both sides of the equation

$$-\text{curl curl } \mathbf{E} = \mu \cdot \partial(\text{curl } \mathbf{H})/\partial t \qquad (1.3)$$

and insert in the place of curl **H** Ampere's law:

$$\boxed{\text{curl } \mathbf{H} = \mathbf{j} + \partial \mathbf{D}/\partial t} \qquad (1.4)$$

with $\mathbf{j} = \sigma \cdot \mathbf{E}$ (Ohm's law) (1.5)

with $\mathbf{D} = \varepsilon \cdot \mathbf{E}$ (2. relation of material) (1.6)

and $\tau_1 = \varepsilon/\sigma$ (relaxation time [1-4]) (1.7)

$$\boxed{\text{curl } \mathbf{H} = \varepsilon \cdot (\mathbf{E}/\tau_1 + \partial \mathbf{E}/\partial t)} \qquad (1.8)$$

$$-\text{curl curl } \mathbf{E} = \mu \cdot \varepsilon \cdot (1/\tau_1 \cdot \partial \mathbf{E}/\partial t + \partial^2 \mathbf{E}/\partial t^2) \qquad (1.9)$$

with the abbreviation: $\mu \cdot \varepsilon = 1/c^2$ (1.10)

The generally known result describes a damped electromagnetic wave [1-5]:

$$\boxed{\underbrace{-\text{curl curl } \mathbf{E} \cdot c^2}_{\text{transverse}} = \underbrace{\partial^2 \mathbf{E}/\partial t^2}_{\text{- wave}} + \underbrace{(1/\tau_1) \cdot \partial \mathbf{E}/\partial t}_{\text{+ vortex damping}}} \qquad (1.11)$$



On the one hand it is a transverse wave. On the other hand there is a damping term in the equation which is responsible for the losses of an antenna. It indicates the wave component, which is converted into standing waves, can also be called field vortices, which produce vortex losses for their part with the time constant $\tau_1$ in the form of heat.

Where, at close range of an antenna proven and with transponders technically used longitudinal wave components hide themselves in the field equation (1.11)?

## 1.5 Wave equation according to Laplace

In textbooks the Laplace equation is given. Originally it stems from his teacher d'Alembert (1747) but in a one-dimensional formula. By use of the Laplace operator the famous French mathematician Laplace considerably earlier than Maxwell did find a comprehensive formulation of waves and formulated it mathematically:

$$\boxed{\underbrace{\Delta \mathbf{E}}_{\substack{\text{Laplace}\\\text{operator}}} \cdot c^2 = \underbrace{-\text{curl curl } \mathbf{E} \cdot c^2}_{\substack{\text{transverse-}\\\text{(radio wave)}}} + \underbrace{\text{grad div } \mathbf{E} \cdot c^2}_{\substack{\text{longitudinal-}\\\text{(scalar wave)}}} = \underbrace{\delta^2 \mathbf{E}/\delta t^2}_{\text{wave}}} \qquad (1.12)$$

On the one side of the wave equation the Laplace operator stands, which describes the spatial field distribution and, according to the rules of vector analysis, can be decomposed into two parts [3-1]. On the other side the description of the time dependency of the wave can be found.

## 1.6 The wave equations in the comparison

If the wave equation according to Laplace (1.12) is compared to equation (1.11) derived from the Maxwell equations, then two differences clearly come forward:

1. In the Laplace equation the damping term is missing.
2. With divergence **E** a scalar factor appears in the wave equation and a scalar wave as a consequence.

A Practical example of a scalar wave is the plasma wave. This case forms according to the 3. Maxwell equation:

$$\operatorname{div} \mathbf{D} = \varepsilon \cdot \operatorname{div} \mathbf{E} = \rho_{el} \tag{1.13}$$

the space charge density consisting of charge carrier's $\rho_{el}$ the scalar portion. These move in form of a shock wave longitudinal forward and present in its whole an electric current.

Since both descriptions of wave's posses equal validity, we are entitled in the sense of a coefficient comparison to equate the damping term due to eddy currents according to Maxwell (1.11) with the scalar wave term according to Laplace (1.12).

Physically seen the generated field vortices form and establish a scalar wave.

The presence of div **E** proves a necessary condition for the occurrence of eddy currents. Because of the well-known skin effect [ 1-6 ] expanding and damping acting eddy currents, which appear as a consequence of a current density **j** , set ahead an electrical conductivity $\sigma$ (acc. to eq. 1.5).



## 1.7 The view of duality

Within the near field range of an antenna opposite conditions are present. With bad conductivity in a general manner a vortex with dual characteristics would be demanded for the formation of longitudinal wave components. I want to call this contracting antivortex a **potential vortex** contrasting the expanding vortex by eddy currents.

If we examine the potential vortex with the Maxwell equations for validity and compatibility, then the potential vortex would be Zero. The derivation of the damped wave equation (1.1 to 1.11) can take place in stead of the electrical also for the magnetic field strength. Both wave equations (1.11 and 1.12) do not change their shape. In the Laplace equation in this dual case however, the longitudinal scalar wave component through div **H** is described and this is according to Maxwell zero!

4. Maxwell's equation: $\operatorname{div} \mathbf{B} = \mu \cdot \operatorname{div} \mathbf{H} = 0$ (1.14)

If this is correct, then there may not be a near field, no wireless transfer of energy, and finally also no transponder technology. Therefore, the correctness (of eq. 1.14) is to be examined, what would be the result if potential vortices exist forming scalar waves in the air around an antenna, as the field vortices form among themselves a shock wave.

Besides still another boundary problem will be solved: since in div **D** electrical monopoles can be seen (1.13) there should result from duality to div **B** magnetic monopoles (1.14). But the search was so far unsuccessful [1-7]. Vortex physics will give the answer.

## 2. The approach: Faraday instead of Maxwell

If a measurable phenomenon for example the close range of an antenna should not be described with the field equations according to Maxwell mathematically, then prospect is to explore a new approach. All efforts to prove the correctness of the Maxwell theory with the Maxwell theory end inevitably in a tail-chase, which does not prove anything in the end.

In a new approach high requirements are posed. Requirement about do not contradict the Maxwell theory, since these supply correct results in most practical cases and may be seen as confirmed. It would be only an extension permissible, in which the past theory is contained as a subset.
Let's go on the quest.

### 2.1 Vortex and anti-vortex

In the eye of a tornado the same calm prevails as at great distance, because here a vortex and its anti-vortex work against each other. In the inside the expanding vortex is located and on the outside the contracting anti-vortex. One vortex is the condition for the existence of the other one and vice versa. Already Leonardo da Vinci knew both vortices and has described the dual manifestations [2-1].

In the case of flow vortices the viscosity determines the diameter of the vortex tube where the coming off will occur. If for instance a tornado soaks itself with water above the open ocean, then the contracting potential vortex is predominant and the energy density increases



threateningly. If the tornado runs overland and rains out, it again becomes bigger and less dangerous.
Influences are understood in fluid mechanics. They are usually well visible and without further aids observable.


Fig.: 1 [2-1]: The Tornado i.e. shows a physical basic principle of vortex and anti-vortex

In electrical engineering it's different: here field vortices remain invisible. Only so a theory could find acceptance, although it only describes mathematically the expanding eddy current and ignores its anti-vortex. I call the contracting anti-vortex „potential vortex“ and point to the circumstance, that every eddy current entails the anti-vortex as a physical necessity. By this reconciliation it is ensured that the condition in the vortex centre corresponds in the infinite one, complete in analogy to fluid mechanics.

## 2.2 The Maxwell approximation

The approximation, which is hidden in the Maxwell equations, thus consists in neglecting the anti-vortex dual to the eddy current. It is possible that this approximation is allowed, as long as it only concerns processes inside conducting materials. The transition to insulators however, which requires for the laws of the field refraction steadiness, is incompatible with the acceptance of eddy currents in the cable and a nonvortical field in air. In such a case the Maxwell approximation will lead to considerable errors.
If we take as an example lightning and ask how the lightning channel is formed: "Which mechanism is behind it, if the electrically insulating air for a short time is becoming a conductor?" From the viewpoint of vortex physics the answer is obvious: The potential vortex, which in the air is dominating, contracts very strong and doing so squeezes all air charge carriers and air ions, which are responsible for the conductivity, together at a very small space to form a current channel.

The contracting potential vortex thus exerts a pressure and with that forms the vortex tube. Besides the cylindrical structure another structure can be expected. It is the sphere, which is the only form, that can withstand a powerful pressure equally from all directions of space; think of ball lightning!

We imagine now a spherical vortex, in whose inside an expanding vortex is enclosed and which is held together from the outside by the contracting potential vortex and is forced into its spherical shape. From the infinite measured, this spherical vortex would have an electrical charge and all the characteristics of a charge carrier.



| | |
|---|---|
| Inside: | expanding eddy current (skin effect) |
| Outside: | contracting anti-vortex (potential vortex) |
| Condition | for coming off: equally powerful vortices |
| Criterion: | electric conductivity (determines diameter) |
| Result: | spherical structure (consequence of the pressure of the vacuum) |

Fig. 2: The electron as an electromagnetic sphere-vortex

## 2.3 Discussion about magnetic monopoles

With the tendency of the potential vortex for contraction, inevitably the ability is linked to a structural formation. The particularly obvious structure of a ball would be a useful model for quanta.

A to the sphere formed field-vortex would be described mathematically in its inside with the expanding vortex div **D**. For the potential vortex working against from the outside div **B** would apply. The divergence may be set therefore neither with the electrical field (4th Maxwell equation) nor with the magnetic field (3rd Maxwell equation) to zero!

If however both equations are necessary for the derivation of an electron, then it is a mistake in reasoning to assign one alone to an electrical and the other one to a magnetic monopole.

Since the radius at which it comes to vortex detaching the size of the sphere vortex depends on its conductivity, electrical monopoles and among them rank numerous elementary particles, would be extremely small.
However Magnetic monopoles would have to take enormous, no longer for us measurable dimensions.

## 2.4 The discovery of the law of induction

In the choice of the approach the physicist is free, as long as the approach is reasonable and well founded. In the case of Maxwell's field equations two experimentally determined regularities served as basis. On the one hand Ampère's law and on the other hand the law of induction of Faraday. The mathematician Maxwell thereby gave the finishing touches for the formulations of both laws. He introduced the displacement current D and completed Ampère's law without a chance of being able to measure and prove the measure. Only after his death was this possible experimentally. This afterwards makes clear the format of this man.

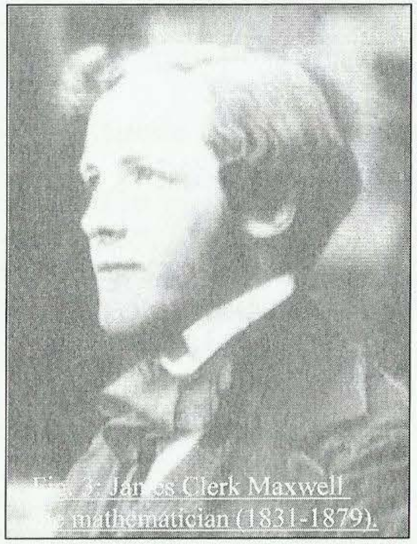


Fig. 3: James Clerk Maxwell the mathematician (1831-1879).

In the formulation of the law of induction Maxwell was completely free, because the discovery Michael Faraday had done without specifications. As a man of practice and of experiment the mathematical notation was less important for Faraday. For him the attempts with which he could show his discovery of the induction to everybody, e.g. his unipolar generator, stood in the foreground.

His 40 years younger friend and professor of mathematics Maxwell however had something completely different in mind. He wanted to describe the light as an electromagnetic wave and in doing so the wave



description of Laplace went through his mind, which in turn needs a second time derivation of the field factor.

Because Maxwell for this purpose needed two equations with each time a first derivation, he had to introduce the displacement current in Ampère's law and had to choose an appropriate notation for the formulation of the law of induction to get to the wave equation.

His light theory initially was very controversial. Maxwell found faster acknowledgement for bringing together the teachings of electricity and magnetism and the representation as something unified and belonging together [2-2] than for mathematically giving reasons for the principle discovered by Faraday.

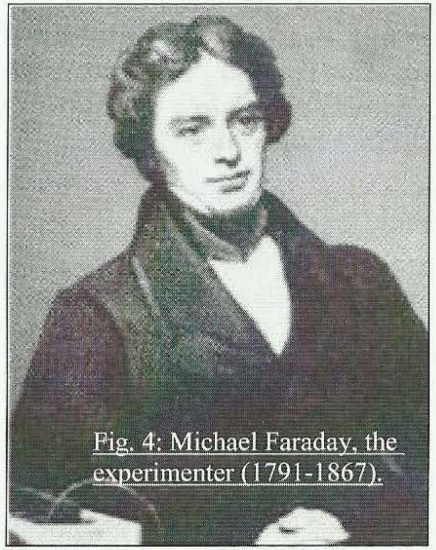


Fig. 4: Michael Faraday, the experimenter (1791-1867).

Nevertheless questions should be asked. If Maxwell has found the suitable formulation, if he has understood 100 % correct his friend Faraday. If the discovery (from 29.08.1831) and the mathematical formulation (1862) stem from two different scientists, who in addition belong to different disciplines, misunderstandings are not possible? It will be helpful to work out the differences.

## 2.5 The unipolar generator

If one turns an axially polarized magnet or a copper disc situated in a magnetic field, then perpendicular to the direction of motion and perpendicular to the magnetic field pointer a pointer of the electric field will occur, which everywhere points axially to the outside. In the case of this by Faraday developed unipolar generator, by means of a brush between the rotation axis and the circumference, a tension voltage can be called off.

The mathematically correct relation $\mathbf{E} = \mathbf{v} \times \mathbf{B}$ (2.1)

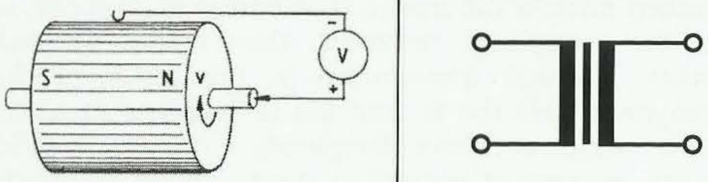
i call Faraday-law, despite the fact that it appears in this form in textbooks later in time [2-3]. The formulation usually is attributed to the mathematician Hendrik Lorentz, since it appears in the Lorentz force in exactly this form. Much more important than the mathematical formalism are the experimental results and the discovery by Michael Faraday, for which the law concerning unipolar induction is named after Faraday.

Of course we must realize that the charge carriers at the time of the discovery hadn't been discovered yet and the field concept couldn't correspond to that of today. The field concept was an abstracter one, free of any quantisation.

That of course is also valid for the field concept advocated by Maxwell, which we now contrast with the „Faraday-law" (fig. 5). The second Maxwell equation, the law of induction (2.2), also is a mathematical description between the electric field strength **E** and the magnetic induction **B**. But this time the two aren't linked by a relative velocity **v**.



| e.g.: unipolar generator | e.g. transformer |
|---|---|




| Discovery of Faraday | 2nd Maxwell equation |
|---|---|
| $\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$ (2.1) | $\boxed{\text{curl } \mathbf{E} = -\partial\mathbf{B}/\partial t}$ (2.2) |
| unipolar induction | law of induction generally |

Fig. 5: Two formulations for one law
As a mathematical relation between the vectors of the electric field strength **E** and the induction **B** (= magnetic flux density)

In place stands the time derivation of **B**, with which a change in flux is necessary for electric field strength to occur. As a consequence the Maxwell equation doesn't provide a result in the static or quasi-stationary case. In such cases is usual to fall back upon the unipolar induction according to Faraday (e.g. in the case of the Hall-probe, the picture tube, etc.). The falling back should only remain restricted to such cases, so the normally idea used. The question is then asked "Which restriction of the Faraday-law to stationary processes is made?"

The vectors **E** and **B** can be subject to both, spatial and temporal fluctuations. In that way the two formulations suddenly are in competition with each other and we are asked, to explain the difference, as far as such a difference should be present.

## 2.6 Different induction laws

For instance such a difference it is common practice to neglect the coupling between the fields at low frequencies. At high frequencies in the range of the electromagnetic field the **E**- and the **H**-field are mutually dependent while at lower frequency and small field change the process of induction drops correspondingly according to Maxwell, so that a neglect seems to be allowed. Now electric or magnetic field can be measured independently of each other. Usually is proceeded as if the other field is not present at all.

That is not correct. A look at the Faraday-law immediately shows that even down to frequency zero both fields are always present. The field pointers however stand perpendicular to each other, so that the magnetic field pointer wraps around the pointer of the electric field in the form of a vortex ring in the case that the electric field strength is being measured and vice versa.

The closed-loop field lines are acting neutral to the outside; they hence need no attention, so the normally used idea. It should be examined more closely if this is sufficient as an explanation for the neglect of the not measurable closed-loop field lines, or if not after all an effect arises from fields, which are present in reality.

Another difference concerns the commutability of **E**- and **H**-field, as is shown by the Faraday-generator, how a magnetic field becomes an electric field and vice versa as a result of a relative velocity **v**. This directly influences the physical-philosophic question:

*"What is meant by the electromagnetic field?"*



## 2.7 The electromagnetic field

The textbook opinion, based on the Maxwell equations, names the static field of the charge carriers as a cause for the electric field, whereas moving ones cause the magnetic field [1-6 et al.]. But that could not have been the idea of Faraday, to whom the existence of charge carriers was completely unknown.

For his contemporaries, completely revolutionary abstract field concept, is based on the works of the Croatian Jesuit priest Boscovic (1711-1778). In the case of the field it should less concern a physical quantity in the usual sense, than rather the „experimental experience“ of an interaction according to his field description.
We should interpret the Faraday-law to the effect that *we experience an electric field if we are moving with regard to a magnetic field with a relative velocity* and vice versa.

In the commutability of electric and magnetic fields a duality between the two is expressed, which in the Maxwell formulation is lost, as soon as charge carriers are brought into play. The question then becomes, *"Is the Maxwell field the special case of a particle free field?"*

Much evidence points to then answer as "yes", because after all a light ray can run through a particle free vacuum. If fields can exist without particles, particles without fields however are impossible, then the field should have been there first as the cause for the particles! In conclusion, the Faraday description should form the basis from which all other regularities can be derived.

What do the textbooks say to that?

## 2.8 Contradictory opinions in textbooks

Obviously there exist two formulations for the law of induction (2.1 and 2.2), which more or less have equal rights. Science stands for the questions: "*Which mathematical description is the more efficient one? If one case is a special case of the other case, which description then is the more universal one?*"

What Maxwell's field equations tell us is sufficiently known, so that derivations are unnecessary. Numerous textbooks are standing by, if results should be cited. Let us hence turn to the Faraday-law (2.1).

Often one searches in vain for this law in schoolbooks. Only in more pretentious books one makes a find under the keyword *unipolar induction.* If one compares the number of pages which are spent on the law of induction according to Maxwell with the few pages for the unipolar induction, then one gets the impression that the later is only an unimportant special case for low frequencies.

Küpfmüller speaks of a „special form of the law of induction" [2-4], and cites as practical examples the induction in a brake disc and the Hall-effect. Afterwards Küpfmüller derives from the "special form" the "general form" of the law of induction according to Maxwell, a postulated generalization, which needs an explanation. But a reason is not given [2-4].

Bosse gives the same derivation, but for him the Maxwell-result is the special case and not his Faraday approach [2-5]. In addition he addresses the Faraday-law as equation of transformation and points out the meaning and the special interpretation.



On the other hand he derives the law from the Lorentz force, completely in the style of Küpfmüller [2-4] and with that again takes it part of its autonomy.
Pohl looks at that differently. He inversely derives the Lorentz force from the Faraday-law [2-6]. We should follow this very much convincing representation.

## 2.9 The equation of convection

If the Bosse [2-5] prompted term "equation of transformation" is justified or not at first is unimportant. That is a matter of discussion.

If there should be talk about equations of transformation, then the dual formulation (to equation 2.1) belongs to it, then it concerns a pair of equations, which describes the relations between the electric and the magnetic field.

The **new and dual field approach** consists of

**equations of transformation**

| of the electric | | and | of the magnetic field | |
|---|---|---|---|---|
| $\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$ | (2.1) | and | $\boxed{\mathbf{H} = -\mathbf{v} \times \mathbf{D}}$ | (2.3) |
| unipolar induction | | | equation of convection | |

Written down according to the rules of duality there results an equation (2.3), which occasionally is mentioned in some textbooks.

While both equations in the books of Pohl [2-6, p.76 and 130] and of Simonyi [2-7] are written down side by side having equal rights and are compared with each other, Grimsehl [2-8] derives the dual regularity (2.3) with the help of the example of a thin, positively charged and rotating metal ring. He speaks of "equation of convection", as moving charges produce a magnetic field and so-called convection currents. Doing so he refers to the work of Röntgen 1885, Himstedt, Rowland 1876, Eichenwald, and many others, which today are hardly known.
In his textbook Pohl also gives practical examples for both equations of transformation. He points out that one equation changes into the other one, if as a relative velocity **v** the speed of light **c** should occur [2-6].



## 3. The derivation from text book physics

We now have found a field-theoretical approach with the equations of transformation, which in its dual formulation is clearly distinguished from the Maxwell approach. The reassuring conclusion is added: **The new field approach roots entirely in textbook physics**, and are the results from literature research. We can completely do **without postulates**.
The next step is to test the approach utilizing mathematics for freedom from contradictions. In particular is the question, "which known regularities can be derived under which conditions?"
Moreover, the conditions and the scopes of the derived theories should result correctly, for example of what the Maxwell approximation consists and why the Maxwell equations describe only a special case.

### 3.1 Derivation of the field equations acc. to Maxwell

As a starting-point and as approach serve the equations of transformation of the electromagnetic field, the Faraday-law of unipolar induction (2.1) and the according to the rules of duality formulated law called equation of convection (2.3).

$$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}} \quad (2.1) \quad \text{and} \qquad \boxed{\mathbf{H} = -\mathbf{v} \times \mathbf{D}} \quad (2.3)$$

If we apply the curl to both sides of the equations:

$$\boxed{\text{curl}\,\mathbf{E} = \text{curl}\,(\mathbf{v} \times \mathbf{B})}\ (3.1), \boxed{\text{curl}\,\mathbf{H} = -\,\text{curl}\,(\mathbf{v} \times \mathbf{D})}\ (3.2)$$

then according to known algorithms of vector analysis the curl of the cross product each time delivers the sum of four single terms [3-1]:

$$\boxed{\text{curl } \mathbf{E} = (\mathbf{B} \text{ grad})\mathbf{v} - (\mathbf{v} \text{ grad})\mathbf{B} + \mathbf{v} \text{ div } \mathbf{B} - \mathbf{B} \text{ div } \mathbf{v}} \quad (3.3)$$

$$\boxed{\text{curl } \mathbf{H} = -[(\mathbf{D} \text{ grad})\mathbf{v} - (\mathbf{v} \text{ grad})\mathbf{D} + \mathbf{v} \text{ div } \mathbf{D} - \mathbf{D} \text{ div } \mathbf{v}]} \quad (3.4)$$

Two of these again are zero for a constant relative motion $\mathbf{v}(\mathbf{x}) = d\mathbf{x}/dt$ all along the curve given by $\mathbf{x} = \mathbf{r}(t)$ :

$$(\mathbf{B} \text{ grad})\mathbf{v} = 0 \quad \text{resp.} \quad (\mathbf{D} \text{ grad})\mathbf{v} = 0 \quad (3.5)$$

(acc. to the derivation given in the mathematical appendix on page 68 ff.)

$$\text{and} \qquad \mathbf{B} \text{ div } \mathbf{v} = 0 \quad \text{resp.} \quad \mathbf{D} \text{ div } \mathbf{v} = 0 \quad (3.5^*)$$

One term concerns the vector gradient ($\mathbf{v}$ grad)$\mathbf{B}$, which can be represented as a tensor. By writing down and solving the accompanying derivative matrix the vector gradient becomes a partial time derivation of the field vector $\mathbf{B}(\mathbf{x},t)$ to t,

$$\boxed{(\mathbf{v} \text{ grad})\, \mathbf{B}(\mathbf{x},t) \Big|_{\mathbf{x}=\mathbf{r}(t)} = \frac{\partial \mathbf{B}(\mathbf{x},t)}{\partial t}} \quad \text{and} \quad \boxed{(\mathbf{v} \text{ grad})\, \mathbf{D}(\mathbf{x},t) \Big|_{\mathbf{x}=\mathbf{r}(t)} = \frac{\partial \mathbf{D}(\mathbf{x},t)}{\partial t}} \quad (3.6)$$

Easily provable by looking at the components in $\mathbf{x} \in R^3$ and $t \in [0, \infty)$ :

$$(\mathbf{v} \text{ grad})\, \mathbf{B} = \left( \frac{\partial x}{\partial t} \cdot \frac{\partial B_x}{\partial x} \, , \; \frac{\partial y}{\partial t} \cdot \frac{\partial B_y}{\partial y} \, , \; \frac{\partial z}{\partial t} \cdot \frac{\partial B_z}{\partial z} \right) = \frac{\partial \mathbf{B}}{\partial t} \quad (3.7)$$

For the final not yet explained terms are written down the vectors $\mathbf{b}$ and $\mathbf{j}$ as abbreviations.

$$\boxed{\begin{aligned} \text{curl } \mathbf{E} &= -\partial \mathbf{B}/\partial t + \mathbf{v} \text{ div } \mathbf{B} = -\partial \mathbf{B}/\partial t - \mathbf{b} \\ \text{curl } \mathbf{H} &= \partial \mathbf{D}/\partial t - \mathbf{v} \text{ div } \mathbf{D} = \partial \mathbf{D}/\partial t + \mathbf{j} \end{aligned}} \quad \begin{aligned} (3.8) \\ (3.9) \end{aligned}$$

With equation 3.9 we in this way immediately look at the well-known law of Ampère (1st Maxwell equation).



### 3.2 The Maxwell equations as a special case

The result will be the **Maxwell equations**, if:

- the potential density $\mathbf{b} = -\mathbf{v} \text{ div } \mathbf{B} = 0$ , (3.10)
  (eq. 3.8 ≡ law of induction 1.1,
  if $\mathbf{b} = 0$ resp. $\text{div } \mathbf{B} = 0$).

- the current density $\mathbf{j} = -\mathbf{v} \text{ div } \mathbf{D} = -\mathbf{v} \cdot \rho_{el}$ , (3.11)
  (eq. 3.9 ≡ Ampère's law 1.4,
  if $\mathbf{j}$ ≡ with $\mathbf{v}$ moving negative charge carriers
  ($\rho_{el}$ = electric space charge density).

The comparison of coefficients (3.11) in addition delivers a useful explanation to the question, what is meant by the current density $\mathbf{j}$: it is a space charge density $\rho_{el}$ consisting of negative charge carriers, which moves with the velocity $\mathbf{v}$ for instance through a conductor.

The current density $\mathbf{j}$ and the dual potential density $\mathbf{b}$ mathematically seen at first are nothing but alternative vectors for an abbreviated notation. While for the current density $\mathbf{j}$ the physical meaning already could be clarified from the comparison with the law of Ampère, the interpretation of the potential density $\mathbf{b}$ is still due:

$$\mathbf{b} = -\mathbf{v} \text{ div } \mathbf{B} \quad (= 0) \quad . \qquad (3.10)$$

From the comparison of eq. 3.8 with the law of induction (eq.1.1) we merely infer, that according to the Maxwell theory this term is assumed to be zero. But that is exactly the Maxwell approximation and the restriction with regard to the new and dual field approach, which takes root in Faraday.

### 3.3 The Maxwell approximation

In that way also the duality gets lost with the argument that magnetic monopoles (div **B**) in contrast to electric monopoles (div **D**) do not exist and until today could evade every proof. It has not yet been searched for the vortices dual to eddy currents, which are expressed in the neglected term.

Assuming a monopole concerns a special form of a field vortex, then immediately it is clear why the search for magnetic poles has to be a dead end and their failure isn't good for a counterargument. The missing electric conductivity in a vacuum prevents current densities, eddy currents, and the formation of magnetic monopoles. Potential densities and potential vortices however can occur. As a result, without exception, only electrically charged particles can be found in the vacuum.

Let us record: **Maxwell's field equations can directly be derived from the new dual field approach under a restrictive condition**. Under this condition the two approaches are equivalent and with that also error free. Both follow the textbooks and can, so to speak, be the textbook opinion.

The restriction (**b** = 0) surely is meaningful and reasonable in all those cases in which the Maxwell theory is successful. It only has an effect in the domain of electrodynamics. Here usually a vector potential **A** is introduced and by means of the calculation of a complex dielectric constant a loss angle is determined. Mathematically the approach is correct and dielectric losses can be calculated.



Physically the result is extremely questionable since as a consequence of a complex $\varepsilon$ a complex speed of light would result,

according to the definition: $c = 1/\sqrt{\varepsilon \cdot \mu}$ (3.12).

With that electrodynamics offends against all specifications of the textbooks, according to which c is constant and not variable and less then ever complex.

But if the result of the derivation physically is wrong, then something with the approach is wrong, therefore the fields in the dielectric perhaps have an entirely other nature, and then dielectric losses perhaps are vortex losses of potential vortex decay?

Is the introduction of a vector potential **A** in electrodynamics a substitute of neglecting the potential density **b**? Do two ways mathematically lead to the same result?

And what about the physical relevance? After classic electrodynamics being dependent on working with a complex constant of material, in what is buried an insurmountable inner contradiction, the question is asked for the freedom of contradictions of the new approach. At this point the decision has to be done, if physics has to make a decision for the more efficient approach among several possibilities.

My book "Self consistent electrodynamics" has to content about this and other problems, such as the discovery of magnetic monopoles in 2009 by the German Helmholtz Society and about the consequences on the classical electrodynamics. Here comes to physical reality what the author had worked for over 20 years.

In books that were published before 2009, such as the present book, the approach had to be formulated as a hypothesis, although the derivation of the extended field equations from accepted textbooks allow no other conclusion. This has changed now.

### 3.4 The magnetic field as a vortex field

The abbreviations **j** and **b** are further transformed, at first the current density in Ampère's law

$$\mathbf{j} = -\mathbf{v}\cdot\rho_{el} \quad (3.11)$$

as the movement of negative electric charges.

By means of Ohm's law $\mathbf{j} = \sigma\cdot\mathbf{E}$ (1.5)

and the relation of material $\mathbf{D} = \varepsilon\cdot\mathbf{E}$ (1.6)

the current density $\boxed{\mathbf{j} = \mathbf{D}/\tau_1}$ (3.13)

also can be written down as dielectric displacement current with the characteristic relaxation time constant for the eddy currents $\tau_1 = \varepsilon/\sigma$ (1.7).

In this representation of the law of Ampère:

$$\boxed{\text{curl }\mathbf{H} = \partial\mathbf{D}/\partial t + \mathbf{D}/\tau_1 = \varepsilon\cdot(\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1)} \quad (3.14)$$

clearly is brought to light, why the magnetic field is a vortex field, and how the eddy currents produce heat losses depending on the specific electric conductivity σ. As one sees, with regard to the magnetic field description, we move around completely in the framework of textbook physics.



### 3.5 The derivation of the potential vortex

Let us now consider the dual conditions. The comparison of coefficients looked at purely formal, results in a potential density

$$\boxed{\mathbf{b} = \mathbf{B}/\tau_2} \quad (3.15)$$

in duality to the current density **j** (eq. 3.13), which with the help of an appropriate time constant $\tau_2$ founds vortices of the electric field. I call these "potential vortices".

$$\boxed{\text{curl }\mathbf{E} = -\partial\mathbf{B}/\partial t - \mathbf{B}/\tau_2 = -\mu\cdot(\partial\mathbf{H}/\partial t + \mathbf{H}/\tau_2)} \quad (3.16)$$

In contrast to that the Maxwell theory requires an **irrotationality of the electric field**, which is expressed by taking the potential density **b** and the divergence **B** equal to zero. The time constant $\tau_2$ thereby tends towards infinity.

There isn't a way past the potential vortices and the new dual approach,

1. as the new approach gets along without a postulate, as well as
2. consists of accepted physical laws,
3. why also all error free derivations are to be accepted,
4. no scientist can afford to already exclude a possibly relevant phenomenon in at the approach,
5. the neglect by Maxwell's approximation is to examine,
6. to which a potential density measuring instrument is necessary, which may not exist according to the Maxwell theory.

With such a tail-chase incomplete theories could always confirm themselves.

## 4. The derivation of the wave equation

It has already been shown, as and under which conditions the wave equation from the Maxwell's field equations, limited to transverse wave-portions, is derived (chapter 1.4). Usually one proceeds from the general case of an electrical field strength $\mathbf{E} = \mathbf{E}(\mathbf{x},t)$ and a magnetic field strength $\mathbf{H} = \mathbf{H}(\mathbf{x},t)$ (with $\mathbf{x} = \mathbf{r}(t)$).
We want to follow this example [4-1], this time however under consideration of the potential vortex term.

### 4.1 The completed field equations

The two equations of transformation and also the from that derived field equations (3.14 and 3.16) show the two sides of a medal, by mutually describing the relationship between the electric and magnetic field strength:

$$\boxed{\text{curl}\,\mathbf{H} = \partial\mathbf{D}/\partial t + \mathbf{D}/\tau_1 = \varepsilon\cdot(\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1)} \qquad (4.1)$$

$$\boxed{\text{curl}\,\mathbf{E} = -\,\partial\mathbf{B}/\partial t - \mathbf{B}/\tau_2 = -\,\mu\cdot(\partial\mathbf{H}/\partial t + \mathbf{H}/\tau_2)} \qquad (4.2)$$

We get on the track of the meaning of the "medal" itself, by inserting the dually formulated equations into each other. If the calculated **H**-field from one equation is inserted into the other equation then as a result a determining equation for the **E**-field remains. The same vice versa also functions to determine the **H**-field. Since the result formally is identical and merely the **H**-field vector appears at the place of the **E**-field vector and since it equally remains valid for the **B**-, the **D**-field and all other known field factors, the determining equation is more than only a calculation instruction. It reveals a fundamental physical principle. I call it the complete or the "fundamental field equation".



The derivation always is the same: If we again apply the curl operation to curl **E** (law of induction 4.2) also the other side of the equation should be subjected to the curl:

$$-\,\text{curl curl}\,\mathbf{E} = \mu\cdot\partial(\text{curl}\,\mathbf{H})/\partial t + (\mu/\tau_2)\cdot(\text{curl}\,\mathbf{H}) \qquad (4.3)$$

If for both terms curl **H** is expressed by Ampère's law 4.1, then in total four terms are formed:

$$-\,\text{curl curl}\,\mathbf{E} = \mu\cdot\varepsilon\cdot[\partial^2\mathbf{E}/\partial t^2 + (1/\tau_1)\cdot\partial\mathbf{E}/\partial t + (1/\tau_2)\cdot\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1\tau_2] \qquad (4.4)$$

With the definition for the speed of light c:

$$\boxed{\varepsilon\cdot\mu = 1/c^2} \quad , \qquad (1.10)$$

the fundamental field equation reads:

$$\boxed{\begin{array}{l}\underbrace{-\,c^2\cdot\text{curl curl}\,\mathbf{E}}_{a} = \underbrace{\partial^2\mathbf{E}/\partial t^2}_{b\ (\text{electromagnetic wave})} + \\ \underbrace{+\,(1/\tau_1)\cdot\partial\mathbf{E}/\partial t}_{c} + \underbrace{(1/\tau_2)\cdot\partial\mathbf{E}/\partial t}_{d} + \underbrace{\mathbf{E}/\tau_1\tau_2}_{e} \\ \text{+ eddy current + potential vortex + I/U}\end{array}} \qquad (4.5)$$

The four terms are: the wave equation (a-b) with the two damping terms, on the one hand the eddy currents (a-c) and on the other hand the potential vortices (a-d) and as the fourth term the Poisson equation (a-e), which is responsible for the spatial distribution of currents and potentials.

## 4.2 A possible world equation

Not in a single textbook is there a mathematical linking of the Poisson equation with the wave equation, which we have succeeded in doing so for the first time. It, however is the prerequisite to be able to describe the conversion of an antenna current into electromagnetic waves near a transmitter and equally the inverse process, as it takes place at a receiver. Numerous model concepts, like they have been developed by HF- and EMC-technicians as a help, can be described mathematically correct by the physically founded field equation.

In addition, further equations can be derived, for which until now was supposed to be impossible, for instance the Schrödinger equation (Term d and e). As diffusion equation it has the task to mathematically describe field vortices and their structures.

As a consequence of the Maxwell equations in general and specifically the eddy currents (a-c) not being able to form structures, every attempt has to fail, to derive the Schrödinger equation from the Maxwell equations.

The ***fundamental field equation*** however contains the newly discovered potential vortices, which owing to their concentration effect (in duality to the skin effect) form spherical structures, for which reason these occur as eigenvalues of the equation. For these eigenvalue-solutions numerous practical measurements are present, which confirm their correctness and with that have probative force with regard to the correctness of the new field approach and the fundamental field equation. By means of the pure formulation in space and time and the interchange ability of the field pointers



here a physical principle is described, which fulfills all requirements a world equation must meet.

## 4.3 The quantisation of the field

The Maxwell equations are nothing but a special case, which can be derived (if $1/\tau_2 = 0$). The new approach however, which among others bases on the Faraday-law, is universal. It describes a physical basic principle, the alternating of two dual experience or observation factors, their overlapping and mixing by continually mixing up cause and effect. It is a philosophic approach, free of materialistic or quantum physical concepts of any particles.

Maxwell on the other hand describes without exception the fields of charged particles, the electric field of resting and the magnetic field as a result of moving charges. The charge carriers are postulated for this purpose, so that their origin and their inner structure remain unsettled.

With the field-theoretical approach the field is the cause for the particles and their measurable quantisation. The electric vortex field, at first source free, is itself forming its field sources in form of potential vortex structures. The formation of charge carriers in this way can be explained and proven mathematically, physically, graphically and experimentally understandable according to the model.

Let us first cast our eyes over the wave propagation.

## 4.4 The mathematical derivation (Laplace eq.)

The first wave description, model for the light theory of Maxwell, was the Laplace equation (1.12):

$$\boxed{\Delta \mathbf{E} \cdot c^2 = \partial^2 \mathbf{E}/\partial t^2} \text{ with } \boxed{\Delta \mathbf{E} = \text{grad div } \mathbf{E} - \text{curl curl } \mathbf{E}} \quad (4.6)$$

Here we ask some questions:

- Can also this mathematical wave description be derived from the new approach?
- Is it only a special case and how do the boundary conditions read?
- In this case how should it be interpreted physically?
- Are new properties present, which can lead to new technologies?

The Starting-point is the fundamental field equation (4.5). We should remember the interchangeability of the field pointers, that the equation doesn't change its form, if it is derived for **H**, for **B**, for **D** or any other field factor instead of for the **E**-field pointer. This time we write it down for the magnetic flux density and consider the special case $\mathbf{B}(\mathbf{x},t)$ with $\mathbf{x} = \mathbf{r}(t)$ [acc. to 4-2]:

$$-c^2 \cdot \text{curl curl } \mathbf{B} = \frac{\partial^2 \mathbf{B}}{\partial t^2} + \frac{1}{\tau_2}\frac{\partial \mathbf{B}}{\partial t} + \frac{1}{\tau_1}\frac{\partial \mathbf{B}}{\partial t} + \frac{\mathbf{B}}{\tau_1 \tau_2} \quad (4.7)$$

that we are located in a badly conducting medium, as usual for a propagating wave in air. But with the electric conductivity $\sigma$ also $1/\tau_1 = \sigma/\varepsilon$ tends towards zero (eq. 1.7). With that the eddy currents and their damping and other properties disappear from the field equation. This makes sense too.



There remains the potential vortex term $(1/\tau_2)\cdot\partial\mathbf{B}/\partial t$ , which using the already introduced relations (eq.3.6):

$$\frac{1}{\tau_2}\frac{\partial \mathbf{B}}{\partial t} = (\mathbf{v} \text{ grad}) \frac{\mathbf{B}}{\tau_2} \quad (3.6)$$

(and with eq. 3.15):

$$\mathbf{b} = \frac{\mathbf{B}}{\tau_2} = -\mathbf{v} \text{ div } \mathbf{B} \quad (3.10)$$

Involved with the wave propagation $\mathbf{v}(\mathbf{x}) = d\mathbf{x}/dt$ , (3.7*)

can be transformed directly to:

$$(1/\tau_2)\cdot\partial\mathbf{B}/\partial t = -\|\mathbf{v}\|^2 \cdot \text{grad div } \mathbf{B} . \quad (4.8)$$

The divergence of a field vector (div **B**) mathematically is seen a scalar, for which reason this term as part of the wave equation founds so-called „scalar waves“ and that means that potential vortices, as far as they exist, will appear as a scalar wave. To that extent the derivation prescribes the interpretation.

$$\boxed{\|\mathbf{v}\|^2 \text{ grad div } \mathbf{B} - c^2 \text{ curl curl } \mathbf{B} = \partial^2 \mathbf{B}/\partial t^2} \quad (4.9)$$

| | | |
|---|---|---|
| longitudinal with v = arbitrary (scalar wave) | transverse with c = const. (em. wave) | wave velocity of propagation |

The simplified field equation (4.7) possesses thus the same force of expression as the general wave equation (4.9). This equation can be divided into longitudinal and transverse wave parts, which can propagate with different velocity.

## 4.5 The result of the derivation

Physically seen the vortices have particle nature as a consequence of their structure forming property. With that they carry momentum, which puts them in a position to form a longitudinal shock wave similar to a sound wave. If the propagation of the light one time takes place as a wave and another time as a particle, then this simply and solely is a consequence of the wave equation.

Light quanta should be interpreted as evidence for the existence of scalar waves. Here however also occurs the restriction that light always propagates with the speed of light. It concerns the special case $v = c$. With that the derived wave equation (4.9) changes into the Laplace equation (4.6).

The electromagnetic wave in general is propagating with c. As a transverse wave the field vectors are standing perpendicular to the direction of propagation. The velocity of propagation therefore is decoupled and constant.

Completely different is the case for the longitudinal wave. Here the propagation takes place in the direction of an oscillating field pointer, so that the phase velocity permanently is changing and merely an average group velocity can be given for the propagation. There exists no restriction for v and $v = c$ only describes a special case.

It will be helpful to draw, for the results in a mathematical way, a graphical model.



# 5. The field model of the waves and vortices

High-frequency technology is distinguished between the near-field and the far-field. Both have fundamentally other properties.

## 5.1 The far field (electromagnetic wave acc. to Hertz)

Heinrich Hertz did experiments in the short wave range at wavelengths of meters. From today's viewpoint his work would rather be assigned the far-field. As a professor in Karlsruhe he had shown that the electromagnetic wave propagates like a light wave and can be refracted and reflected in the same way.

It is a transverse wave for which the field pointers of the electric and the magnetic field oscillate perpendicular to each other and both again perpendicular to the direction of propagation. Besides the propagation with the speed of light, it also is characteristic that there occurs **no phase shift** between **E**-field and **H**-field.

*Heinrich Hertz:* **electromagnetic wave** (transverse)

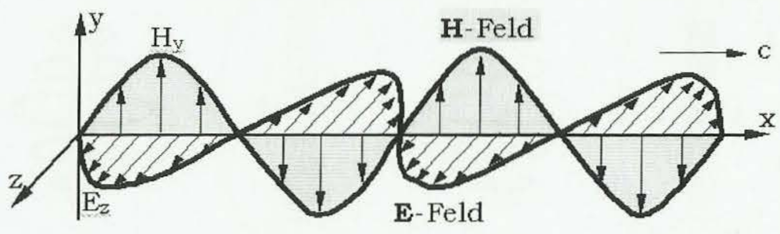



Fig. 6: The planar electromagnetic wave in the far zone.

## 5.2 The near field (Scalar wave acc. to Tesla)

In the proximity it looks completely different. The proximity concerns distances to the transmitter of less than the wavelength divided by $2\pi$. Nikola Tesla has broadcasted in the range of long waves, around 100 Kilohertz, in which case the wavelength already is several kilometers. For the experiments concerning the resonance of the earth he has operated his transmitter in Colorado Springs at frequencies down to 6 Hertz. Doing so, the whole earth moves into the proximity of his transmitter. We probably have to proceed from assumption that the Tesla radiation primarily concerns the proximity, which also is called the radiant range of the transmitting antenna.

For the approach of vortical and closed-loop field structures derivations for the near-field are known [1-3]. The calculation provides the result that in the proximity of the emitting antenna a phase shift exists between the pointers of the **E**- and the **H**-field. The antenna current and the **H**-field coupled with it lag the **E**-field of the oscillating dipole charges for 90°.

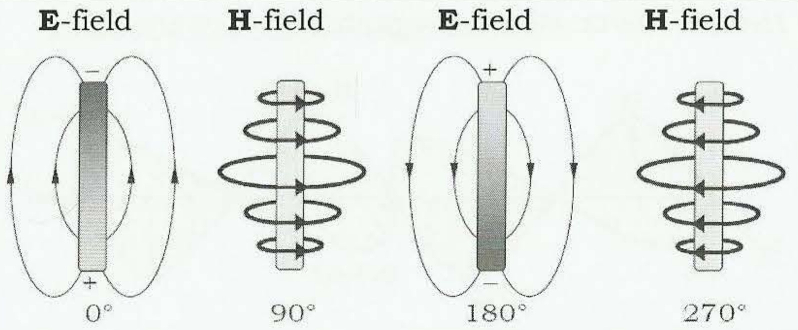



Fig. 7: The fields of the oscillating dipole antenna



The phase shift hints at why an energy transfer is only possible in the near-field, not in the far-field relying on electromagnetic waves. For this purpose, nitpickers calculate the

energy density of the wave-field: $w = (\varepsilon \cdot E^2 + \mu \cdot H^2)/2$

or the Poynting vector: $\mathbf{S} = \mathbf{E} \times \mathbf{H}$

for the case that for example the electrical field strength E turns zero. In case of the electromagnetic wave (Fig. 6), at this point, the magnetic field strength also turns zero, with a 90° phase shift however (Fig. 7), it then becomes maximal.

## 5.3 The near field as a vortex field

In the text books one finds the detachment of a wave from the dipole accordingly explained.

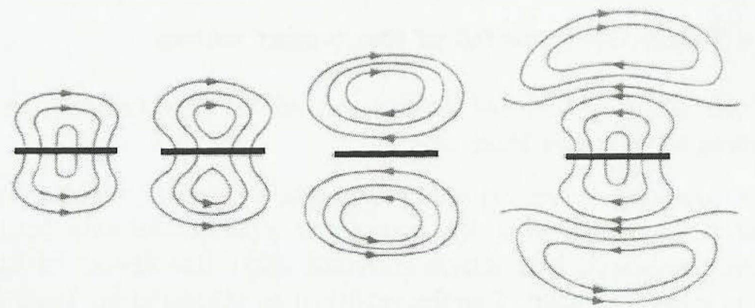


Fig. 8: The coming off of the electric field lines from a dipole.

If we regard the structure of the outgoing fields, then we see field vortices, which run around one point, which we can call the vortex center. We continue to recognize in the picture how the generated field structures establish a shock wave as one vortex knocks against the next.

Thus a Hertzian dipole doesn't emit Hertzian waves! An antenna as near-field without exception emits vortices, which only at the transition to the far-field unwind to create electromagnetic waves.

At the receiver the conditions are reversed. Here the wave (a-b in eq. 4.5) is rolling up to a vortex (a-c-d), which usually is called and conceived as a ***standing wave***. Only this field vortex causes an antenna current (a-e) in the rod which the receiver afterwards amplifies and utilizes.

The function mode of sending and receiving antennas with the puzzling near field characteristics explain themselves directly from the wave equation (4.5).

## 5.4 The vortex model of the scalar waves

What would a useful vortex-model for the rolling up of waves to vortices look like ?

We proceed from an electromagnetic wave, which does not propagate after the retractor procedure any longer straight-lined, but turns instead with the speed of light in circular motion. Furthermore it is transverse, because the field pointers of the **E**-field and the **H**-field oscillate perpendicular to **c**. By means of the orbit the speed of light **c** now has become the vortex velocity.



*Nikola Tesla:* **electric scalar wave** (longitudinal):

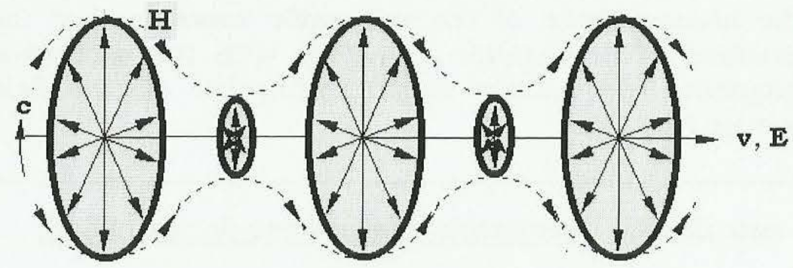



Fig. 9: Magnetic ring-vortices form an electric wave.

**Wave** and **vortex** turn out to be **two** possible and **stable field configurations**. For the transition from one into the other no energy is used; it only is a question of **structure**.

It is the circumstance that the vortex direction of the ring-like vortex is determined and the field pointers are standing perpendicular to it, as well as perpendicular to each other. This results in two theoretical formation forms for the scalar wave.

In the first case (fig. 9) the vector of the **H**-field points into the direction of the vortex centre and that of the **E**-field axially to the outside. The vortex however will propagate in this direction in space and appear as a scalar wave, so that the propagation of the wave takes place in the direction of the electric field. It may be called an **electric wave**.

### 5.4 Magnetic scalar waves (acc. To Meyl)

In the second case the field vectors exchange their place. The characteristic of the **magnetic wave** is that the direction of propagation coincides with the oscillating magnetic field pointer (fig.10), while the electric field pointer rolls up.

*new (Meyl):* **magnetic scalar wave** (longitudinal):

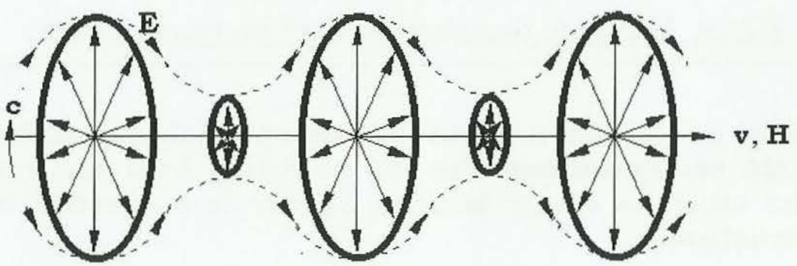



Fig.10: electric ring-vortices form an magnetic wave.

The vortex picture of the rolled up wave already fits very well, because the propagation of a wave in the direction of its field pointer characterizes a longitudinal wave. Also, because all measurement results are perfectly covered by the vortex model. In the text book of Zinke and Brunswig (German text book about HF-Technology) as one example the near field is computed as exactly this vortex-structure is postulated! [5-1].



### 5.5 The antenna noise

It is well known that longitudinal waves have no firm propagation speed. Since they run toward an oscillating field pointer, also that the speed vector **v** will oscillate. At so called relativistic speeds within the range of the speed of light the field vortices underlie the ***Lorentz contraction***. This means, the faster the oscillating vortex is on its way, the smaller it becomes. The ***vortex constantly changes its diameter*** as an impulse-carrying mediator of a scalar wave.

Since it is to concern that vortices are rolled up waves, the vortex speed will still be **c**, with which the wave runs now around the vortex center in circular motion. Hence it follows that with smaller becoming diameter the wave-length of the vortex likewise decreases, while the natural frequency of the vortex increases accordingly.

If the vortex oscillates in the next instant back, the frequency decreases again. The **vortex works as a frequency converter**! The mixture of high frequency signals developed in this way distributed over a broad frequency band is called **noise**.

Antenna losses concern the portion of radiated field vortices, which did not unroll themselves as waves, which are measured with the help of wide-band receivers as *antenna noise* and in the case of the vortex decay are responsible for heat development.

In the expressions of the fundamental field equation (4.5) it concerns wave damping. The wave equation (4.9) explains besides, why a Hertz signal is to be only received if it exceeds the scalar noise vortices in amplitude.

## 6. Scalar wave technology

A suitable model is required to apply a newly discovered physical phenomenon in everyday technology. Parallel to its introduction, a technological impact assessment should be performed, but unfortunately is routinely delayed or neglected altogether in favour of rapid progress and opportunity.

Tesla had described the *biological efficacy of scalar waves* and warned of the dangers of X-ray radiation, but no one would listen. Carefree, children put their feet in X-ray devices found in shoe stores of the past, which were used to check how much spare room there remained within new shoes.

„Comfort Locking“ is the name given to a new generation of car keys not needing batteries and receiving energy wirelessly to power a microwave device transmitting personal ID, thereby unlocking the vehicle's doors. This comfort is paid for by permanent exposure to the energy transmitter's near-field, irradiating the driver from head to toe during the entire ride.

But that's not all: Meanwhile, the key in the driver's pocket functions as a microwave transmitter. The car's body reflects much of this radiation back onto its passengers.

And this is not supposed to be unhealthy? How else should a wireless system that ignores this disadvantage be devised?

*Company ignorance doesn't prevent company liability.*



### 6.1 Spark's disease

The general ignorance regarding scalar waves is due to the scientific conflict between Heinrich Hertz and Nikola Tesla. Each claimed error on the other's part, each claimed having demonstrated the real wave as described by Maxwell. Only one would prevail in this conflict, and it turned out to be Hertz.

But in actuality, his historical experiment consisted of an energy transfer, as the receiver was constructed as a spark gap and operated within the near-field! He used both ends of the dipole-antennae, there were spherical electrodes, just like on Tesla's assembly. Therefore, we have to assume that he, in fact was utilizing Tesla-radiation.

However, he had measured merely the unused, even though by his device also emitted transversal waves, and it is only for this that he has been honored. As irony would have it, at Karlsruhe University, where he accomplished the proof in 1888, there is Fig. 8 at the entrance, depicting field vortices within a dipole's near field, which have almost nothing to do with Hertz'ian waves in the far field (Fig. 6).

In the 1930's navy radio operators, also known as sparks, complained about headaches, vertigo, lack of concentration, and malaise. Today, this is called *"spark's disease"* but has withered after high frequency technicians have learned to maximize the efficiency of antennae. Thus, scalar wave proportions, suspected of being responsible for electromagnetic pollution, are being minimized. Today's high frequency technicians are being taught numerous rules for noise suppression and how to maximize antenna-gain by power adjustment and optimization of antenna geometry.

## 6.2 Measuring the standing wave

A scalar wave technician can rightfully be described as a *"inverse" high frequency technician* as he is doing things differently than what is taught in textbooks. He is intent on maximizing noise signals while electromagnetic waves are considered waste.

A practical scalar wave transmitter would, for example, be a flat, spirally winded Tesla coil, whose outer end is grounded and inner end is connected to a spherical antenna. It is stimulated by ***self resonance***.
If no receiver is present, or if it's running idle, the emitted scalar waves exhibit distinct standing wave behaviour.

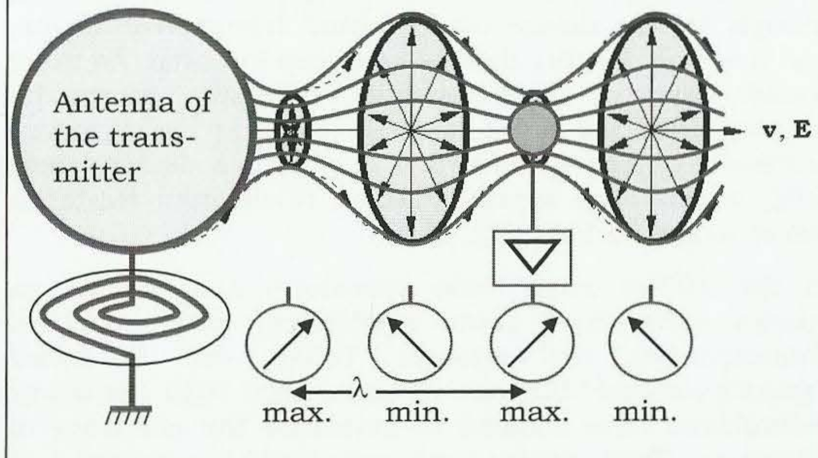



Fig 11. Scanning the standing wave properties



## 6.3 Optimization of range

From the distance of one measured peak to another, one can determine the wavelength. Multiplying the wavelength with the operational frequency yields the *velocity of propagation*, which usually differs from that of light. *Upon this velocity depend both the* ***stability of field-vortices*** *and therefore the* ***range*** *of a line of transmission.*

With the experimental assembly patented by Tesla it can be easily proven that using a *larger spherical electrode as the emitting antenna increases amplitude oscillation of vortices, greater velocity of propagation, more stable vortices, and an overall greater range can be attained.*

The same results can be reached by utilizing a higher operational voltage which provide the vortices with greater ***acceleration voltage***, thereby increasing range.

Tesla didn't rely on high voltage without reason, earning him the reputation as the *"master of lightning"*. With his system, he transmitted energy over enormous distances, far beyond an emitter's near field [6-1].

Calculations regarding the near field found in today's textbooks only examine its propagation at the speed of light, but that's merely a special case!

What happens to the distribution of electric flux lines of a scalar wave once the receiver's not running idle, but is being fully loaded as required by a wireless transfer of energy?

## 6.4 The field of radiation

A receiver for energy is pretty much the opposite of a receiver for measurements. While measurement of a field calls for the diversion of as little power as possible in order not to distort the data, an energy converter, as utilized within a transponder, alters the field totally by attracting it.

This is also called *"the field of radiation of the antenna"*.

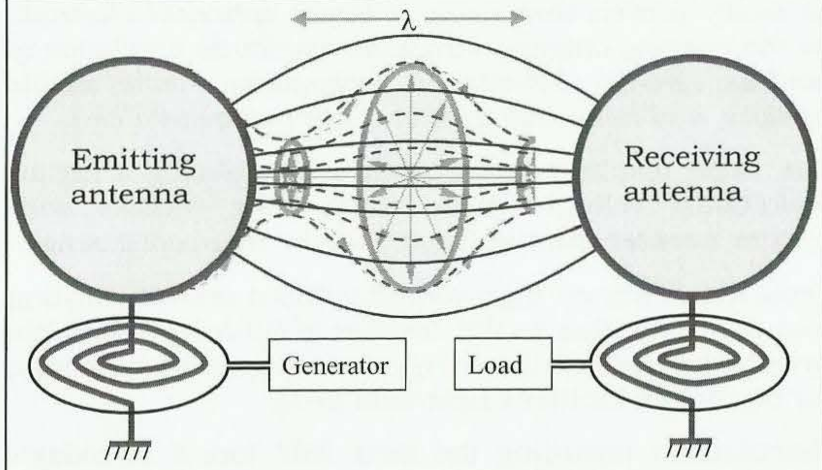



Fig 12. Scalar wave or energetic radiation

Let's examine the borderline case, which constitutes the energetic optimum: All flux lines emitted end at the receiving antenna.

Thereby, *all wave properties vanish*, wavelength is no longer determinable, and consequently no velocity of propagation definable.



## 6.5 Resonance

Strictly speaking, one can no longer distinguish emitter and receiver. Both are tightly connected by the field. *They form an **oscillating circuit** operated at **self-resonance**.*

The necessary conditions for ***resonance*** pertain to:

1. *Identical frequency*
2. *Opposite phase shift (180°)*
3. *Identical wave shape, respectively modulation*

Transponders usually utilize sinusoidal-shaped signals for transmitting energy, so that only frequency (1) and phase (2) are relevant. *Ideally, when no scatter fields are emitted, no field will be measurable at all during operation, and therefore as a further benefit, there will be no biological effectiveness.*

*The disadvantage of resonant coupling* is the characteristic ***hysteresis***: Upon increasing the distance, the oscillation breaks off eventually, only to be restored by closing the gap.

If there is more than one receiver within range, they will both resonate and draw the necessary power from the emitter. If, however, the emitter is fully loaded already, the receiver located farthest away from it will be the first to terminate resonance.

Apart from these particularities, the *"law of distance squared" doesn't apply* - field strength does not decrease with increasing distance from the emitter.

## 6.6 Dielectric losses

In case of resonance, the radiation field resembles that of a ***capacitor*** with the flux lines running oriented longitudinally from one electrode to the other. As long as no flux line gets lost and none is scattered in from the outside the transmission line's efficiency amounts to exactly 100 percent.

During practical operation however, this special condition is hardly attainable. Some flux lines coil into vortices and form a scalar wave, maintaining their longitudinal orientation. Some of these vortices in turn disintegrate and generate heat.

Capacitors turn hot when operated at high frequencies as well. One speaks of *dielectric losses* and usually faults the isolating materials [6-2]. However, it is to assume that within a capacitor, disintegrating field vortices generate lost heat in the same way.

If both *noise signals inside a capacitor* as well as *antenna noise* represent scalar waves, and *dielectric losses* as well as *antenna losses* represent vortex losses, it now becomes clear what both of these extreme cases have in common: On the one hand *the radiation field of an antenna* (Tesla radiation, Fig 13 left) and on the other hand *the electromagnetic wave* (or Hertz'ian wave, Fig 13 right). It is the scalar wave eliminated from Maxwell's equations which is always involved (Fig 13, middle).



## 6.7 Overview of scalar waves

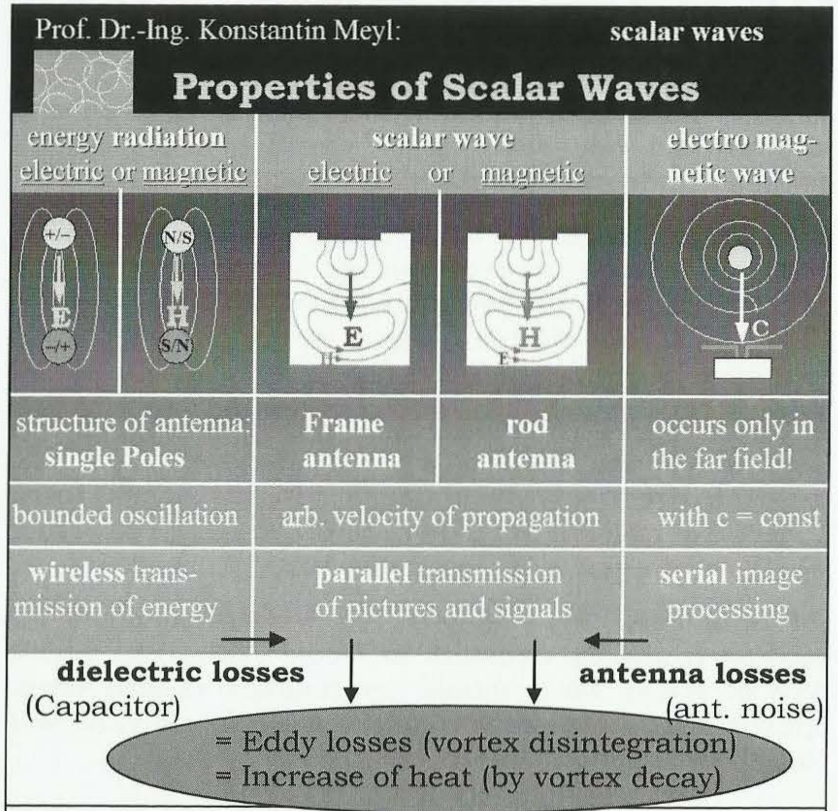



Fig 13: Overview of the attribution of scalar waves

Where the newly or repeatedly discovered scalar wave answers questions to physical processes, there is a vast gap in all common textbooks.
*Through the model of **disintegrating vortices**, scalar wave theory additionally provides us with a valuable model concerning thermodynamics, i.e. regarding the question: What is **temperature**?*
At this point every unified theory calls for an answer!

## 7. Far range transponders in practice

### 7.1 Electrical or magnetic coupling?

While the question is whether a pole- (Fig 7) or frame-antenna should be used on the emitter end, on the receiver end one will ponder whether it should be devised as ***absorber*** *for electrical or magnetic fields.*

An absorber is marked by the feature that on one side more waves are absorbed than are emitted on its other side. It can only be considered that all that is being absorbed is no wave anymore. Eventually, the wave condition of propagation at the speed of light is no longer given.

Resorting to the image of a standing wave or a vortex rolling in, both of which amount to the same, there appear two possibilities either the coiled magnetic vortex (Fig 9) or its electric analogon (Fig 10).

Up until now the magnetic vortex was examined as relating to the experiments of Nicola Tesla. But which type of scalar wave should an engineer choose when optimising a scalar wave transponder? Certainly, he will pick the magnetic scalar wave!

Commercial electric motors always operate with magnetic forces, as these are at least 100 times as strong as electric forces and therefore are smaller. Consider the same factor in comparison to electrostatic motors (e.g. the Whimshurst machine).

This fact should be remembered and therefore magnetic fields preferred in cases of a pure radiation field generated by coils.



### 7.2 Magnetically coupled telemetry

At MIT (Massachusetts Institute of Technology, Cambridge), in 2007, a wireless transfer of energy was accomplished on the *"basis of magnetic resonance in the near field"* which was published worldwide as a sensation [7-1]. Over a distance of 2 m, a 60-Watt light bulb could be made to glow. The process was attributed a ratio of efficiency of 40% [7-2].

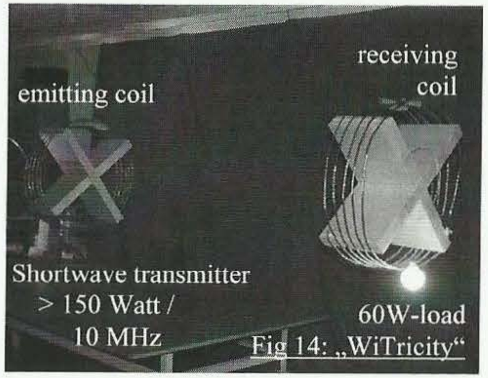


Fig 14: „WiTricity"

The magnetic coils made out of copper had a diameter of 25 cm.

The team of researchers made the experience that a decrease in coil diameter led to a decrease in bridgeable distance. This can be explained by the flux lines' inclination to travel the shortest route, i.e. that of the smallest magnetic resistance, which is the one occupied by the scatter fields that leads right around the coils and generates nothing but leakage.

These fields then miss within the useful spectrum and deteriorate efficiency. It is at this point that the greatest disadvantage of the system shows.

Doubtlessly, it is advantageous that neither wooden or metal objects, nor electronic devices or humans within the transfer path substantially interfere with the energy transfer. The message was spread, that the idea should be new, but it was not!

### 7.3 Magnetic inference

A substantial obstacle on the way to a wireless future is posed by obtaining feedback. Ideally, a closed magnetic circuit with permeable core material should be utilized, but then, the idea of wireless energy transfer would be obsolete.

Therefore, an air transformer needs to subsist with the permeability of vacuum $\mu_o$. The emitting coil represents the primary and the receiving coil the secondary transformer coil. Let's take a look at the resulting distribution of the magnetic flux lines.

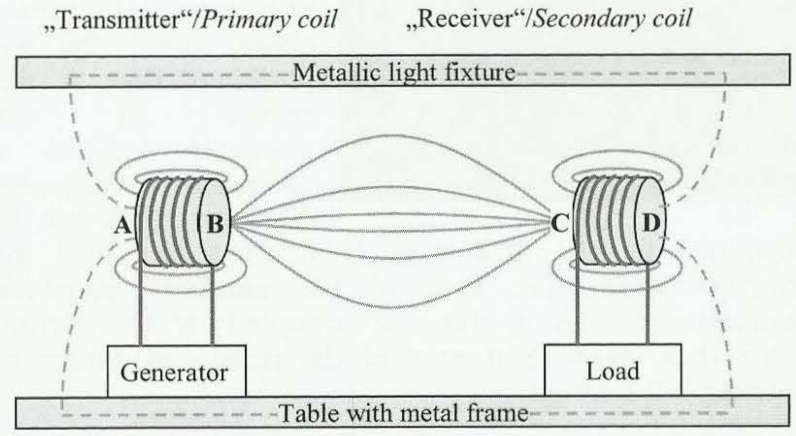



Fig 15. Energy radiation in case of magnetic coupling

Operation in resonance demands that at points A and C, the same (e.g. north), while at B and D, reverse polarity (south) must prevail. Then, the flux lines of complementary poles are connected:



1. from B to C, the usable length
2. from D to A, the feedback, and
3. directly from B to A, respectively from D to C,

which represents the scatter field of the coils. However, the scatter field length (3) is shorter than the usable length (1) and well shorter than the relatively long way of the feedback (2), which is why the bulk of it can't reach the receiver. Here every little piece of metal is helpful enhancing the feedback (2) – a table with metal frame secretly placed underneath the experiment as well as a metal light fixture coincidentally placed above.

Also helpful is operation in self resonance, as it stimulates the coils' amplitudes, thereby creating substantially greater field strengths than possible outside of resonance.

Nicola Tesla pointed this out over 100 years ago.

### 7.4 Electrical inference

As already mentioned, Tesla worked with electrical energy radiation. That begs the question how he solved the problem of circuit closure. In his case, it was about the electric field which calls for high dielectric or a good electric conductor to persuade the field to take the detour from the receiver back to the emitter. In the simplest case, this is achieved by a cable.

Thus, in the connecting cable there is a measurable current driving the resonant circuit. Therefore, this "one wire transmission" is not genuinely "wireless", but its efficiency is excellent.

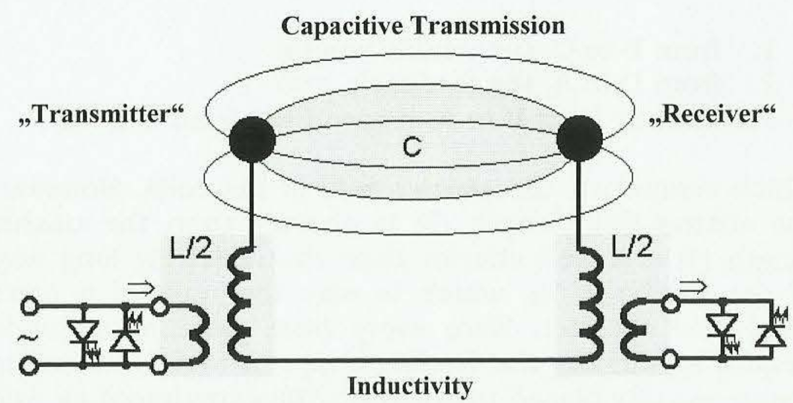



Fig 16: Electrical energy transmission acc. to Tesla

The electrical resonant circuit consists of the spirally wound Tesla coils of emitter and receiver and the capacitive transmission route in between both spherical electrodes.

If one, for example, inadvertently sets up the transmission route near an electrically conductive metal frame, the flux lines possibly wouldn't run directly from sphere to sphere, but take a detour from the emitting sphere to the metal frame to the receiving sphere. The operator wouldn't actually notice, as the field would remain longitudinal and its efficiency sensationally high (at about 100%). Ultimately, the useful field (1) benefits not the circuit closure (2).

With this system considerably more power (500W) has been transmitted over greater distances (>100m) without noteworthy losses when compared to the MIT's system. For do-it-yourself experiments, an experimental kit containing instructions is available [7-3].



### 7.5 Tesla's dream: wireless energy supply

It is apparent from Tesla's patents that instead of using a connection line he grounded his pancake coils on one side. At the high voltages and frequencies he used the earth behave as part capacitive and part electrical conductor [6-1].
However with this technique any grounded consumer load in resonance can deduct energy. That might include a disagreeable competitor.

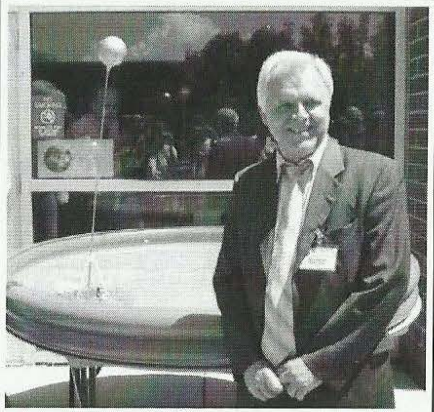
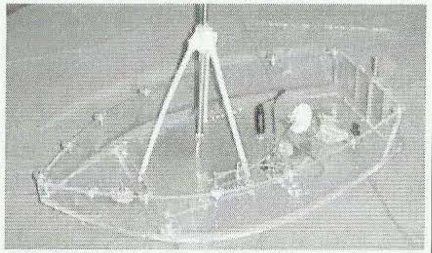


Fig 17: The author with his miniatur boat at the TeslaTech Conference 2007 in Salt Lake City



That's why the project to wirelessly supply ships on the ocean with energy wasn't put into practice.

However the feasibility of this principle was proven in 2001 by the "First Transfer Centre for Scalar Wave Technology" using a miniature boat.

*"The boat is working without a battery"*, proclaims the narrator in a ZDF documentary. *"Also, it isn't dragging a cable along"*.

The power output of its motor is approximately 5 Watts and the installation's efficiency is about 100%.

### 7.6 A comparison of the systems

As the electrical circuit closure is much easier to realize in practice than the magnetic one, at an unattainably high efficiency, especially the Tesla principle is considered economically viable.

In addition, metal parts are oftentimes present, functioning as potential equalization panel or return conductor, in a car for example the body, or the iron parts in a machine tool, the conduction system of heating pipes in consumption counters or the guiding rails in elevators or other rail-bound vehicles.

No one can ignore the fact that only in the case of resonance; energy will reach the receiver, i.e. at the same frequency and opposite sign. For the layman, that can be illustrated by the image of power "flowing out" of a power plant then "flowing in" to its consumer. Both leads in the cable thereby induce resonance as the two-poled plug is put into the socket.

In principle, this is also possible with only one cable, only then, the resonance is no longer forced, which is why the receiver can drop (i.e. energy does not reach it any longer). By optimising range and conservation of resonance, for example by variation of the coil and antennae geometry, these problems are manageable.

In wireless energy supplies as utilized in remote controls or mobile phones no "return conductor" is available. It is in these circumstances that magnetic coupling with all its disadvantages comes into play.



The disadvantages culminate at the point where the receiver, entirely without guidance wires or other means of connection to the emitter, doesn't know which signal to resonate with. The limiting factor in practical use is not the distance over which resonance can still be maintained, but the tuning distance over which the wireless transmission system is capable of starting up without foreign assistance.

The tasks of a transponder include not only wireless energy, but also information transfer. Now both systems benefit from the fact that intertwined with the magnetic radiation field, magnetic scalar waves always appear, analogous to the electric ones accompanying electrical energy radiation.

To keep down transmission losses a minimization of scalar waves is the aim. In any case, the wave remainder is modulateable and usually sufficient for information conduction in both ways (i.e. from emitter to receiver and vice versa). That would be a ***point-to-point*-*connection of energy and information.***

A ***multi-point*-*connection*** is set up so a power emitter supplies many stations with radiation energy, eliminated the need for a battery or external power supply. If a receiving station is being modulated (i.e. fed with information), this is noticeable at all other stations. Equipped with a code (i.e. with a pattern match comparable to a telephone number), individual communications within a vast network are also conceivable. That's the basis of a cell phone network relying on scalar waves, without radio masts, without harmful e-smog and with less that a thousandth of the emitting power common today.

# 8. Summary

## 8.1 RFID Technology or scalar wave transponder?

In comparison, RFID technology (radio frequency identification) comes off badly, especially when both energy and bidirectional information transmission each rely on a separate system. While a scalar wave transponder can unify all three systems!
The verdict on using RFID becomes even more devastating when examining the occurring scatter fields.

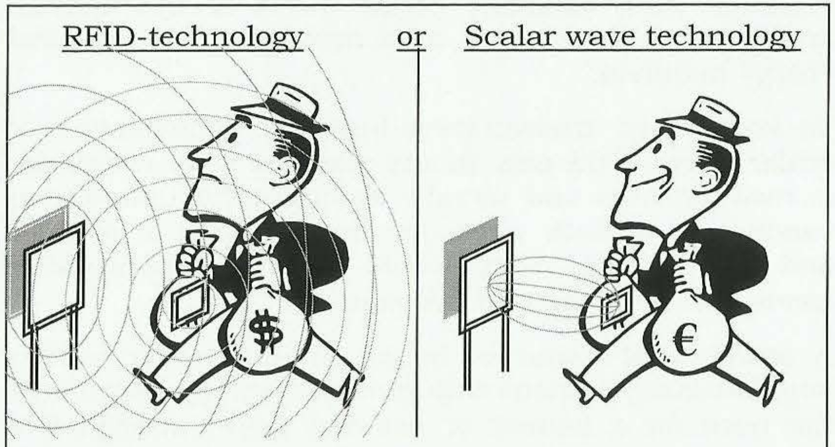



Fig 18. Transversal or longitudinal fields

Today's RFID technology is a compromise, making clear the limitations of Hertz'ian wave technology. Energy transmission occurs at around 120 KHz, so that the useful near-field area is maximized, while information is sent back in the microwave spectrum, so that its emitter is small enough for storage in a credit card.



People in the vicinity are exposed to the sum of both scatter fields. That is a fact, regardless of the biological effects of VLF- or microwave radiation.

For precautionary measure, but also for reasons of efficiency, in the future all signal routes such as wireless LAN or Bluetooth are to be combined with a wireless energy transmission on the basis of scalar waves as the only way to eliminate scatter fields and to prevent biological effects.

## 8.2 From practical experience

If the antenna efficiency is very low (i.e. in case of misadjusted antennae), the useful amplitude decreases while simultaneously antenna noise increases.

According to the wave equation, the explanation could be different: From all the emitted waves the transversal waves decrease in favour of longitudinal waves. But the latter are being utilized in transponder technology, which is why unconventional antennae structures oftentimes allow for better results than common or time tested ones.

Spherical antennae have proven especially useful in electrical transmission lines. The larger the sphere, the more the reception area for energy can be extended past the near field. This effect can be demonstrated experimentally quite convincingly.

So far, high frequency technicians have only concerned themselves with maximizing the transversal wave so that it wouldn't be overwhelmed by noise. The construction of far range transponders calls for misadjusted antennae, the very opposite of what is being taught today in the field of HF technology, for inverted technical solutions.

And thus, the introduction and development of a new transponder technology first demands an extended view and secondly novel ways of high frequency technology education.

### 8.3 The extended field theory

It could be demonstrated that Maxwell's field equations contain an approximation and therefore only constitute a special case of a new, dually formulated and more universal approach.

The mathematical derivations of the Maxwell field and the wave equation uncover what the Maxwell approximation is. The dual counter vortex, with its skin effect expanding and contracting towards the vortex current, also referred to as potential vortex, is being omitted. Is it capable of forming structures and propagates as longitudinal scalar wave in badly conductive materials such as air or vacuum.

At relativistic velocities, the potential vortices are affected by Lorentz contraction. As scalar waves propagate longitudinally in the direction of an oscillating field pointer, the potential vortices experience a steady oscillation in size, consequently to their oscillating propagation. Imagining the field vortex as planar but coiled transversal wave, it follows from the oscillations in size and thus wavelength at a constant vortex velocity (= c) a permanent change in frequency, which is being measured as noise.



This noise turns out to be the potential vortex term omitted from the Maxwell equations. If, for example, a noise signal is being measured at an antenna this proves the existence of potential vortices.

If, however, the Maxwell equations' scope of validity is left behind, misinterpretations and ignorance of accordant phenomena from the field theory are the consequence and the noise or near field can not be further calculated or conclusively explained.

For example this leads to mobile phone industry claims that a mobile phone is less harmful to the human organism when the antenna efficiency is reduced by artificially shortening the antenna, thereby fewer Hertz'ian waves are being emitted.

In fact, the antenna noise (i.e. the biological relevant scalar wave proportion), is being increased, only it is not measured in a laboratory for electromagnetic environmental compatibility (EMC).

Already in principle, it is impossible to reproduce measure vortices since they will vortex at the probe, or else they wouldn't be vortices!

It's being said that there are faithful apostles of science who only think of the measurable as real. What they can not measure can not exist, and therefore they have trouble accepting the existence of scalar waves. It's that easy to deny the existence of scalar waves, although only until it comes to an industrial practical usage of this physical phenomenon, for example for scalar wave transponders.
Then suddenly everyone knew in the first place...

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## 9. Mathematical Appendix

Where the electric field strength is $\mathbf{E} = \mathbf{E}(\mathbf{r},t)$
and the magnetic flux density $\mathbf{B} = \mathbf{B}(\mathbf{r},t)$
and the vector of velocity $\mathbf{v} = \mathbf{v}(\mathbf{r}) = d\mathbf{r}(t)/dt$
along the trajectory $\mathbf{r}(t) \in R^3$ in the time $t \in [0, \infty)$
forming the vector cross product:

$$\mathbf{E} = \mathbf{v} \times \mathbf{B} \qquad (9.1 \equiv 2.1)$$

The curl operation applied to the cross product

$$\text{curl}\,\mathbf{E} = \text{curl}\,(\mathbf{v} \times \mathbf{B}) \qquad (9.2 \equiv 3.1)$$

is determined by four terms:

$$\text{curl}\,\mathbf{E} = -(\mathbf{v}\,\text{grad})\mathbf{B} + (\mathbf{B}\,\text{grad})\mathbf{v} + \mathbf{v}\,\text{div}\,\mathbf{B} - \mathbf{B}\,\text{div}\,\mathbf{v} \quad (9.3)$$

$$\nabla \times (\mathbf{v} \times \mathbf{B}) = -(\mathbf{v}\cdot\nabla)\cdot\mathbf{B} + (\mathbf{B}\cdot\nabla)\cdot\mathbf{v} + \mathbf{v}(\nabla\cdot\mathbf{B}) - \mathbf{B}(\nabla\cdot\mathbf{v}) \qquad (\equiv 3.3)$$

For evaluation of all four terms it may be helpful to consider the vectors in matrix notation.

With the vector for: $\mathbf{r}(t) = (x, y, z)$

Is the vector velocity:

$$\mathbf{v}(\mathbf{r}(t)) = (v_x = dx/dt\,,\ v_y = dy/dt\,,\ v_z = dz/dt) \qquad (9.4)$$

The vector for the Nablaoperator is:

$$\nabla|_{\mathbf{r}=(x,y,z)} = (\partial/\partial x\,,\ \partial/\partial y\,,\ \partial/\partial z)^T \qquad (9.5)$$



In equation 9.3 terms in the form $(\mathbf{v}\cdot\nabla)$ appear and vice versa such of the form $(\nabla\cdot\mathbf{v})$. The vector product returnes different results:

$$(\mathbf{v}\cdot\nabla) = (v_x, v_y, v_z)\cdot\left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right)^T =$$

$$= \frac{\partial x}{\partial t}\cdot\frac{\partial}{\partial x} + \frac{\partial y}{\partial t}\cdot\frac{\partial}{\partial y} + \frac{\partial z}{\partial t}\cdot\frac{\partial}{\partial z} = \left(\frac{\partial}{\partial t}, \frac{\partial}{\partial t}, \frac{\partial}{\partial t}\right) \qquad (9.6)$$

But $(\nabla\cdot\mathbf{v}) =$

$$\left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right)^T\cdot(v_x, v_y, v_z) = \begin{pmatrix} \partial v_x/\partial x\,, & \partial v_y/\partial x\,, & \partial v_z/\partial x \\ \partial v_x/\partial y\,, & \partial v_y/\partial y\,, & \partial v_z/\partial y \\ \partial v_x/\partial z\,, & \partial v_y/\partial z\,, & \partial v_z/\partial z \end{pmatrix} \qquad (9.7)$$

This term $(\nabla\cdot\mathbf{v})$ is zero under the assuption,that it is a constant velocity $\mathbf{v}$ in space. (Assumed is a constant velocity along the track of the curve given by $\mathbf{r} = \mathbf{r}(t)$).
This restricts the application of the rule (written first for the most general case): (9.8)

$$\frac{d\,\mathbf{v}(\mathbf{r},t)}{d\,t} = \frac{\partial\,\mathbf{v}(\mathbf{r},t)}{\partial\,t} + \frac{\partial\,\mathbf{v}(\mathbf{r},t)}{\partial\,\mathbf{r}}\cdot\frac{d\,\mathbf{r}(t)}{d\,t} \quad \text{with } \mathbf{v} = \frac{d\,\mathbf{r}(t)}{d\,t}$$

Where: $\partial\,\mathbf{v}(\mathbf{r},t)/\partial\,\mathbf{r} = 0$, when $\mathbf{v}$ = constant in $\mathbf{r}$. (9.9)

In this case, the derivation to time is equal to the partial derivation:

$$d\,\mathbf{v}/d\,t = \partial\,\mathbf{v}/\partial\,t \qquad (9.10)$$

With the help of this secondary calculation and the condition, that

$$(\nabla\cdot\mathbf{v}) = 0 \qquad (9.11)$$

The individual terms in equation 9.3 will be determined.

- The first term is, with equation 9.6:

  $(\mathbf{v}\ \mathrm{grad})\cdot\mathbf{B} = (\mathbf{v}\cdot\nabla)\cdot\mathbf{B} =$

  $$= (\partial B_x/\partial t\ ,\ \partial B_y/\partial t\ ,\ \partial B_z/\partial t) = \partial\mathbf{B}/\partial t \qquad (9.12)$$

- The second term in equation 9.3 is a similarly structured tensor $< \mathbf{B}, \nabla, \mathbf{v} >$, where the vectors **v** and **B** change places:

  $$(\mathbf{B}\ \mathrm{grad})\cdot\mathbf{v} = (\mathbf{B}\cdot\nabla)\cdot\mathbf{v} = (\nabla\cdot\mathbf{v})\cdot\mathbf{B} = 0 \qquad (9.13)$$

The tensor product $(\nabla\cdot\mathbf{v})$, acting as an operator for the field vector **B**, becomes zero in the case of a spatially constant velocity **v** (according to equation 9.11).

Both terms by itself, applied in equation 9.3 give the law of induction in the famous formulation of Maxwell:

$$\mathrm{rot}\ \mathbf{E} = -\,\partial\mathbf{B}/\partial t \qquad (9.14)$$

The restriction is not depending on the field vectors, but only on the velocity **v**, which no longer occurs after completion of the derivation. The importance can be quite different in the physical nature (for example, as rotation of a field vortex, or as the movement of charge carriers in an electrical conductor, etc.). This question is at first still regarded as open.

- The third term $\quad \mathbf{v}\ \mathrm{div}\ \mathbf{B} = \mathbf{v}\cdot(\nabla\cdot\mathbf{B}) = -\,\mathbf{b} \quad (9.15)$
  Is abbreviated by the letter **b**: $\quad \mathbf{b} = \mathbf{b}(\mathbf{r},t)$

  (Note: in chapter 3 (page 29 ff.) the physical meaning of **b** is discussed. **b** $[V/m^2]$, seen from the dimension, has the property of a potential density vector).



- At least the fourth term is equal to zero, as according to equation 9.11 the term $(\nabla\cdot\mathbf{v}) = 0$:

  $$\mathbf{B}\ \mathrm{div}\ \mathbf{v} = \mathbf{B}\cdot(\nabla\cdot\mathbf{v}) = 0 \qquad (9.16)$$

As justification, the limiting condition of a spatially constant speed also comes into play again.

- Taking into account all 4 terms the 2nd Maxwell-equation is extended by $\mathbf{b}(\mathbf{r},t)$:

$$\boxed{\mathrm{curl}\ \mathbf{E} = -\,\partial\mathbf{B}/\partial t - \mathbf{b} = -\,\mu\cdot(\partial\mathbf{H}/\partial t + \mathbf{H}/\tau_2)} \qquad \begin{matrix}(9.17 \equiv)\\(3.8{+}4.2)\end{matrix}$$

by the use of the material equation $\quad \mathbf{B} = \mu\cdot\mathbf{H} \quad (1.2)$

and the potential density $\quad \mathbf{b} = -\,\mathbf{v}\ \mathrm{div}\ \mathbf{B} = \mathbf{B}/\tau_2\ . \quad (9.18 \equiv 3.15)$

The most important special case of this field equation is without doubt the law of induction (2nd Maxwell-eq. with $\mathbf{b} = 0$ and acc. to 3.15 the 3rd Maxwell-eq.: $\mathrm{div}\ \mathbf{B} = 0$.

- The calculation method for the dual case (curl on eq.2.3 = eq.3.2 and determining the terms in eq. 3.4) is carried out in an identical manner:

$$\mathrm{curl}\ \mathbf{H} = (\mathbf{v}\ \mathrm{grad})\mathbf{D} - (\mathbf{D}\ \mathrm{grad})\mathbf{v} - \mathbf{v}\ \mathrm{div}\ \mathbf{D} + \mathbf{D}\ \mathrm{div}\ \mathbf{v} \qquad \begin{matrix}(9.19 \equiv)\\(3.4)\end{matrix}$$

The result of the derivation appears in a striking duality. It is Ampères law (1st Maxwell equation). An extension is not required and the scope is not restricted:

$$\boxed{\mathrm{rot}\ \mathbf{H} = \partial\mathbf{D}/\partial t + \mathbf{j} = \varepsilon\cdot(\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1)} \qquad \begin{matrix}(9.20 \equiv)\\(3.9{+}4.1)\end{matrix}$$

using the material equation $\quad \mathbf{D} = \varepsilon\cdot\mathbf{E} \quad (1.6)$

and the current density $\quad \mathbf{j} = -\,\mathbf{v}\ \mathrm{div}\ \mathbf{D} = \mathbf{D}/\tau_1 \quad (9.21)$ $(\equiv 3.13)$

The current density j also depends on the electrical conductivity $\sigma$ : $\mathbf{j} = \sigma \cdot \mathbf{E}$ (9.22 ≡ 1.5)

- Derivation oft he special case when $\sigma = 0$.

In vacuum and approximately in air no conductivity is present ($\sigma = 0$). As a result, the current density $\mathbf{j}(\mathbf{r},t)$ is back to zero. Ampère's law reads thus:

$$\text{curl } \mathbf{H} = \varepsilon \cdot (\partial \mathbf{E} / \partial t) \quad (9.23)$$

resp. $$\text{curl curl } \mathbf{H} = \varepsilon \cdot (\partial (\text{curl } \mathbf{E}) / \partial t) \quad (9.24)$$

As usual, the law of induction (9:17) is inserted, (which by the way also works in reverse).

$$\text{curl curl } \mathbf{H} = -\varepsilon \cdot \mu \cdot (\partial^2 \mathbf{H} / \partial t^2 + (\partial / \partial t)(\mathbf{H} / \tau_2)) \quad (9.25)$$

This is already the wave equation, extended to include a damping term in the dielectric. The newly discovered potential vortex is the reason for the vortex damping.

$$-(\partial / \partial t)(\mathbf{H} / \tau_2) = \partial^2 \mathbf{H} / \partial t^2 + c^2 \text{ curl curl } \mathbf{H} \quad (9.26)$$

With the speed of light c : $\varepsilon \cdot \mu = 1 / c^2$ (9.27) (≡1.10)

Already used correlations come again into play of this damping term:

Eq.9.12: $(\partial / \partial t)\mathbf{H} = (\mathbf{v} \text{ grad}) \cdot \mathbf{H}$ (9.28)

with eq. 1.2

and eq.9.18: $-\mathbf{H} / \tau_2 = \mathbf{v} \cdot \text{div } \mathbf{H}$

$$-(\partial / \partial t)(\mathbf{H} / \tau_2) = (\mathbf{v} \text{ grad})(\mathbf{v} \text{ div } \mathbf{H}) \quad (9.29)$$

If this damping term is inserted into equation 9.26, so it could be the well known but advanced wave equation at constant velocity:

$$\boxed{\|\mathbf{v}\|^2 \text{ grad div } \mathbf{H} - c^2 \text{ curl curl } \mathbf{H} = \partial^2 \mathbf{H} / \partial t^2} \quad (9.30) \; (\equiv 4.9)$$



The important finding needs to be commented in detail:

* The extension consists in the derivation of a longitudinal wave, which travels at any speed v, and to be referred to as a 'scalar wave'. Anyone who follows the derivation back, will notice that only the extension of the law of induction by the vector $\mathbf{b}(\mathbf{r},t)$ allows the existence of such scalar waves.

The reverse is logical that there can be no scalar waves, if the classical approach is taken as a basis, with the

3rd Maxwell-equation: $\text{div } \mathbf{B} = 0$

and the derived factor: $\mathbf{b} = -\mathbf{v} \text{ div } \mathbf{B} = 0$ .

By the discovery of magnetic monopoles (Helmholtz Society, Dresden, 2009), the classical approach has lost the right to be valid in all practical cases. The occurrence of scalar waves theoretically is given. The probability that the theoretical model is getting a practical physical reality rises through the complete abandonment of postulates in the present mathematical derivation and that the approach is only based on accepted physical laws.

* The term 'scalar wave' has been introduced by the author, since the divergence of the vector field is scalar. This makes the expression of a scalar wave plausible, whereas the gradient of the scalar gives the directional propagation of the wave.

* An important special case occurs when v = c. Thus, the general wave equation becomes the Laplace equation, as it is found in all textbooks:

$$c^2 \Delta \mathbf{E} = \partial^2 \mathbf{E} / \partial t^2 \quad (1.12)$$

* Obviously the properties of the velocity v are getting comparable to those of the speed of light c, as a description for the range of propagation of a wave in space. c is known as a temporal and spatial constancy. This is to be regarded as justification for the restrictive condition, as it was used several times in the mathematical derivation.

On the other hand, applies the saying *where there is light, there is shadow.* Each shadow is reminding of the directional vector property of light. This circumstance requires to write the propagation of a field structure just from the beginning of a derivation as a vector, even if this property is lost at the end:

$$\|\mathbf{v}\|^2 = v^2 \quad , \quad \text{just as} \quad \|\mathbf{c}\|^2 = c^2$$

So the at first mentioned as an open question, concerning the nature of the velocity vector **v**, now at the end gives the answer himself.

* The question is remaining after the structure of div **E**, with a scalar size within the scalar wave. Quantum physics would answer the question with quantum postulates, for example, charge carriers, and they would prove the physical relevance with respect to plasma waves. We could be content, but there is still the postulate of arbitrariness blocking the way.

The author proposes a different structure, which strictly obeys the generalized wave equation and its derivation. An electromagnetic wave propagating with the speed of light in a circle, so this wraps around the electric or magnetic field pointer and covers those fields inside the vortex. Seen from outside the vortex appears as an eddy field source, described mathematically by div **E** resp. div **H** . (Shown in Fig. 9, page 45 and Fig. 10, page 46).



## 10. Table of formula symbols

| Electric field | | | Magnetic field | | |
|---|---|---|---|---|---|
| **E** | V/m | Electric field strength | **H** | A/m | Magnetic field str. |
| **D** | $As/m^2$ | Electric displacement | **B** | $Vs/m^2$ | flux density |
| U | V | Tension voltage | I | A | Current |
| **b** | $V/m^2$ | potential density | **j** | $A/m^2$ | Current density |
| $\varepsilon$ | As/Vm | Dielectricity | $\mu$ | Vs/Am | Permeability |
| Q | As | Charge | $\phi$ | Vs | Magnetic flux |
| e | As | Elementary charge | m | kg | Mass |
| $\tau_2$ | s | Relaxation time constant of the potential vortices | $\tau_1$ | s | Relaxation time constant of the eddy currents |

other symbols and Definitions:

| | | |
|---|---|---|
| Specific electric conductivity | $\sigma$ | Vm/A |
| Electric space charge density | $\rho_{el}$ | $As/m^3$ |
| Dielectricity | $\varepsilon = \varepsilon_r \cdot \varepsilon_o$ | As/Vm |
| Permeability | $\mu = \mu_r \cdot \mu_o$ | Vs/Am |
| Speed of light | $c = 1/\sqrt{\varepsilon \cdot \mu}$ | m/s |
| Speed of light in a vacuum | $c_o = 1/\sqrt{\varepsilon_o \cdot \mu_o}$ | m/s |
| Time constant of eddy currents | $\tau_1 = \varepsilon/\sigma$ | s |

Concerning vector analysis:

**Bold print** = field pointer (vector)

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## 12. Appendix

Some parts of the book had been presented and published first, such as:

1st Annual RFID Eurasia Conference & Exhibitions
September 5-6, 2007 ISTANBUL, TURKEY
"MEET THE NEED FOR RFID" at **RFID Eurasia 2007,**
organized by **Istanbul Technical University**

and and

Technical co-sponsorship by the University of Arkansas

5th September 2007, **Chair**: Prof. Dr. Konstantin Meyl
***"Field-physical basis for electrically coupled bidirectional far range transponders"***


1. Published in the **Proceedings,** RFID Eurasia Conference 2007, Istanbul, IEEE + ies + Istanbul Technical University, ISBN 978-975-01566-0-1, IEEE Catalogue Number: 07EX1725, p. 78 - 89
2. K.Meyl: Scalar Wave Effects according to Tesla - ANNUAL 2006 of the Croatian Academy of Engine-ering, ISSN 1332-3482, Zagreb, 3/2007, pp. 243-276
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5. K. Meyl: Wireless Power Transmission by Scalar Waves, PIERS Proceedings, Moscow, Russia, August 19–23, 2012, p. 665 – 668.
6. K. Meyl: Wireless Power Transmission, by Enlarging the Near Field, PIERS Proceedings, Stockholm, Sweden, August 12–15, 2013, page 1735-1739





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**Paper 2010:**

## ABOUT THE CLASSICAL ELECTRODYNAMICS AND PRACTICAL APPLICATIONS INFLUENCED BY THE DISCOVERY OF MAGNETIC MONOPOLES


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### ABSTRACT


Even though one usually calculates capacitor losses with a complex Epsilon it still offends the principle of a constant speed of light.
Maxwell's term $c^2 = 1/\varepsilon\cdot\mu$ would even entail a physically unexplicable complex speed! By such an offence against basic principles every physicist is asked to search and to repair the mistake in the textbooks.
In the present treatise vortex losses get in the place of a postulated and fictive imaginary part of the material constant $\varepsilon$ when the function of a microwave oven, welding of PVC foils or capacitor losses are to be ex-plained. The responsible potential vortices can be derived without postulate from approved physical laws and their existence can even be proved experimentally.



***Key words:*** Magnetic Monopoles, Electrodynamics, Maxwell Equations, Field Theory, Dielectric Losses, Poynting Vector, Vector Potential, Potential Vortex.

### 1. Introduction

The error search leads over Poynting's theorem to the vector potential **A**. At this point a new abyss opens. It shows quickly how and where the whole electrodynamics get entangled in contradictions.

The vector potential **A** assumes, as everybody knows that no magnetic monopoles exist. Mathematically expressed it should be

$$\operatorname{div} \mathbf{B} = \operatorname{div} \operatorname{curl} \mathbf{A} = 0 . \qquad (1)$$

(Called the 3rd equation of Maxwell).

On the 16th of October, 2009 sixteen authors reported in the magazine "*Science*" about the discovery of magnetic monopoles [1]. For the vector potential and all derivations constructing it, this new discovery means the final death blow from the mathematical-physical view.

However, a new way must be found. A way to electrodynamics free of contradictions, without vector potential **A** and without complex ε!

Vortex physics offers such a way free from contradictions, with the derivation of potential vortices by a potential density vector **b** which adequately substitutes for the outdated vector potential. Also the dielectrically losses, from now on as vortex losses of disintegrating potential vortices can be calculated in the electrodynamics free of contradiction without complex ε.

Besides, **b** is by no means postulated but is derived from approved physical legitimacies according to textbooks.

### 2. The discovery of the law of induction

In the choice of the approach the physicist is free as long as the approach is reasonable and well founded. In the case of **Maxwell's field equations** two experimentally determined regularities served as basis: On the one hand, **Ampère's law** and on the other hand the **law of induction of Faraday**.
Maxwell, the mathematician, thereby gave the finishing touches for the formulations of both laws. He introduced the displacement current **D** and completed Ampère's law accordingly, and doing so without a chance of being able to measure and prove the measure. Only after his death this was possible experimentally, what afterwards makes clear the abilities of this man.



In the formulation of the law of induction, **Maxwell** was completely free because the **discoverer Michael Faraday** had done so without specifications. As a man of practice and of experiment the mathematical notation was less important for Faraday. For him the attempts with which he could show his discovery of the induction to everybody (e.g. his unipolar generator), stood in the foreground.

However, his 40 years younger friend and professor of mathematics Maxwell had something completely different in mind. He wanted to describe the light as an electromagnetic wave and doing so certainly the wave description of Laplace went through his mind, which in turn needs a second time derivation of the field factor.

Because Maxwell for this purpose needed two equations with each time a first derivation, he had to introduce the displacement current in Ampère's law and had to choose an appropriate notation for the formulation of the law of induction to get to the wave equation.

His light theory initially was very controversial. Maxwell faster found acknowledgement for bringing together the teachings of electricity and magnetism and the representation as something unified and belonging together [2] than for mathematically giving reasons for the principle discovered by Faraday.

Nevertheless, questions should be asked.
If Maxwell has found the suitable formulation, if he has understood 100 percent correct his friend Michael Faraday's discovery.
If the discovery (1831) and the mathematical formulation (1862) stem from two different scientists, who in addition belong to different disciplines, thus it is not unusual for misunderstandings to occur. It will be helpful to work out the differences.

### 3. The unipolar generator

If one turns an axially polarized magnet or a copper disc situated in a magnetic field, then perpendicular to the direction of motion and perpendicular to the magnetic field pointer a pointer of the electric field will occur, which everywhere points axially to the outside. In the case of this by **Michael Faraday**, he developed a **unipolar generator** - by means of a brush between the rotation axis and the circumference a voltage is picked off.

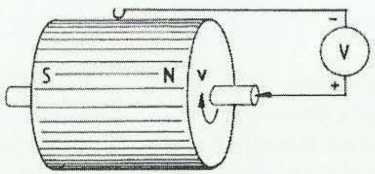
The mathematically correct relation $\mathbf{E} = \mathbf{v} \times \mathbf{B}$ (2)

I call this the "*Faraday-law*", despite the fact that it appears in this form in textbooks later in time [3]. The formulation usually is attributed to the mathematician **Hendrik Lorentz**, since it appears in the **Lorentz force** in exactly this form. Much more important than the mathematical formalism are the experimental results and the discovery by Faraday, for which the law concerning unipolar induction is named after him the "**Faraday-law**".

Of course we must realize that the charge carriers at the time of the discovery hadn't been discovered yet and the field concept couldn't correspond to that of today. The field concept is an abstracter one, free of any quantization.

That of course is also valid for the field concept advocated by Maxwell, which we now contrast with the „*Faraday-law*" (fig. 1). The second Maxwell equation, the law of induction (2), also is a mathematical description between the electric field strength **E** and the magnetic induction **B**. But this time the two aren't linked by a relative velocity **v**.

e.g.: unipolar generator

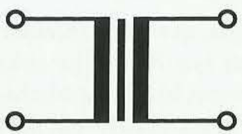



Discovery of Faraday

$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$ (2)

unipolar induction

i.e. transformer



2nd Maxwell equation

$\boxed{\text{curl } \mathbf{E} = -\, \partial \mathbf{B} / \partial t}$ (3)

law of induction generally

*Fig. 1: Two formulations for one law*
*As a mathematical relation between the vectors of the electric field strength **E** and the magnetic flux density **B***



In place stands the time derivation of **B**, with which a change in flux is necessary for an electric field strength to occur. As a consequence the Maxwell equation doesn't provide a result in the static or quasi-stationary case. In such cases it is usual to fall back upon the unipolar induction according to Faraday (e.g. in the case of the Hall-probe, the picture tube, etc.). The falling back should only remain restricted to such cases, so the normally idea is used. The question then asked: "*Which restriction of the "Faraday-law" to stationary processes is made*?"
The vectors **E** and **B** can be subject to both spatial and temporal fluctuations. In that way the two formulations suddenly are in competition with each other and we are asked to explain the difference, as far as such a difference should be present.

### 4. Different induction laws

For instance, such a difference it is common practice to neglect the coupling between the fields at low frequencies. At high frequencies in the range of the electromagnetic field the **E**- and the **H**-field are mutually dependent.

While at lower frequency and small field change the process of induction drops correspondingly according to Maxwell so that a neglect seems to be allowed. Under these conditions electric or magnetic field can be measured independently of each other. Usually it is proceeded as if the other field is not present at all.
That is not correct. A look at the "*Faraday-law*" and immediately it shows that even down to frequency zero both fields are always present. The field pointers however stand perpendicular to each other, so that the magnetic field pointer wraps around the pointer of the electric field in the form of a vortex ring. In this case the electric field strength is being measured and vice versa.
The closed-loop field lines are acting neutral to the outside; so is the normal used idea. However they need no attention.

It should be examined more closely if this is sufficient as an explanation for the neglect of the not measurable closed-loop field lines or, if not after all, an effect arises from fields which are present in reality.
Another difference concerns the commutability of **E**- and **H**-field, as is shown by the Faraday-generator, how a magnetic field becomes an electric field and vice versa as a result of a relative velocity v. This directly influences the physical-philosophic question: "*What is meant by the electromagnetic field*?"

### 5. The electromagnetic field

The textbook opinion, based on the *Maxwell equations*, names the static field of the charge carriers as cause for the electric field, whereas moving ones cause the magnetic field [4 e.g.]. But that could not have been the idea of **Faraday**, to whom the existence of charge carriers was completely unknown.

For his contemporaries, completely revolutionary abstract field concept, based on the works of the **Croatian Jesuit priest Boscovic** (1711-1778). In the case of the field it should less concern a physical quantity in the usual sense, than rather the "*experimental experience*" of an interaction according to his field description.

We should interpret the "*Faraday-law*" to the effect that we experience an electric field if we are moving with regard to a magnetic field with a relative velocity and vice versa.

In the commutability of electric and magnetic field a duality between the two is expressed, which in the Maxwell formulation is lost as soon as charge carriers are brought into play. The question then becomes, "*Is the Maxwell field the special case of a particle free field*?"
Much evidence points to the answer as "*yes*", because, after all, a light ray can run through a particle free vacuum. As we see, fields can exist without particles but particles without fields are impossible! In conclusion, the field should have been there first as the cause for the particles. The Faraday description should form the basis from which all other regularities can be derived.

What do the textbooks say to that?

### 6. Contradictory opinions in textbooks

Obviously there exist two formulations for the law of induction (2 and 3), which more or less have equal rights. Science stands for the questions: "*Which mathematical description is the more efficient one? If one case is a special case of the other case, which description then is the more universal one*?"



What Maxwell's field equations tell us is sufficiently known so that derivations are unnecessary. Numerous textbooks are standing by, if results should be cited. Let us hence turn to the "*Faraday-law*" (2). Often one searches in vain for this law in schoolbooks. Only in more pretentious books one makes a find under the keyword unipolar induction. If one compares the number of pages which are spent on the law of induction according to Maxwell with the few pages for the unipolar induction, then one gets the impression that the later is only a unimportant special case for low frequencies.

Prof. **Küpfmüller** (TU Darmstadt) speaks of a "*special form of the law of induction*" [4, p.228, eq.22], and cites as practical examples the induction in a brake disc and the Hall-effect. Afterwards Küpfmüller derives from the "*special form*" the "*general form*" of the law of induction according to Maxwell, a postulated generalization, which needs an explanation. But a reason is not given.

Prof. **Bosse** (as successor of Küpfmüller at the TU Darmstadt) gives the same derivation, but for him the Maxwell-result is the special case and not the Faraday approach [5, p.58]! In addition he addresses the "*Faraday-law*" as an equation of transformation, points out the meaning, and the special interpretation.

On the other hand he derives the law from the "*Lorentz force*", completely in the style of Küpfmüller [4] and with that again takes part of its autonomy.

Prof. **Pohl** (University of Göttingen, Germany) looks at that differently. He inversely derives the "*Lorentz force*" from the "*Faraday-law*" [3, p.77]. We should follow this very convincing representation.

### 7. The equation of convection

If Bosse [5] prompted term "*equation of transformation*" is justified or not is unimportant at first. That is a matter for discussion.

If there should be talk about "*equations of transformation*", then the dual formulation (to equation 2) belongs to it, and then it concerns a **pair of complementary equations** which describes the relations between the electric and the magnetic field.

The **new and dual field approach** consists of

**equations of transformation**

of the electric and of the magnetic field

$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$ (2) and $\boxed{\mathbf{H} = -\mathbf{v} \times \mathbf{D}}$ (4)

***unipolar induction*** ***equation of convection***

Written down according to the rules of duality there results an equation (4), which occasionally is mentioned in some textbooks.

While both equations in the books of **Pohl** [3, p.76 and 130] and of **Simonyi** [6, p.924] are written down side by side having equal rights and are compared with each other, **Grimsehl** [7, p.130] derives the dual regularity (4) with the help of the example of a thin, positively charged, and rotating metal ring. He speaks of *"equation of convection"* as moving charges produce a magnetic field and so-called convection currents. Doing so he refers to workings of **Röntgen** 1885, **Himstedt**, **Rowland** 1876, **Eichenwald** and many others.

In his textbook **Pohl** also gives practical examples for both equations of transformation. He points out that one equation changes into the other one, if as a relative velocity v the speed of light c should occur [3, p.77].

### 8. The derivation from text book physics

We now have found a field-theoretical approach with the equations of transformation, which in its dual formulation is clearly distinguished from the Maxwell approach. The reassuring conclusion is added: **The new field approach roots entirely in textbook physics**, and are the results from literature research.

We can completely do **without postulates!**

As a starting-point and as approach serve the *equations of transformation* of the electromagnetic field, the *"Faraday-law"* of *unipolar induction* (2) and the according to the rules of duality formulated law called *equation of convection* (4).

$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$ (2) and $\boxed{\mathbf{H} = -\mathbf{v} \times \mathbf{D}}$ (4)



If we apply the curl to both sides of the equations:

$\boxed{\text{curl } \mathbf{E} = \text{curl } (\mathbf{v} \times \mathbf{B})}$ (5), $\boxed{\text{curl } \mathbf{H} = -\text{ curl } (\mathbf{v} \times \mathbf{D})}$ (6)

then according to known algorithms of vector analysis the curl of the cross product each time delivers the sum of four single terms [8]:

$$\boxed{\text{curl } \mathbf{E} = (\mathbf{B} \text{ grad})\mathbf{v} - (\mathbf{v} \text{ grad})\mathbf{B} + \mathbf{v} \text{ div } \mathbf{B} - \mathbf{B} \text{ div } \mathbf{v}} \quad (7)$$

$$\boxed{\text{curl } \mathbf{H} = -[(\mathbf{D} \text{ grad})\mathbf{v} - (\mathbf{v} \text{ grad})\mathbf{D} + \mathbf{v} \text{ div } \mathbf{D} - \mathbf{D} \text{ div } \mathbf{v}]} \quad (8)$$

Two of these again are zero for a non-accelerated relative motion

$$\mathbf{v}(\mathbf{r}) = d\mathbf{r}/dt \quad (9)$$

all along the curve given by $\mathbf{r}(t)$.

$$(\mathbf{B} \text{ grad})\mathbf{v} = 0 \quad \text{resp.} \quad (\mathbf{D} \text{ grad})\mathbf{v} = 0 \quad (9^*)$$

and

$$\mathbf{B} \text{ div } \mathbf{v} = 0 \quad \text{resp.} \quad \mathbf{D} \text{ div } \mathbf{v} = 0 \quad (9^{**})$$

One term concerns the vector gradient ($\mathbf{v}$ grad)$\mathbf{B}$, which can be represented as a tensor. By writing down and solving the accompanying derivative matrix and giving consideration to the above determination of the $\mathbf{v}$-vector, the vector gradient becomes the time derivation of the field vector $\mathbf{B}(\mathbf{r},t)$,

$$\boxed{(\mathbf{v} \text{ grad}) \mathbf{B} = \frac{\partial \mathbf{B}}{\partial t}} \quad \text{and} \quad \boxed{(\mathbf{v} \text{ grad}) \mathbf{D} = \frac{\partial \mathbf{D}}{\partial t}}, \quad (10)$$

according to the rule, valid in this special case:

$$(\mathbf{v} \text{ grad}) \mathbf{B} = \left( \frac{\partial x}{\partial t}\frac{\partial B_x}{\partial x}, \frac{\partial y}{\partial t}\frac{\partial B_y}{\partial y}, \frac{\partial z}{\partial t}\frac{\partial B_z}{\partial z} \right) = \frac{\partial \mathbf{B}}{\partial t} \quad (11)$$

For the final not yet explained terms are written down the vectors $\mathbf{b}$ and $\mathbf{j}$ as abbreviation.

$$\text{curl } \mathbf{E} = -\partial\mathbf{B}/\partial t + \mathbf{v} \text{ div } \mathbf{B} = -\partial\mathbf{B}/\partial t - \mathbf{b} \quad (12)$$

$$\text{curl } \mathbf{H} = \partial\mathbf{D}/\partial t - \mathbf{v} \text{ div } \mathbf{D} = \partial\mathbf{D}/\partial t + \mathbf{j} \quad (13)$$

With equation 13 we in this way immediately look at the well-known law of Ampère (1st Maxwell equation).

### 9. The Maxwell equations as a special case

The result will be the **Maxwell equations**, if:

- the potential density $\mathbf{b} = -\mathbf{v}\,\mathrm{div}\,\mathbf{B} = 0$ , (14)
  (eq. 12 ≡ law of induction, if $\mathbf{b} = 0$ resp. $\mathrm{div}\,\mathbf{B} = 0$).
- the current density $\mathbf{j} = -\mathbf{v}\,\mathrm{div}\,\mathbf{D} = -\mathbf{v}\cdot\rho_{el}$ , (15)
  (eq. 13 ≡ Ampère's law,
  if $\mathbf{j}$ ≡ with $\mathbf{v}$ moved neg. charge carriers;
  $\rho_{el}$ = electric space charge density).

In addition the comparison of coefficients (15) delivers a useful explanation to the question, "*What is meant by the current density* **j**"? It is a space charge density $\rho_{el}$ consisting of negative charge carriers, which moves with the velocity **v**, for instance through a conductor.

The current density **j** and the dual potential density **b** mathematically seen at first are nothing but alternative vectors for an abbreviated notation. While for the current density **j** the physical meaning already could be clarified from the comparison with the *law of Ampère*, the interpretation of the potential density **b** is still due:

$$\mathbf{b} = -\mathbf{v}\,\mathrm{div}\,\mathbf{B} \quad (= 0) \quad , \qquad (14)$$

From the comparison of eq. 12 with the *law of induction* (eq. 3) we merely infer, that according to the *Maxwell theory* that this term is assumed to be zero. But that is exactly the **Maxwell approximation** and the restriction with regard to the new and dual field approach, which takes root in Faraday.

### 10. The Maxwell approximation

Also the duality gets lost with the argument that magnetic monopoles (div **B**) in contrast to electric monopoles (div **D**) do not exist and until today could evade every proof. It has not yet been searched for the vortices dual to eddy currents, which are expressed in the neglected term.

Assuming a monopole concerns a special form of a field vortex, then immediately it is clear why the search for magnetic poles in the past had to be a dead end and their failure isn't good for a counterargument. The missing electric conductivity in a vacuum prevents current densities, eddy currents, and the formation of magnetic monopoles. Potential densities and potential-vortices however can occur. As a result, without exception, only electrically charged particles can be found in the vacuum.



Let us record: **Maxwell's field equations can directly be derived from the new dual field approach under a restrictive condition.**

Under this condition the two approaches are equivalent and with that also error free. Both follow the textbooks and can, so to speak, be the textbook opinion.

The restriction ($\mathbf{b} = 0$) surely is meaningful and reasonable in all those cases in which the Maxwell theory is successful. It only has an effect in the domain of electrodynamics. Here usually a vector potential **A** is introduced and by means of the ***calculation of a complex dielectric constant*** a loss angle is determined. Mathematically the approach is correct and dielectric losses may be calculated.

Physically the result is extremely questionable since as a consequence of a complex ε a *complex speed of light* in dielectric matter would result,

according to the definition: $$c = 1/\sqrt{\varepsilon\cdot\mu} \qquad (16).$$

With that electrodynamics offends against all specifications of the textbooks, according to which c is constant and not variable and less then ever complex!

But if the result of the derivation physically is wrong, then something with the approach is wrong, therefore we ask if the fields in the dielectric perhaps have an **entirely other nature** and then **dielectric losses** perhaps are **vortex losses** of the **potential-vortex decay**?

### 11. The magnetic field as a vortex field

Is the introduction of a vector potential **A** in electrodynamics a substitute of neglecting the potential density **b**? Do two ways mathematically lead to the same result? And what about the physical relevance?
After classic electrodynamics, being dependent on working with a complex constant of material is buried an insurmountable inner contradiction.

The answer begs for the **freedom of contradictions of the new approach**.

The abbreviations **j** and **b** are further transformed, at first the current density in *Ampère's law*

$$\mathbf{j} = -\mathbf{v}\cdot\rho_{el} \qquad (15)$$

as the movement of negative electric charges.

By means of Ohm's law $\mathbf{j} = \sigma\cdot\mathbf{E}$ (17)

and the relation of material $\mathbf{D} = \varepsilon\cdot\mathbf{E}$ (18)

the current density $\boxed{\mathbf{j} = \mathbf{D}/\tau_1}$ (19)

also can be written down as dielectric displacement current with the characteristic relaxation time constant for the eddy currents

$$\tau_1 = \varepsilon/\sigma \qquad (20).$$

In this representation of the law of Ampère:

$$\boxed{\text{curl}\,\mathbf{H} = \partial\mathbf{D}/\partial t + \mathbf{D}/\tau_1 = \varepsilon\cdot(\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1)} \qquad (21)$$

clearly is brought to light why the magnetic field is a vortex field, and how the eddy currents produce heat losses depending on the specific electric conductivity $\sigma$. As one sees, with regard to the magnetic field description, we move around completely in the framework of textbook physics.

### 12. The derivation of the potential-vortex

Let us now consider the dual conditions. The comparison of coefficients looked at purely formal, results in a *potential density*

$$\mathbf{b} = \mathbf{B}/\tau_2 \qquad (22)$$

in duality to the current density **j** (eq. 19), which with the help of an appropriate time constant $\tau_2$ founds vortices of the electric field. I call these ***"potential vortices"***

$$\boxed{\text{curl}\,\mathbf{E} = -\partial\mathbf{B}/\partial t - \mathbf{B}/\tau_2 = -\mu\cdot(\partial\mathbf{H}/\partial t + \mathbf{H}/\tau_2)} \qquad (23)$$

In contrast to that the Maxwell theory it requires an **irrotationality of the electric field**, which is expressed by taking the potential density **b** and the divergence **B** equal to zero. The time constant $\tau_2$ thereby tends towards infinity.

There isn't a way past the potential-vortices and the new dual approach,

1. as the new approach gets along **without a postulate**, as well as
2. consists of **accepted physical laws**,



3. why also **all error free derivations** are to be accepted,
4. no scientist can afford to already exclude a possibly **relevant phenomenon** at the approach,
5. the **Maxwell approximation** for it's negligibleness is to examine,
6. to which a **potential density measuring instrument** is necessary, which may not exist according to the Maxwell theory.

Supported by the discovery of magnetic monopoles by the Helmholtz Center [1] in Berlin and Dresden we are forced to accept a div **B** different from zero which forbids the usual use of the vector potential **A** in the new physics. In its place come the potential density **b** and the potential-vortices with the characteristic time constant $\tau_2$.
Nevertheless, we should check the new field approach for plausibility. At this point particularly the question of the calculation of dielectric losses in capacitors and insulators interests us.

### 13. The extended Poynting Vector

The Poynting vector $\mathbf{S} = \mathbf{E} \times \mathbf{H}$ (24)

stands for the energy flux density of the electromagnetic field. With this usual abbreviation the calculation of the entire energy balance is possible. First the power flux density is determined:

$$\text{div}\,\mathbf{S} = \text{div}\,(\mathbf{E} \times \mathbf{H}) = \mathbf{H}\cdot\text{curl}\,\mathbf{E} - \mathbf{E}\cdot\text{curl}\,\mathbf{H} \qquad (25)$$

Then the enlarged field equations are used for [12 or 23 (curl **E**) and for 13 or 21 (curl **H**)]:

$$\text{div}\,\mathbf{S} = -\mathbf{H}\cdot\partial\mathbf{B}/\partial t - \mathbf{H}\cdot\mathbf{b} - \mathbf{E}\cdot\partial\mathbf{D}/\partial t - \mathbf{E}\cdot\mathbf{j} \qquad (26)$$

By consideration of the material equations and the relation, that

$$\varepsilon\cdot\int_0^{\mathbf{E}} \mathbf{E}\cdot d\mathbf{E} = \tfrac{1}{2}\varepsilon\cdot\mathbf{E}^2 \quad \text{resp.} \quad \mathbf{E}\cdot\partial\mathbf{D}/\partial t = \partial/\partial t(\tfrac{1}{2}\varepsilon\cdot\mathbf{E}^2) \qquad (27)$$

and accordingly: $\mathbf{H}\cdot\partial\mathbf{B}/\partial t = \partial/\partial t(\tfrac{1}{2}\mu\cdot\mathbf{H}^2)$ (28)

the energy balance for an infinitesimal volume element (Poynting theorem) in enlarged form is:

$$\text{div}\,\mathbf{S} + \partial/\partial t(\tfrac{1}{2}\varepsilon\cdot\mathbf{E}^2 + \tfrac{1}{2}\mu\cdot\mathbf{H}^2) + \mathbf{E}\cdot\mathbf{j} + \mathbf{H}\cdot\mathbf{b} = 0 \qquad (29)$$

Four of the five appearing terms in the entire balance are described and discussed in numerous textbooks [e.g. 9: Blume, page 68].

Thus div **S** stands for the input power,
$\varepsilon \cdot \mathbf{E}^2/2$ describe the stored electric
and $\mu \cdot \mathbf{H}^2/2$ the magnetic energy density,
while the expression $\mathbf{E} \cdot \mathbf{j}$ explains the losses.

Thus the electric energy stored in a condenser amounts:

$$W_{el} = \iiint_V (\tfrac{1}{2}\varepsilon \cdot E^2) dV = \frac{\varepsilon\, U^2}{2\, d^2} d \cdot A = \frac{1}{2} U^2 \frac{\varepsilon\, A}{d} = \frac{1}{2} C \cdot U^2 \tag{30}$$

with the capacity of the condenser $C = \varepsilon \cdot A/d$ (31)

Analogously the magnetic energy stored in an inductance amounts to:

$$W_{mag} = \iiint_V (\tfrac{1}{2}\mu \cdot H^2) dV = \frac{\mu\, I^2}{2 s^2} s \cdot A = \frac{1}{2} I^2 \frac{\mu\, A}{s} = \frac{1}{2} L \cdot I^2 \tag{32}$$

with the inductance of a conductor loop $L = \mu \cdot A/s$ (33)

A certain duality between the electric and the magnetic field can't be neglected.

If the stored power is subtracted from the supplied input power only the losses are left in the energy balance. Besides, there also appear two terms of losses $\mathbf{E} \cdot \mathbf{j}$ and $\mathbf{H} \cdot \mathbf{b}$, which require a more exact investigation.

## 14. Joule effect losses in the energy balance

All textbooks about electrodynamics agree to the fact that only **one** term of loss should appear. This being the heat in an electrically conducting medium on the basis of currents or eddy-currents. For calculating the energy transformed into heat one puts the volume integral over the power density $\mathbf{E} \cdot \mathbf{j}$ (with the Ohm's law $E = j/\sigma$ after eq. (17)):

$$P = \iiint_V E \cdot j \, dV = \iiint_V (j^2/\sigma)\, dV = (j^2/\sigma) \cdot A \cdot d = I^2 \cdot R \;, \tag{34}$$

Because the current density j defines the current

$$I = j \cdot A \tag{35}$$

and together with the specific conductance $\sigma$
the resistance R:

$$R = d/\sigma \cdot A \tag{36}$$



The relaxation-time constant $\tau_1 = \varepsilon/\sigma$ represents the eddy-currents and describes the vortex decay as we had mentioned in eq. 20.
If we substitute the conductivity and attach the surface A as disks of a capacitor and d as their distance to each other (after eq. 31) the loss resistance gets a slightly different meaning:

$$R = \frac{d}{A \cdot \sigma} = \frac{d}{A} \frac{\tau_1}{\varepsilon} = \frac{\tau_1}{C} \tag{37}$$

Thus the time constant of the eddy-currents suggests a **R-C-circuit** with the time constant

$$\tau_1 = R \cdot C \tag{38}$$

One might calculate the loss factor of a capacitor run on alternating currents in this manner [10, p.135]

$$\tan \delta = 1/\omega \cdot R \cdot C \tag{39}$$

but what remains unnoticed is the fact that here exclusively the *Joule effect* is calculated, while an electric conductivity $\sigma$ forms the basic condition for the realization of the currents and eddy-currents.

A good insulator does not fulfill this basic condition any better than standard capacitors. And this is only one **point of critique** among many.

If we run the capacitor, for example with AC currents and exchange the dielectric with one of less conductivity, then the time constant will grow and also the losses are supposed to grow to infinity. This never will be true!

A derivation which still works fine in the case of conducting materials is completely useless for calculating dielectric losses. In formulary and application books show the measured loss factors listed as a substitute for the offered model and have a limited validity as they only work as guidelines [e.g. 4, p.157].

Of course there is always a complex $\varepsilon$ and the implied offence against the constancy of the speed of light hidden behind these loss factors! Thus one mistake causes the other. In the end the whole electrodynamics subject is under heavy critique. Fortunately, there is a solution to all our problems, as the extended *Poynting vector* (29) offers a **new loss term** in addition to the known ones.

## 15. Potential-vortex losses in the energy balance

The potential density **b**, introduced in the Maxwell equations stands for the origin of potential-vortices like they are expected to be found in poorly conducting materials and particularly in capacitors and insulators. In contrast to eddy-currents with their "*skin effect*" the potential-vortices move towards the *vortex center* to decay there and to generate *heat*.

Again we calculate the power by using the volume integral over the power density **H·b** (in eq. 26); (with $H = B/\mu = b\cdot\tau_2/\mu$ after eq. (22)):

$$P = \iiint_V H\cdot b \, dV = \iiint_V (b^2\tau_2/\mu)\, dV = (b^2\tau_2/\mu)\cdot A\cdot s$$
$$= b^2\cdot A^2\cdot\tau_2\cdot s/\mu\cdot A = U^2\cdot\tau_2/L = U^2/R_2 , \qquad (40)$$

because the *potential-density* b gives the voltage

$$U = b\cdot A \qquad (41)$$

and the inductivity of a conductor loop L is given by equation 33.

The *time constant* $\tau_2$ being responsible for **heat generation by vortex decay of the potential-vortices** suggests an R-L-behavior:

$$\tau_2 = L/R_2 \qquad (42)$$

whereas the parameters $R_2$ and L are also in this case to be understood as parameters of an alternitive model. However, this time the resistance is in the denominator which corresponds to reality even better. If we converted this into current losses with R (after eq. 36) for better comparability:

$$R_2 = \frac{\mu\cdot A}{\tau_2\cdot s}\,\frac{\sigma}{\sigma} = \frac{\mu}{\tau_2\cdot\sigma\cdot R} = \frac{\tau_1}{\tau_2}\cdot\mu^2\cdot\frac{1}{R} \quad , \qquad (43)$$

then the losses ascertained in textbooks would have to be corrected according to the time constants $\tau_2/\tau_1$ (i.e. for the purposes of the potential-vortices in the dielectric and to the loads of the counter-rotating eddy-currents).

However, the actual efficiency of the new approach only shows when calculating a concrete case. When looking through technical literature, take Prof. **Simonyi** as an example [6, p.698]. Simonyi first calculates the special case of a frame antenna as a current loop by the harmlessly wrong assumption of a *vector potential* **A**.



The mathematically won result for the emitted power is very similar to that of a dipole antenna. This makes Simonyi understand his loop as a magnetic dipole and create the duality to the electric dipole. He writes, "*We can imagine it like this: just as there are electric charges flowing in an electric dipole there are virtual magnetic currents flowing in the form of virtual magnetic charges here.*"

In this explanation the lack of duality is to be taken into account because a current is never dual to a current! The variable dual to the current density **j** is the *potential density* **b**, which Simonyi calls *magnetic current density* $\mathbf{j}_m$.

Mathematically, the new approach fits perfectly, according to Simonyi, "*The magnetic loads introduced here are of course virtual, however, the radiation field can be calculated as if they were real.*" Furthermore, he calls the introduction of $\mathbf{j}_m$ (= **b**) suitable, "*because one can thereby convert more complicated radiation fields back to the known dipole fields.*"

## 16. Table of Formula Symbols

| | Electric field | | | Magnetic field | |
|---|---|---|---|---|---|
| **E** | V/m | Electric field strength | **H** | A/m | Magnetic field str. |
| **D** | As/m² | Electric displacement | **B** | Vs/m² | flux density |
| U | V | Tension voltage | I | A | Current |
| **b** | V/m² | potential density | **j** | A/m² | Current density |
| $\varepsilon$ | As/Vm | Dielectricity | $\mu$ | Vs/Am | Permeability |
| $\tau_2$ | s | Relaxation time constant of the potential-vortices | $\tau_1$ ($\tau_1 = \varepsilon/\sigma$) | s | Relaxation time constant of the eddy currents |
| $\sigma$ | Vm/A | Specific electric conductivity | | | |
| $\rho_{el}$ | As/m³ | Electric space charge density | | | |

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## 18. ADDRESS

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## 19. APPENDIX, about the erroneous Proca equations:

*Simonyi* certifies the mathematical applicability to the new approach and, in addition, points to its superiority compared to the outdated approach. But with his view he remains a special physicist among the electrodynamicists who all still calculate with $\mathbf{B} = 0$ and with the vector potential $\mathbf{A}$ whereas the approach is used

$$\mathbf{B} = \operatorname{curl} \mathbf{A} \quad (1).$$

This approach is not allowed anymore due to the **discovery of magnetic monopoles in 2009**. At the same time all attempts to insert the vector potential into the Maxwell equations are to be cancelled. These are known as *Proca equations* [11, p.521].

These equations clearly indicate the contradictions of the old or *classical electrodynamics*. If one sets the electric conductivity close to zero, all the additional terms disappear and the *Maxwell equations* are left. The failure is hardwired if it is about the calculation of insulators.

Also, in the case of the *Proca equations* taking another look for the *Poynting theorem*, the energy balance does not deliver any additional loss term with which the *dielectric losses* could be explained.

This extension is somewhat helpful, although we agree that an extension is necessary in the Maxwell equations. However, this has to occur mathematically and has to be physically correct.

For the rehabilitation of the *Proca equations* it should be mentioned that in isolated cases the extension by potential also generate correct results. Thus *Lehner* derives ***longitudinal waves*** [11, page 528], which I call "***scalar waves***" [12].

However, he limits his result by pointing out the fact that there are no "*longitudinal waves of this form in the classical theory. They are only possible if space charges exist.*" Hence he limits the validity of his derivation to the special case of a ***plasma wave***.

The general derivation of *scalar waves*, proven already 100 years ago by **Nikola Tesla** experimentally and still existing today within every **near field of an antenna**, is found in my book "*Scalar wave transponder*" [12, p.39]. With which instead of the *vector potential* **A** the *potential density* **b** is used.

In direct comparison, the results once more confirm that several ways can lead to the aim but that an extension is however, necessary in any case. In the question which expansion is to be recommended everything points at the potential density **b** - not only because of broader validity of the *calculated scalar waves* but also the possibility of a correct *calculation of losses* within capacitors and microwave ovens.

> The discovery of the *potential-vortices* and the *new approach* lead far beyond it to a unified world of physics and a big unification of all interactions and the removal of all unsettled physical constants [13 (Material collection) and 14].

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