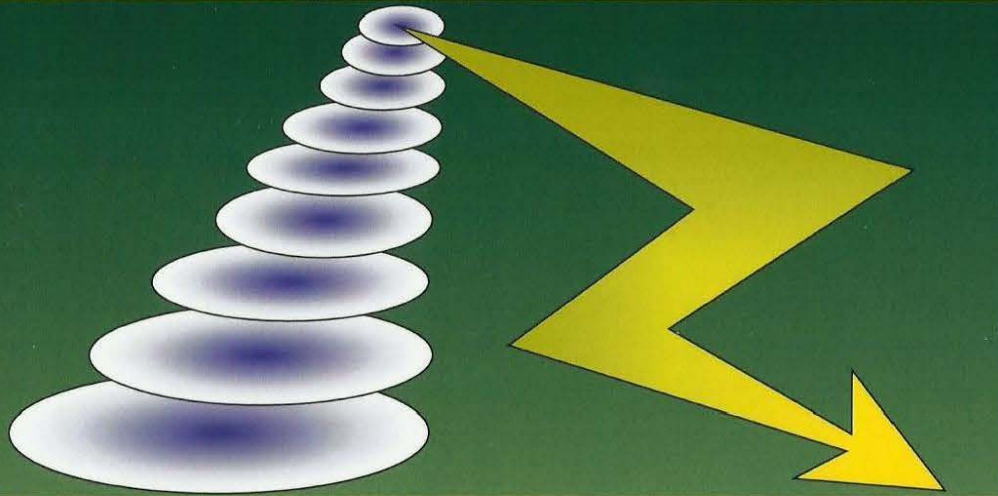
Konstantin Meyl

From Vortex Physics to the World Equation

$$\Delta \mathbf{E}\cdot c^2 = \delta^2\mathbf{E}/\delta t^2 + (1/\tau_1)\cdot\delta\mathbf{E}/\delta t + (1/\tau_2)\cdot\delta\mathbf{E}/\delta t + \mathbf{E}/\tau_1\tau_2$$



Contributions to the scientific discussion and interpretation, its physical and technical application, based on the mathematical calculation of recently discovered potential vortices

Potential Vortex Volume 1

Potential Vortex Vol. 1

From Vortex Physics to the World Equation

by Prof. Dr. Konstantin Meyl

This book proves to be a journey of adventure to readers committed to and interested in the science of nature. The new field of potential vortices is introduced by demonstrative examples from the area of vortex physics. By the example of dielectric losses of capacitors, the vortex decay is verified, motivating the subsequent extension of Maxwell's Equations. In detail, the extension of Faraday's law of induction leads to the potential vortices and ultimately to the fundamental field equation, which fulfills all requirements demanded by such a world equation.

All derivations, which are not based on postulates, are of mathematical validity. The derivation of the Schrödinger equation from the "world equation" shows that the newly formulated field equations of electromagnetism are able to fulfill the postulates of quantum mechanics.

Potential vortices, therefore, have an effect also at microcosmic scale and in nuclear physics and not only in the case of microwaves, high-frequency welding, or in the biosphere of our planet.

Contributions to the scientific discussion and interpretation, its physical and technical application, based on the mathematical calculation of recently discovered potential vortices

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Preface (belonging to the 1st Edition 1990)

In conflict with the existing doctrine, according to which the electric field is vortex-free, the author was, for the first time, able to calculate a corresponding Potential Vortex. The derivation is thus conducted without the need for a postulate, without exception from recognized laws of field physics. The result is a new formulation of Maxwell's field equations, in particular the extension of the law of induction by a Potential Density Vector.

This vortex phenomenon, by systematical observation, opens up a new world to scientists and scientifically interested readers.
Numerous domains of knowledge are affected, contexts are re-interpreted and unresolved phenomena explained scientifically.
It is the aim of this book to set the discussion in motion. In doing so, the quoted examples and contributions should serve solely as suggestion and motivation, and, as well, in no way claim to be complete or accurate.
In order not to unnecessarily complicate the comprehension of the various points of discussion for the reader, the bibliography has been reduced to a minimum. Therefore, the acknowledged book by Prof. Küpfmüller [2a] is being representatively cited for the numerous textbooks on theoretical electrical engineering several times.

One of my teachers, Prof. König (†) of the Technical University of Munich, had summed up the most diverse effects of electric and magnetic fields in his book and points in the final remark to the future task to complement and complete the already existing, of many pieces consisting image [1a].

Anyone who is interested in more details comes across about 600 references in his book. Their repetition in the present book can thus be disregarded. It seems as if the scientific mysteries, provided or processed by König [1], are brought to their mathematical-physical solution by the Potential Vortex Theory at hand.

Numerous chains of proof of illustrative and theoretical kind of the new Potential Vortex Theory are presented. For problem areas, in which the new field theory surpasses the present state of research and doctrine, a stance is taken. This concerns i.e. the question of the existence of magnetic monopoles and in particular the presently prevailing conception of the vortex-free electrostatic potential field.

Once it is shown for the first time that the result, as calculated using the new field equations, encompasses the Schrödinger equation, which is recognized as a correct and experimentally secure solution, the Potential Vortex Theory is beyond any doubt.
This proof forms a highlight and at the same time the end of the first volume, which appears self-contained in this way. The consequence legible from the accordance, that there is no matter at all, but only a vibrational state of the empty space, however, already indicates, that the Potential Vortex theory can not be finished with the present text (see Potential Vortex Volume 2 and 3).

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Villingen-Schwenningen, July 1990 www.meyl.eu

Preface (belonging to the 2nd Edition 2012)

I myself am amazed at the accuracy, with which I was able to predict physical phenomena 22 years ago, such as magnetic monopoles, which could for the first time be discovered in 2009 by the Helmholtz Society and demonstrated by an experiment. For me, as an author, it was worthwhile, that I imposed a strict discipline on myself and allowed no compromises at all, and always tried to answer all open questions, without exception, using valid laws of physics. Only in doing so I was able to formulate a unified theory in the end, but the way was long.

Whoever has accompanied me meanwhile, as a reader or listener, was led from the motivation of the Potential Vortex (1990 to 1992), to the award of the books with the researchers price of DEMVT at Electronica in Munich (1994), the extensive collection of material [27] (1996-2004), to the purely scientific publications, which could only be written after the countless collected aspects have been adequately discussed [see appendix].

By major predictions, which get confirmed sequentially by other scientists, the present book should become more important constantly. Unfortunately it is also becoming old, the readers grab newer editions and the public interest in my oldest corpus impends to cease, although the foundation for the discovery of Potential Vortexes of the electric field had been laid out here. This led me to the publication of the now available second and revised edition.

In the new edition, I have placed value on presenting the road to the advanced field theory, to the fundamental field equation, which I claim to be able to apply as a world equation, remains unchanged and recognizable, just as I had already done 22 years ago.

I will replace only unnecessary and potentially confusing notations (such as the term "hydrotable") or suggestions (like the dowsing phenomenon), whose contribution for achieving the intended purpose is unessential, by a more descriptive illustration in the 2nd Edition of the book.

Lectures and presentations at more than two dozen universities worldwide have helped in the past 22 years to bring some bulky sounding chain of reasoning in a more didactically smoothed form. This shall now also be beneficial to the reader of the new edition.

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Villingen-Schwenningen, January 2012 www.meyl.eu

First English translation by the help of Tristan Itschner

Table of Contents page

1. Introduction to Vortex Physics

As quantum physics nowadays tries to re-frame and explain electric and magnetic field phenomena, we must not be mistaken by the fact that quantum-physics remains a "stepdaughter" of field physics, based solely on postulates, until eventually it will find a way to calculate its quanta. Furthermore, field physics is at least 25 times older and can be traced back all the way to the early Greek natural philosophers.

Vortex physics is another offspring of field physics, however, it has been systematically rejected by quantum physics, which in turn often times has to do a lot with politics and not necessarily with science. It could, in fact, be the case that vortex physics has been suppressed by its own "sister", ever since it, too, has produced distinguished representatives.

A mathematical derivation shows that the currently known formulae and laws of electrodynamics are incomplete and insufficiently describe all phenomena associated with it.

Via a new formulation and extension of Maxwell's equation it will be possible to calculate a potential vortex, its effect on the dielectric medium can be measured, and its existence made evident through observable natural phenomena.

1.1 Question of Existence

In order for these preliminary statements not to contradict known general conclusions, they have to include what follows: Vortices occurring in nature or technology, as a matter of principle, cannot be calculated nor measured and in general are not visible. They are, therefore, out of reach of our precise scientific methods, so it seems practically impossible to prove their existence.

Looking at this in depth we can thus conclude what follows:

Calculating a vortex strictly speaking already ends with the attempt of forming a field equation that is able to determine its dimensions in space and time. Even by taking into consideration all mathematical methods at hand, this four-dimensional field equation (a type of thermal conduction equation) is, to this day, unsolvable. Such an equation can, therefore, only be resolved by applying simplified assumptions of the dimensions of the vortex in space and time.

In trying to measure it, we are faced with the same dilemma. Any kind of measuring probe we use would disrupt the vortex and cause it to swerve aside. We could at best detect anomalies, which would by various measuring attempts lose their repeatability.

We, ultimately, are forced to measure and calculate the vortex effects, for example, its losses and compare those results [4].

Neglects and measurement errors pose an additional difficulty on our way to find the proof of existence of vortices.

We, therefore, rely less on measurements, in relation to eddy currents, but much more on the existence of the established equations of Ampère's law (1826) and the law of induction (Faraday 1831), which J. C. Maxwell in 1873 compiled and complemented.

It would be hard to imagine to not identify and interpret losses of eddy currents as such, without a set of equations. Rather a lack of uniformity, linearity and specific material properties would in this case be accepted as an explanation from a scientific point of view, then the actual causal, but not measurable eddy currents.

This analogy ought to make us reconsider. It implies that neither the measurement of effects, nor the observation of phenomena of a vortex would suffice as a scientific proof of its existence. Only a mathematical description of the vortex through an appropriate field equation can be considered satisfactory, from a precise scientific view point.

1.2 Dual Vortex Phenomena in Fluid Mechanics

In fluid engineering, convincing and strong indications for the correctness of the chosen approach can be found [3]. We benefit from the fact that hydrodynamic vortices can be made visible, e.g. by the injection of smoke into a wind-tunnel.

Already **Leonardo da Vinci** had observed in liquids the existence of *two dual basic types of plane vortices in duality*: "One of these vortices moves slower at the centre, than it does at its perimeter and the other moves faster at its centre, than it does along the perimeter."

A vortex of the first type, also called *"vortex with rigid-body rotation"*, is formed for instance by a liquid in a centrifuge that, due to its inertia of mass, is pressed against the outer wall, because the velocity is fastest there. In an analogous way, the electromagnetic vortex in electrically conductive material shows the well-known "skin effect" (Fig. 1.1).

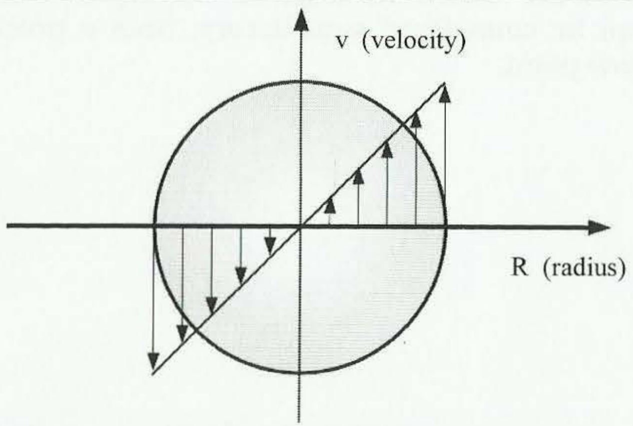


Fig. 1.1: Velocity distribution v(R) for a vortex with rigid body rotation

In order to explain the other vortex, **Newton** describes an experiment in which a rod is dipped into a liquid as viscous as possible and then is stirred. In this *potential vortex* the velocity of the particle increases the closer to the rod it is (Fig. 1.2).

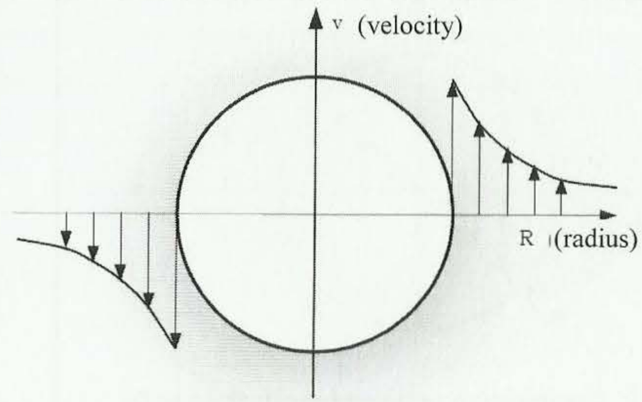


Fig. 1.2: Velocity distribution v(R) in a potential vortex [3].

The duality of both vortex phenomena becomes obvious by contemplating that, in the experiment with the centrifuge, the more liquid is forced towards the outside, the less viscous the medium is. And that, on the other hand, the potential vortex forms more likely, the more viscous the medium is.

As conclusion we read in text books that the *viscosity of the liquid determines whether a vortex with rigid body rotation or a potential vortex is formed.*

When we, in a third experiment, immerse the centrifuge filled with water into a dense medium and rotate the centrifuge, then inside the centrifuge a vortex with rigid body rotation forms and outside the centrifuge a potential vortex (Fig. 1.3).

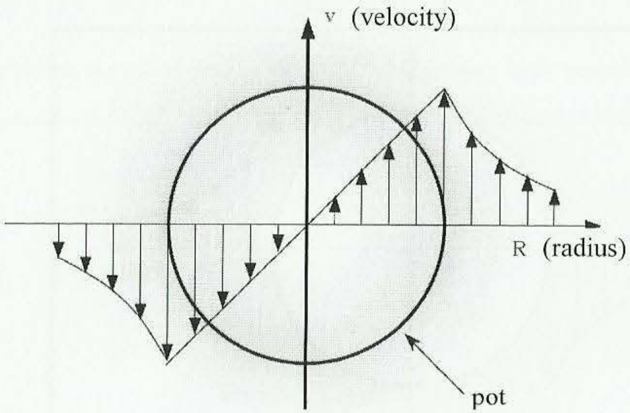


Fig. 1.3: Combination of a vortex with rigid-body rotation and a potential vortex [3]

It is obvious that either one of the vortices always causes the other vortex with opposite properties and so the *existence of one causes that of the other.* So in the first case, that of the vortex with rigid body rotation, outside the centrifuge potential vortices will form in the surrounding air, whereas in the second case, that of the potential vortex, the turning rod itself can be interpreted as a special case of a vortex with rigid-body rotation.

Hence in all conceivable experiments the condition is always fulfilled that in the center of the vortex the same state of "rest", which we can term "zero", prevails as at infinite distance.


Fig. 1.4: Tornado, composed of expanding vortex from inside and counter vortex contracting from outside.

Let us look at a tornado as an example, that is, a whirlwind. In the "eye of the cyclone" there is no wind at all. But if I was to leave the center, I would be blown to the outside. One could really feel this vortex with rigid body rotation on the inside. If, however, one was to stand on the outside, the potential vortex would try to pull you towards its center. This potential vortex is responsible for the structure and, in the end, also for the size of the tornado.

At the *radius of the vortex,* where the wind velocity is fastest, a state of *equilibrium* prevails. The vortex with rigid body rotation and the potential vortex at this point are equally powerful. Their power again is determined by their viscosity, which in turn determines the radius of the vortex.

Therefore meteorologists pursue with interest whether a tornado forms over land or over water. Over the ocean, for instance, it sucks up a lot of water. In that way the power of the potential vortex increases, the radius of the vortex becomes smaller and the energy density increases to a dangerous degree.

1.3 Dual Vortex phenomena in electrical engineering

If the knowledge from hydrodynamics is transferred to the area of electrical engineering, then the role of viscosity is replaced by the electric conductivity. The well-known current vortex (eddy current) occurs in the conductor, whereas its counterpart, the potential vortex, forms in the poorly conducting medium, preferably in the dielectric.
The duality of both vortices is expressed by the fact that the electric conductivity of the medium determines whether eddy currents or potential vortices can form and how fast they decay, i.e. convert their energy into heat. Fig. 1.3 shows that vortex and anti-vortex mutually cause each other.

In the case of *high voltage power lines* we find a striking example for the combination of current vortex and potential vortex.
Inside the conductor, eddy currents form. Thus the current density increases towards the surface of the conductor (skin effect).
Outside the conductor, in the air, the alternating fields find a very poorly conducting medium. If one listens to text book opinion, then the field outside the conductor should be a *non-rotational gradient field.* But this statement causes unsolvable problems.

When *vortices* occur *inside the conductor,* because of a continuous detachment of the vortices at the boundary to the dielectric, the fields in the air surrounding the conductor must also have the shape and the properties of vortices. Nothing would be more obvious as to mathematically describe and interpret these so-called gradient fields as *vortex fields as well.* At closer examination this argument is even necessary.

The laws of field refraction known as *boundary conditions* [2b] in addition demand *continuity* at the boundary of the conductor to the dielectric and, thus, we have no other choice. If there is a vortex field on one side, the field on the other side is also a vortex field, otherwise we would infringe the law. Here an obvious *failure of Maxwell's theory* is evident.

Outside the conductor, in the air, where the alternating fields find a very poorly conducting medium, the potential vortex not only exists theoretically; it even reveals itself. Dependent, among other things, on the frequency and the composition of the surface of the conductor, the potential vortices form around the conductor. If the thereby induced potentials exceed the initial voltage, then impact ionization occurs and the well-known *corona discharge* appears. Everyone of us can hear this as crackling and see the sparkling skin, with which high voltage power lines are covered.

In accordance with the text books, the gradient field increases towards the surface of the conductor too, but a consistent shining would be expected and not a crackling. Without potential vortices the observable structure of the corona would remain an unsolved phenomenon of physics.

But even without knowing the structure forming property of the potential vortices, which acts as an additional support as we must conclude, it can be well observed that especially roughness on the surface of the conductor stimulates the formation of vortices and actually produces vortices. If one is looking for a reason why, with high frequency, the very short impulses of discharge always emerge from surface roughness [2c], one will probably find that potential vortices are responsible for it.

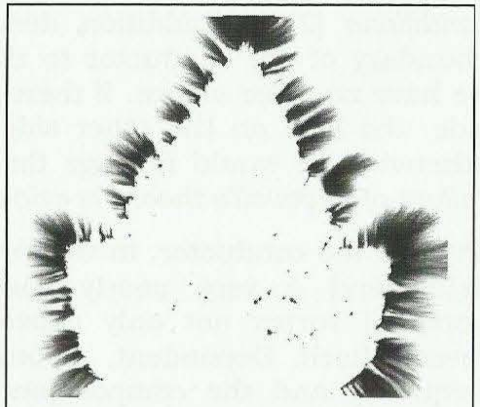


Fig. 1.5: Kirlian photograph of a leave.

By means of a **Kirlian photograph** it can be shown that the corona consists of structured separate discharges (Fig. 1.5).

Students of electrical engineering were able to produce photos of the leaf, using their self built high voltage device in the dark-room, even after the original had been removed(1991). The potential vortices still present underneath the acrylic glas remained detectable by their storage effect.

Several authors have called this a "phantom leaf effect" and it has often been misinterpreted as a paranormal phenomenon [5].

In reality this is due to the storage capacity of the potential vortex having been made visible, which has only ended up in the field of parascience, because Maxwell´s field theory did not include a potential vortex.

With this the approach is motivated, formulated and given reason for. The expositions cannot replace a proof, but they should withstand a critical examination. Let us proceed on our quest for more examples.

1.4 Extended Field Theory According to the Rules of Duality

The commonly used explanation for the *after-effect in dielectrics* is hardly convincing [2d].

By magnetizing a magnetic ring made from solid iron, the current builds up in the opposite direction to the inducting electric flux with a time delay. We know the rational reason for that [4]: we are dealing with eddy currents opposing the cause and therefore counteracting any sudden leap in excitation, only to drift away and eventually decay.

With the help of this vortex theory at hand, the after-effect in dielectrics, hence the characteristic discrepancy between the measurement and the calculation of the progression of the charging process of insulators, can now be explained conclusively: the time delay we can observe during the charging process of a dielectric, is caused by potential vortices counteracting the sudden changes and which only collapse with a time lag.

The well-known rules of duality lead naturally to the computation of the potential vortices, which are supposed to be dual to eddy currents. In any case, this is a quick and straight forward way to archive the required extension of Maxwell´s field equations. One disadvantage to be considered, is the fact that the potential vortex has only been postulated and not mathematically derived, although a traditional method, this still regularly invokes criticism.

Similarly J. C. Maxwell was being criticized for that for over 25 years, until Heinrich Hertz found the experimental verification. He had managed to do so without conclusiveness of proof.

Purely by his theoretical considerations, he laid out the mathematical foundations for wave propagation and thereby, amongst others, a physical explanation of light, by extending Ampère´s law and postulating that besides the free current, it has to have an displacement current (the time dependent derivation of the dielectric displacement).

In accordance with the deduced structured arrangement and the need for a equivalent (dual) description of the magnetic and electric field, the formulation of the law of induction at hand would now also require to have an "displacement" part included alongside the "free" part. This, however, has not yet been implemented, which is why the new formulation of the law of induction needs to be extended by a potential density vector.

The equation demonstrates (Chapter 3 ff.) that the discovery of the potential vortex in electrodynamics is merely the logical consequence of a consistent calculation. Because the new potential density vector **b** [V/m] has the same dimension as the time derivative of the magnetic flux (™**B**/™t), its implementation should turn out to be relatively unproblematic.
The consequences of this extension of the field theory will therefore appear to be even more overwhelming.

2. Properties

We shall conclude the first chapter.
As a point of discussion, we put forward that in the area of electromagnetism two dual vortex phenomena with opposite properties occur. In materials with good conductivity, current vortices (eddy currents) appear, (which are equivalent to the vortex with rigid body rotation and expand in the same way, also known as skin effect).
Ampère´s law and the law of induction in their original formulation will suffice as a mathematical description.
Its complementary vortex forms in media with poor conductivity, in the so called dielectrics. We will focus entirely on the newly introduced potential vortex.

It is part of the task and an area of responsibility of scientists, particularly in this day and age, not to be satisfied merely by the mathematical expression of a newly discovered phenomena, but they also need to concern themselves with the consequences and effects it could be have on all of us and, thus, to set the discussion in motion.

For this purpose we shall first of all consider some of the properties of the potential vortex.

2.1 Concentration Effect

It can be assumed that, until now, there does not yet exist a technical application of the potential vortex theory presented here, unless the phenomenon was used by chance and without knowledge. The transmission of optical light signals via a fibre optic cable can be given as a typical example.

Compared to the transmission of energy impulses using a copper cable, fibre optic cables show a considerably *better degree of efficiency*. The derived potential vortex theory provides a conclusive explanation for this phenomenon and therefore is put here to discussion:

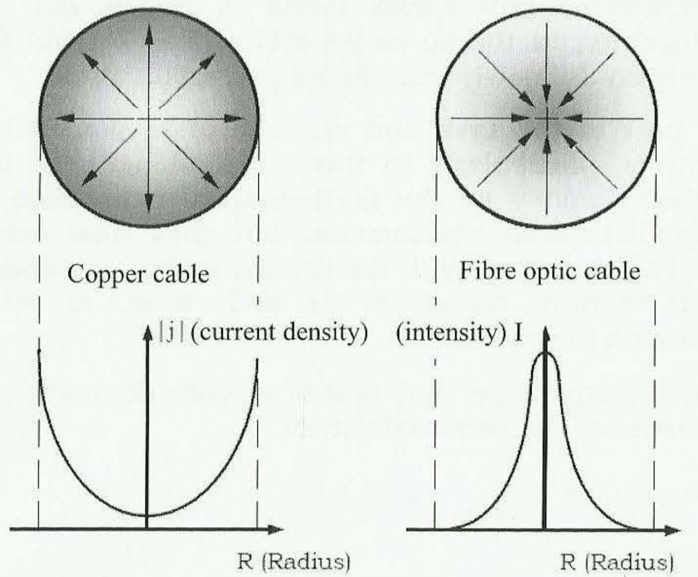


Fig. 2.1: Distribution of the current density (eddy currents) in a copper cable (left side) compared to the distribution of light (potential vortex) within a fibre optic cable (right side).

If we cut through a fibre optic cable and look at the distribution of the light impulses across the cross section, we observe a concentration in the center of the cable (fig. 2.1)

Here the duality between the vortices of the magnetic and the electric field becomes obvious. Whereas the eddy current in a copper conductor causes the well known *"skin effect"*, potential vortices show a *"concentration effect"* and align along the vortex center. The measurable distribution of the light intensity in a fibre optic cable, as shown in fig. 2.1, may confirm this phenomenon of the orientation of the potential vortex towards the vortex center.

For instance, the calculation of the resistance of a copper cable provides as an important result an apparent decrease of the resistance towards the surface of the conductor. In this case, as a consequence of the higher conductivity, the current density increases as well. In the opposite direction, towards the center of the conductor, consequently a decrease of the effective conductivity must be present, regardless of what type of materials are being used. According to the rules of duality, this is a condition for the formation of potential vortices. As mentioned earlier, the conductivity is responsible for this, if the expanding eddy current, with its skin effect or the contracting potential vortex with its concentration effect, are predominant.

Usual fibre optic materials possess not only a small conductivity, but, in addition, are highly dialectic. This additionally favors the formation of vortices of the electric field. If one consciously or unconsciously intensifies the potential vortices, then there is a possibility that the life of the fibre optic cable is

negatively influenced because of the concentration effect.
Of course, it can not be excluded that other effects, like e.g. reflections or the modes of the light are involved in the concentration effect. But it should be guaranteed that this actually concerns causal phenomena and does not concern only alternative explanations out of ignorance of the active vortex phenomenon.

As a consequence, the formal mathematical reason for the concentration effect provides the reverse conclusion in Faraday's law of induction compared to Ampère's law according to the rule of Lenz.

2.2 Vortex Balls and Vortex Lines

It can be assumed that the vortex of the electric field is relevant with regards to the electromagnetic environmental compatibility. This is not only true in case of microcosmic and microscopic vortices, but also in case of macroscopic ones and ones of larger dimensions. Thus single vortices may combine into bales and lines. Evidently we rely on experiences of fluid mechanics once more to study this process [3a].
The interactions of single point vortices have been examined extensively by fluid mechanics. A single vortex rotates on the spot without exterior influence.
This changes if two vortices are adjacent. Then their strength and direction of rotation matter. If their directions of rotation are opposed, while strength is identical, then their centers of rotation move linearly straight forward.
However if their direction of rotation is identical, then they will rotate around one another (fig. 2.2).

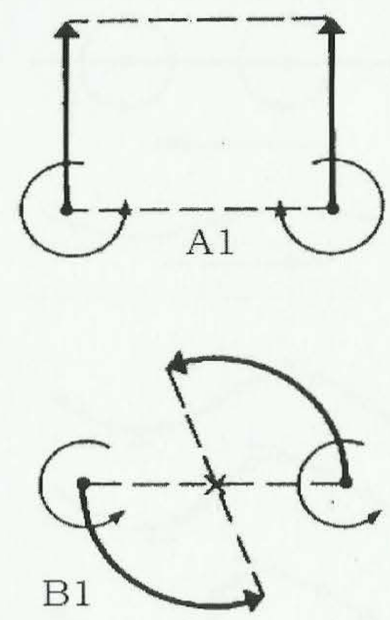


Fig. 2.2:
Motion of two point vortices
A1: with opposite direction
B1: with the same direction of rotation [3a].

Thus a vast number of point vortices is able to form whole vortex bands in the first case and circular vortex bales in the second one. In principle a vortex band may consist of a vast number of potential vortices of identical direction; however it tends to roll up into a vortex bale by external disturbance as computer animations show very demonstratively [3b], (Fig. 2.3).
As a reference point for a discussion, the thesis that vortices of the electric field, too, are in nature usually composed of a vast number of point vortices is proposed, which appear as vortex bands and vortex bales.

The test procedure developed by Scheller yields interesting results, of which is reported [1c]: In strong vortex fields, so-called pathogen spots, "normal blood granules, beads, bubbles and strings over time." It seems to change and roll up. Today, in relation to mobile communications, this is known as "rouleau phenomenon" of the blood curling phenomenon.".

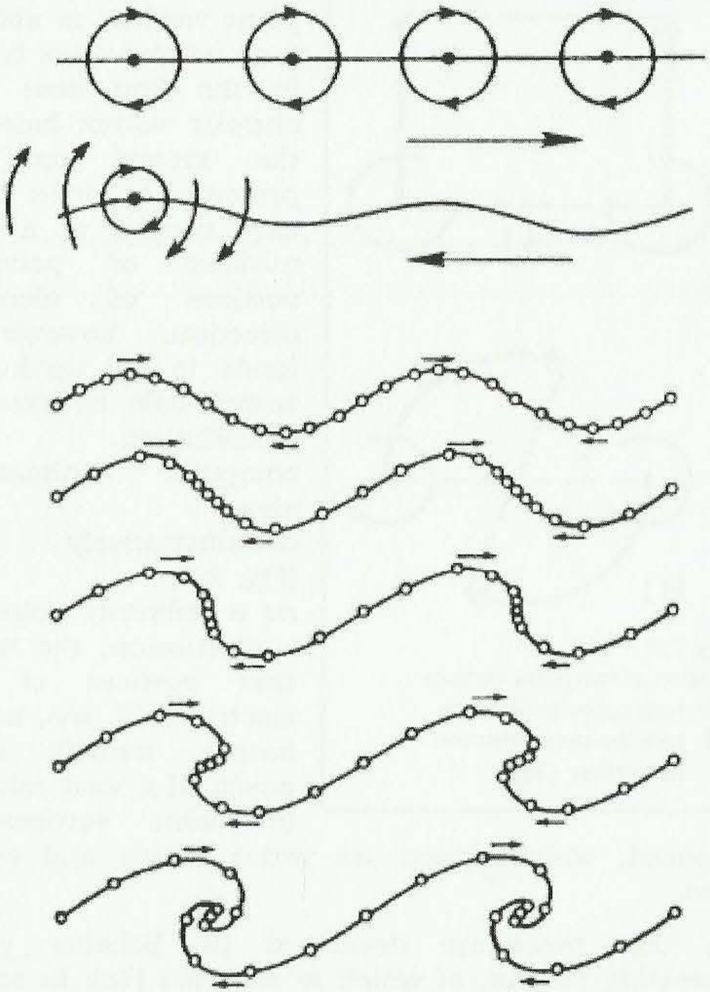


Fig. 2.3: A chain of vortices rolling up into a vortex bale caused by a minor disturbance (acc. to [3b]).

2.3 Transport phenomenon

The vortex principle is self-similar. This is, the same properties of a single vortex may occur and be observed similarly in clusters. The same concentration effect, which keeps together the vortex, shows its effect in the vortex bale and keeps it together.

The same applies to a different fundamental property of potential vortices. That is, to absorb matter inside the vortex and to drag it away with the vortex.
The annular vortices that cigarette smokers are able to blow into the air are commonly known. Of course non-smokers are able to produce these air vortices with their mouth, too, but they remain invisible. It only becomes visible to the human eye by the property of the annular vortex to absorb the smoke.

If our potential vortex transports something, then this should be a dielectric material, preferably water. Thus, if we are in the air around us surrounded by potential vortices, which we may detect e.g. as noise, then they are able to absorb and adhere water inside the vortex by their "transport phenomenon."

Thus air humidity is explained as the ability of air particles to absorb comparatively heavy water molecules. If the vortex decays, then it releases the water particles inevitably and it rains. This is merely an appealing alternative to the classical depiction not claiming thoroughness.

2.4 Water as a Medium

We need to bring to mind that we in the biosphere are located in a comparatively ideal dielectric. The ionosphere and earth are thereby the "capacitor plates." The potential vortex is favored by a poor conductivity and high permittivity. Therefore it will dominate in the biosphere and have an impact.

Life on earth consists predominantly of water and water does have a high permittivity. Therewith the effectivity and persistence of potential vortices increase. Thus the human head consists of 70% and plants of about over 90% of water.
Though it is not just H_2O, but structured water in a colloidal form. This liquid crystal could be a vortex bale, because they consist of a larger number of water molecules in a globular arrangement. They form independent and insoluble particles of negative electric charge.

There is no problem in interpreting the water colloids as vortex bales, due to the structure forming property of potential vortices.

Moreover the transport phenomenon occurs. The globular particles turn their negatively charged side towards the outside and pull the positively charged end towards the ball center. Not observable from the outside, there could be a negatively charged ion inside, which is bound, not able to escape and which gives the whole colloid its characteristic property.
Thus nature knows the different water colloids, of which plants and animals consist.

Though liquid crystals decay at a temperature of 41C. This is not by coincidence the temperature at which human dies. Already 10 millivolt are enough for the electric death of a liquid crystal.

We find a structure similar to the one of a colloid in the composition of atoms. In this case the atom nucleus is held by a vortex-like electron cloud, the atomic shell.

We are going to encounter the transport phenomenon again, when deriving the Schrödinger equation and quantum properties of *elementary particles*.

3. Vortex Losses

Conductive materials like silver, copper or aluminium heat up by electrical currents and eddy-currents.

Dielectrics, as they are used in capacitors and insulating materials, distinguish themselves by a low electric conductivity which is why no eddy-currents are to be expected. Besides, potential-vortices and the accompanying vortex losses are totally unknown in the valid field theory which is why we must continue to search for the reasons why a non-conductor gets hot.

Electrets and other ferroelectric materials with distinctive hysteresis D(E) - characteristics [i.e. barium titanate] are extremely rare. Because the material should be blamed for the measurable losses, the polarization of the material still remains as a possible reason for losses.

3.1 Polarization Losses

If the electric displacement field D follows the electric field E temporally delayed, as caused by a high-frequency polarity reversal, then the loss angle arises, which represents the losses - according to the established doctrine [2e]. This implicates a complex permittivity:

$$\varepsilon = \mathrm{Re}\{\varepsilon\} + j\,\mathrm{Im}\{\varepsilon\} \qquad (3.1)$$

with the loss tangent $\tan\delta = \mathrm{Im}\{\varepsilon\} / \mathrm{Re}\{\varepsilon\}$. (3.2)

This results in a complex speed of light c according to the definition

$$\varepsilon \cdot \mu = 1/c^2 , \qquad (3.3)$$

an infringement of the fundamental principles of physics!

Furthermore such dielectric materials, which are not ferroelectric, should show a transient hysteresis of the D(E)-curve. This is verifiable by frequency dependence, because a direct proportionality is expected, when frequency increases. But the insulator materials, which are so important in engineering, show a constant loss tangent to a large extent. Which physical phenomenon does instead heat an insulator?

Despite the infringement of the constancy of the speed of light, the complex epsilon belongs to the indispensable set of tools of every electrical engineer. He will not tolerate that this tool is taken away from him. Practitioners think and act pragmatic: *"When there is no better theory available,"* many argument, *"then a wrong one is better than non at all."*

For this reason, even unexplored dielectric losses are accounted for by subsuming according to the loss tangent (eq. 3.2).

3.2 The Search for Fault

At least this physically wrong model description yields usable results in many cases [2f]. From the perspective of mathematics we may say that the *description is "harmlessly wrong."*

However, from the perspective of theoretic physics, which is confronted with a complex speed of light, the complex permittivity ε marks the end of all efforts for consistent field physics. If the result of a derivation proves wrong, a search for the fault is announced. The error is then either in the approach or in the derivation.

The latter is presumably accurate, after generation of students had to comprehend the calculations year in and year out. Eventually an error would have attracted attention. Under these circumstances, the error must obviously be in the approach, in the fundamental presumptions of classical electrodynamics [6].

From a mathematical point of view, the vector potential **A** is permissibly introduced. From a physical perspective, this is an extrinsic part of the field theory. Furthermore the vector potential and the potential vortex exclude each other. We will need to decide, whether we are going to calculate dielectric losses by means of a complex epsilon or vortex decay, because doing both simultaneously is mathematically impossible.

3.3 The Field Theory from Maxwell's Desk

James Clerk Maxwell, professor of mathematics, pursued in his book *"A Treatise on Electricity and Magnetism"* (1865) [7] the ambition of deriving Laplace's wave equation from a set of equations of the electric and magnetic field, in order to describe light as an electromagnetic wave.

Especially the version from 1874, extended by the use of quaternions, exceeded the physical phenomena that were experimentally verifiable at that time, because it included the mathematical description of potential vortices, scalar waves and many other impermanent phenomena. However, this field theory did without the vector potential.

Not until 1888, *Heinrich Hertz* experimentally proved one of the numerous phenomena in Karlsruhe: the electromagnetic wave. Aside the eddy current was also recognized because of the laws of *Ampère, Faraday,* and *Ohm,* for which reason *Heaviside* proposed to contract Maxwell's field equations to the verified phenomena. Professor Hertz agreed and professor *Gibbs* wrote down the mutilated field equations in the notation of vector calculus, which is still used today.

Since then the field theory does not describe longitudinal waves, which were already demonstrated by *Nikola Tesla* in 1894 [8] and thus they must be newly postulated, e.g. in the near field of an antenna [9].

3.4 The Vector Potential A

To be able to describe further assured facts in the area of electrodynamics, e.g. dielectric losses, *Maxwell* suggested the introduction of a vector potential **A**:

$$\mathbf{B} = \operatorname{curl} \mathbf{A} \tag{3.4}$$

As a result of this mathematical procedure, the divergence of the magnetic flux density **B** equals zero.

$$\operatorname{div} \mathbf{B} = \operatorname{div} \operatorname{curl} \mathbf{A} = 0 \tag{3.5}$$

J.D.Jackson [6] and his descendants [10a] see magnetic monopoles in div **B** . Because these do not exist, field physicists want to see therein a confirmation of eq. 3.5, which is Gauß's law for magnetism (3rd Maxwell equation). One thought this way hitherto.

On the 03.09.2009 the Helmholtz-Center in Berlin spread the announcement [11, Science, i.a.]: *"Magnetic Monopoles detected for the First Time."* By this discovery inside a magnetic solid body, the vector potential and all its calculations lose ground, regardless of the accuracy and verifiability of all results up to now. One may state that we are now allowed to start from the beginning and consider a new approach.
I propose a vortex description without the use of the vector potential **A** and

$$\operatorname{div} \mathbf{B} \neq 0 \tag{3.6}$$

My approach also explains the *Aharonov Bohm* effect, in which scalar waves are created and verified after they tunneled through a barrier. According to today's interpretation [10], the effect, in which there is no field measurable, was blamed on the vector potential. Other references see even evidence therein.

3.5 Helmholtz's Annular Vortices inside the Aether

The doubts about classical electrodynamics are not new. As early as 1887 *Nikola Tesla* demonstrated in his laboratory in front of *Lord Kelvin* his scalar wave experiments. He told Kelvin about his meeting with the German professor *Hermann von Helmholtz* on the occasion of the World's Columbian Exposition (Chicago 1893). Kelvin did know him very well and had collaborated with him in the past. To describe Tesla's experiments, Helmholtz's concept of vortices and the model of stable annular vortices proved very useful.

In a standing wave, the impulse is passed from one particle to the next. E.g. in case of acoustics, we deal with a standing wave, in which one air molecule gives the next one a push. Thus sound propagates as a longitudinal wave. Therefore the question arises: *In case of Tesla's radiation, which quanta do carry the impulse?*

Lord Kelvin concluded: *"Tesla's experiments prove the existence of longitudinal standing waves of space."*
To the question of what carries the impulse, he concluded: *vortices of the æther!* Therewith he found an answer in the conception.
With the help of his students, he built boxes that could generate coils of smoke to study and demonstrate the specific properties of annular vortices in their fluid-mechanical analogy.

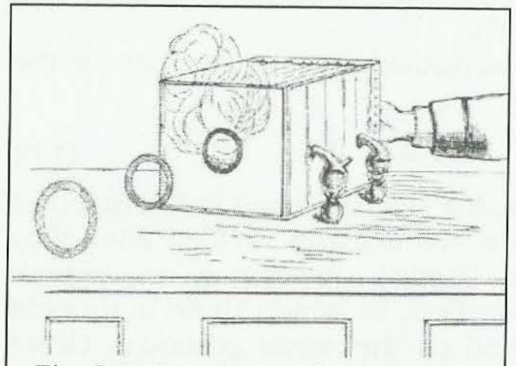


Fig. 3.1: Annular vortices coming out of a smoke box [12]:

But he also did not have an appropriate field theory.

Vortex physics exported from Germany took root in England for a short period, until it became displaced by German quantum physicists. A main proponent was *James Clerk Maxwell*, who thought that the vortex theory was the best and most convincing description of matter [12: James Clerk Maxwell: *"... Helmholtz's annular vortices, which Thomson contemplates to be the true shape of atoms, satisfy more properties of the atom than any other conception hitherto."*].

J. J. Thomson was appointed as his successor at the Cavendish laboratory in Cambridge, who received award for a mathematical treatise on vortices already as a young man. He discovered the electron and contemplated it, how could it be different, as a field vortex [12b: J. J. Thomson: *"The vortex theory is of a much more fundamental character than the conventional theory of solid particles."*].

Emerging quantum physics benefited from the crucial shortcoming of vortex physics: the absence of a useable field theory. This may change dramatically by the discovery of potential vortices, vortices of the electric field.

Furthermore the experimental proof of a vortex transmission as a longitudinal wave in the air or a vacuum, which Tesla provided 100 years ago, is not describable nor compatible by the currently used quantum theory. There is an urgent demand for an extended field theory.

3.6 Excess Noise of a Capacitor

Thus we will apply vortex physics to a dielectric by means of an accordant model conception.

When a wave curls or rolls up into a planar vortex, polarization and propagation velocity obviously stay the same. But how about frequency? Now the wave will circulate around a stationary sport, that is, the vortex center. The propagation velocity of light c will stay the same as vortex velocity. In case of a planar circular vortex, the displacement is outward much longer, than close to the vortex center, therefore on the outside there will be a greater wavelength and as an implication a lower frequency than within.

Thus the vortex is a *frequency converter.* The vortex changes the frequency of the causal wave into a consistent spectrum, which ranges from a low frequency to a very high one.

We observe exactly this property in "*white noise.*" The consequent conclusion is that one deals with a vortex of the electric field in this case. One may easily convince himself of the space-bounding, the frequency-converting property, the fact that vortices are easily influenceable and evade or swirl around an interference, e.g. an antenna.

One only needs a radio receiver adjusted to a poor and noisy signal and move himself or things around the room, to immediately study the effects with the help of the changes in reception.

The very fact that the noise restricts the usability and measurability of signals, shows how much attention potential vortices deserve.

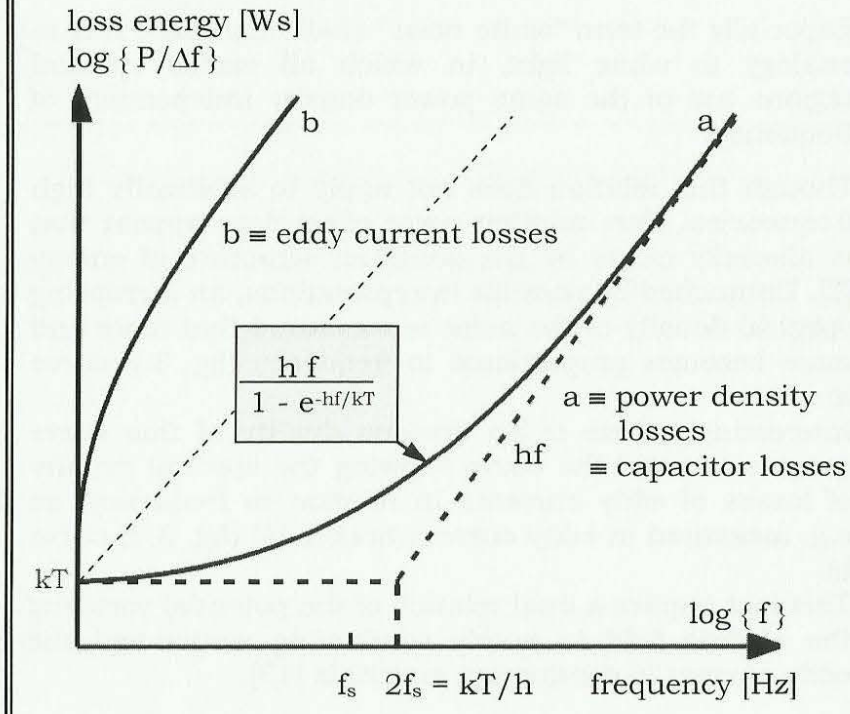


Fig. 3.2: *The power density in relation to frequency of noise (a) according to Küpfmüller [2], as well as of dielectric losses of a capacitor (also a) and of eddy current losses (b) according to Meyl [4], (note the duality of a and b, when mirrored along the dashed line).*

Inside a confined frequency band, the power of the Johnson-Nyquist or resistance noise is not dependent on frequency.

Especially the term "white noise" shall emphasize this in analogy to white light, in which all visible spectral regions are of the same power density independent of frequency.

Though this relation does not apply to arbitrarily high frequencies. Here another noise effect does appear that is allegedly cause by the quantum structure of energy [2]. Untouched by possible interpretations, an increasing spectral density of the noise is measured that more and more becomes proportional to frequency (fig. 3.2 curve a).
Interestingly there is an obvious duality of this curve progression and the curve showing the spectral density of losses of eddy currents in relation to frequency, as e.g. measured in eddy current brakes [4] (fig. 3.2, curve b).
This fact implies a dual relation of the potential vortex of the electric field in poorly conducting media and the eddy current in conducting materials [13].

3.7 Frequency-Dependent Capacitor Losses

Next dielectric losses of a capacitor supplied with alternating current are measured and their relation to frequency is graphed. At first a curve not dependent on frequency is seen that increases towards high frequencies and shows the same characteristic curve progression as the spectral density of Johnson-Nyquist noise mentioned above (fig. 3.2, curve a).

This excellent agreement implies that dielectric losses are actually *vortex losses*.
The vortex phenomena caused by fields changing over time do not only occur in ferromagnetic and conducting materials, but also as their dual phenomena in dielectric and non-conducting media.

Practical examples of use are the high-frequency welding and the microwave. In other words, the process may be described as follows: In both examples, the cause is alternating high-frequency fields that irradiate as an electromagnetic wave into a dielectric, where they roll up into potential vortices and decay inside the vortex center. This process of diffusion causes the desired and applied heat effect.

Recently, a final thesis, which was overseen by the author and a colleague of the University of Konstanz, included a convincing proof. The measured dielectric losses of a commercial MKT film capacitor in relation to frequency were compared to calculations.
In this systematic case, the conventionally calculated progression (according to Lorentz's model) and reality differ significantly, as is known and criticized among experts for a long time. Contrary the progression calculated by the use of potential vortices comes very close to the truth (fig. 3.3).

Prof. Dr. Konstantin Meyl, Summer Term 2010, **Supervisor** of the student Timm Treskatis at the **University of Konstanz**, Germany [14]

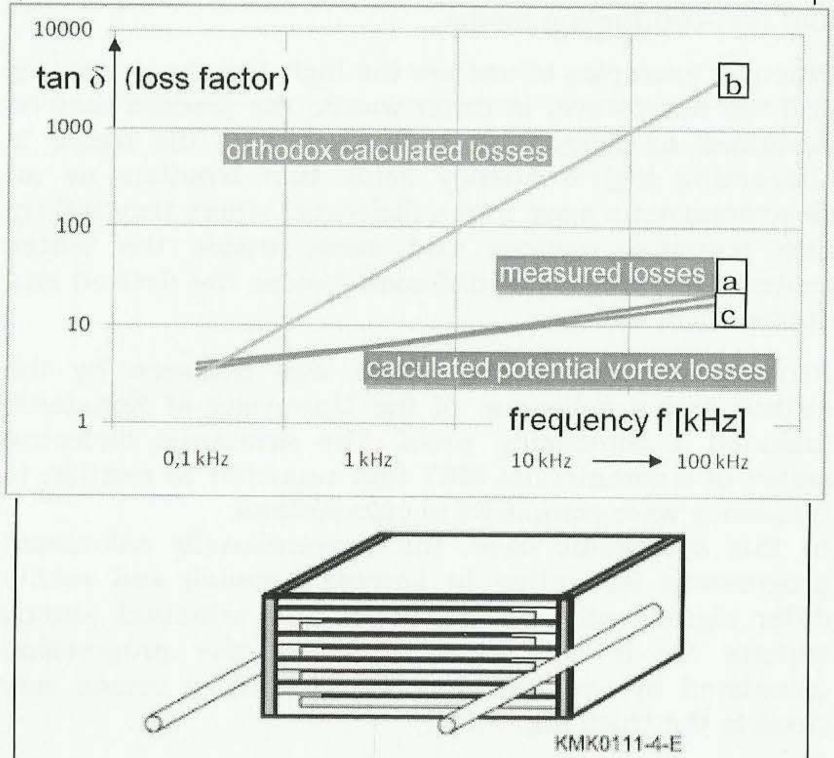


Fig. 3.3: *Experimental proof of the calculated losses (qualitative comparison) by use of a MKT capacitor [14] (built by Siemens-Matsushita)*

a: measured dielectric losses of the MKT-capacitor

b: conventional calculation according to Lorentz's-model

c: calculation of potential vortex losses acc. to Meyl-model

3.8 The Visible Vortex Proof

The drive towards the vortex center gives the potential vortex a structure forming property. As a consequence of this "concentration effect," one expects circular vortex structures comparable to the visible vortices of fluid mechanics (e.g. tornados and whirlwinds).

Simultaneously its complementary vortex, the expanding eddy current, occurs. It, as is known, adopts to the present structure of the conductor, therefore the technical literature correspondingly mentions the "*skin effect.*"

If a conductor and non-conductor are next to each other, then visible structures develop at the boundary surface. One may expect circles, when the expanding eddy current inside and the contractive potential vortex are equally strong.

Actually these circular structures are observed in the aluminum of high- voltage capacitors after they have been used for some time. The formation of these circles, whose cause is unexplained to this day, is examined by science and discussed on an international level [15, 16].

These circular vortex structures may be seen as a visible proof of the existence of potential vortices of the electric field [13].

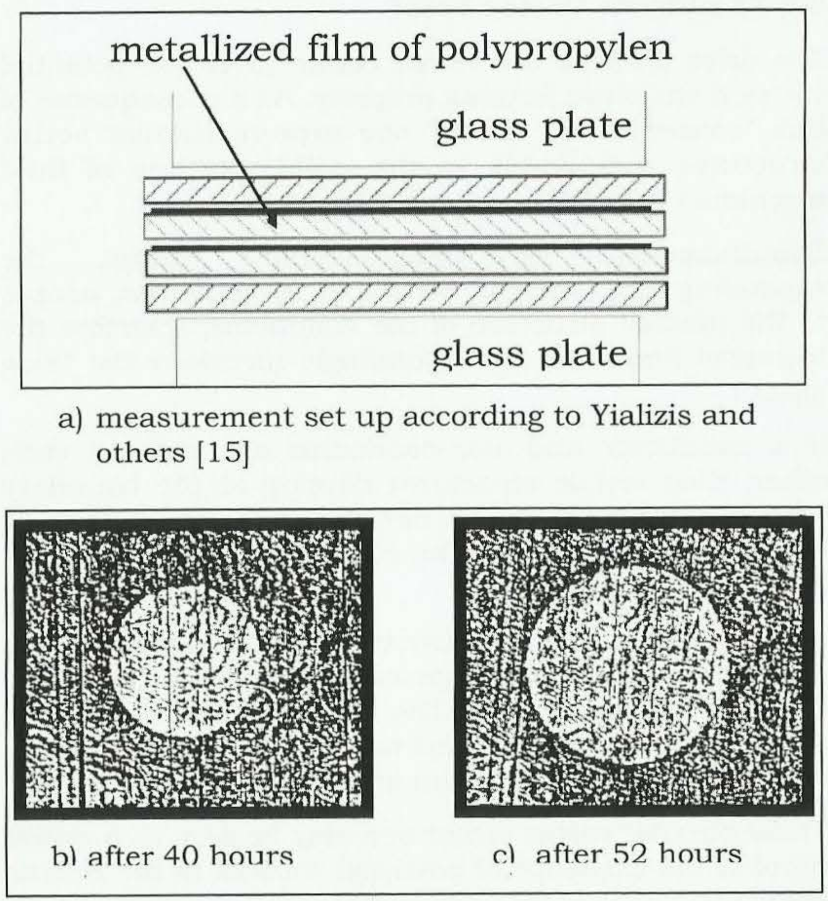


Fig. 3.4: *Test setup (a) and photographs of a vortex structure inside a metallized polypropylene film capacitor at 450 V/ 60 Hz/ 100°C and magnification of 110x. Observation of the formation of a vortex (b) and (c). according to Yializis et al. [15].*

4. The Approach: Faraday Instead of Maxwell

If a measurable phenomenon, as e.g. the near field of an antenna or a visible and calculable vortex appearance inside an insulator, cannot be described by Maxwell's equations, then one should be on the lookout for a new approach. All efforts to prove the validity of Maxwell's theory must end in a circular reasoning, which does not prove anything.

The new approach is confronted by high requirements. It cannot contradict Maxwell's theory, which provides correct results in most practical cases and may be seen as valid. Only an extension may be acceptable, which retains the current theory (excluding the vector potential **A**) as a subset.

Let us search.

4.1 The Maxwell approximation

The approximation of Maxwell's equations consists of the fact that the complementary vortex of the eddy current is neglected, as illustrated in chapter 1.2. Indeed it is possible that this approximation is acceptable, when processes inside conducting materials are concerned. However the transition to insulating materials, which demands continuity according to the laws of field refraction, is incompatible with the assumption of eddy currents inside a cable and a vortex-free field in the air. In this case, Maxwell's theory leads to considerable errors.

Let us take lightning as an example and ask for the reason of the flash of lightning: *Which mechanism causes the electrically insulating air to become a conductor for a short time?*
From the perspective of vortex physics the answer is obvious: The potential vortex prevailing in the air contracts and compresses charge carriers responsible for conductivity and air ions to form a duct of conductivity at smallest scale.

Therefore the contractive potential vortex exerts pressure and thereby forms the vortex tube. Next to the cylindrical structure, one may expect another one. That is, a sphere, the only shape that can withstand great pressure exerted from every direction of space equally.

Just think of ball-lightning. Thus let us imagine a spherical vortex; inside there is an expanding vortex enclosed and kept together by the contractive potential vortex from outside and forced into the spherical shape. Measured from an infinite distance, this spherical vortex would be electrically charged and fulfill all properties of a charge carrier.

Inside:	expanding eddy current (skin effect)
Outside:	contractive complementary vortex (potential vortex)
Condition	for vortex shedding: vortices of equal strength
Criterion:	electric conductivity (determines diameter)
Result:	spherical structure (due to vacuum pressure)

Fig. 4.1: *The electron as an electromagnetic spherical vortex*

4.2 The Magnetic Monopole

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 spherical field vortex may be described inside by the expanding vortex div **D** mathematically. For the opposed potential vortex outside applies div **B**. Therefore divergence cannot be equal to zero, neither of the electric (4th Maxwell equation = Gauß's law), nor of the magnetic field (3rd Maxwell equation = Gauß's law for magnetism).

But if both equations are needed for the derivation of an electron, then there is an error in reasoning to assign one to the electric and the other to the magnetic monopole.

Electric monopoles, that is, numerous fundamental particles, are extremely small, because the radius, where vortex shedding occurs, and thereby the size of the spherical vortex are dependent on conductivity. Contrary magnetic monopoles should generally be of enormous dimensions, too large to be measured.

This explains why it took so long until such formations bound inside spin ice revealed themselves accidentally [11].

4.3 The Discovery of the Law of Induction

A physicist may choose any approach that is rational and reasonable. In the case of Maxwell's field equations, two experimentally determined laws served as a foundation: on the one hand *Ampère's law* and on the other hand *Faraday's law of induction.*

Maxwell, the mathematician, revised the formulations of both laws. He introduced the displacement current **D** and completed Ampère's law accordingly. Unfortunately he was unable to measure and prove this action. This was possible only after his death, which subsequently demonstrates how great this man was.

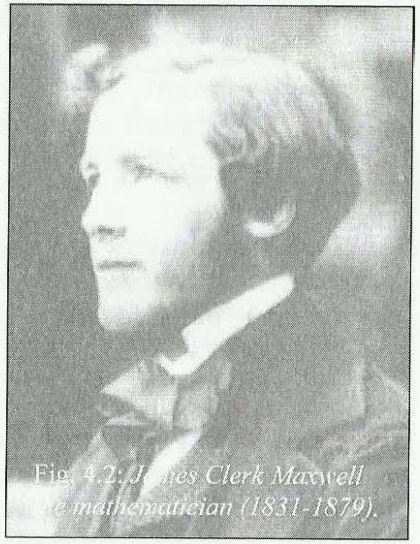


Fig. 4.2: James Clerk Maxwell the mathematician (1831-1879).

Maxwell was the one, who formulated the law of induction, because the *discoverer Michael Faraday* did not do so. Faraday, a man of practice and experiment, was less interested in a mathematical notation. He focused on experiments, e.g. his homopolar generator, with which he was able to present his discovery of induction to anyone.

Contrary his 40 years younger friend and professor of mathematics, Maxwell, had something entirely different in mind. He wanted to describe light as an electromagnetic wave and thus he probably thought of Laplace's wave description, which provides a second derivative with respect to time of the field.

Therefore Maxwell needed two equations of first derivative, thus he introduced the displacement current in Ampère's law and chose a corresponding formulation of Faraday's law of induction to include the wave equation therein.

His theory of light was very controversial. Rather he was acknowledged for combining the theories of electricity and magnetism and describing them uniformly [7]. In this way, he described Faraday's principle mathematically justified and coherent.

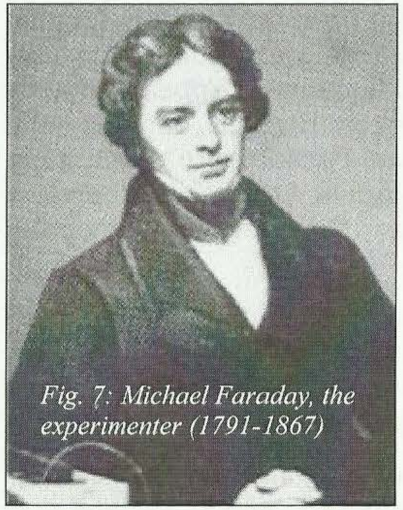


Fig. 7: Michael Faraday, the experimenter (1791-1867)

However the question arises whether Maxwell found the proper formulation, whether he understood his friend Faraday and his discovery completely. If the discovery (from the 29.08.1831) and the mathematical formulation (1862) are made by two different scientists of different disciplines, misunderstandings are not uncommon. Elaborating the differences will be helpful.

4.4 The Homopolar Generator

If an axially polarized magnet or a copper plate inside a magnetic field is rotated, then an electric field perpendicular to the direction of motion and to the magnetic field occurs, which is directed axially outwards. Thus one may tap a voltage between the axis of rotation and the circumference using a slider.
I am going to denote the mathematically correct relation

$$\mathbf{E} = \mathbf{v} \times \mathbf{B} \qquad (4.1)$$

as "*Faraday's law*", although it appeared in this form in textbooks at a later date [17]. The formulation is usually attributed to *Hendrik Lorentz*, because it appears exactly in this form in the *Lorentz force*. But the experimental report and discovery by Michael Faraday are much more significant, than the mathematical formalism, therefore it may be allowed to name the law of homopolar induction after its discoverer.

Of course, we must keep in mind that charge carriers were not discovered at that time and the field conception was different from today's one. The term of the field was an abstract one free of any quantization.

Of course, this applies in the same manner to the field conception represented by Maxwell, which we are now going to compare to "Faraday's law" (figure 4.4).

The second Maxwell equation, the law of induction (4.2), is a mathematical description of the electric field strength **E** and the magnetic induction **B** as well. But in this case, the two vectors are not linked by a relative velocity **v**.

$$\mathrm{curl}\, \mathbf{E} = -\, d\mathbf{B}/dt \qquad (4.2)$$

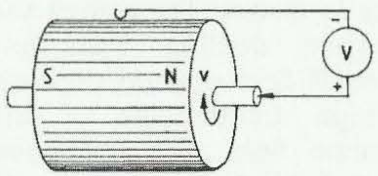
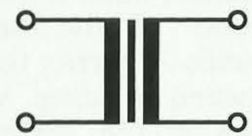
e.g.: homopolar generator	i.e. transformer
	
Discovery of Faraday	2^{nd} Maxwell equation
$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$ (4.1)	$\boxed{\mathrm{curl}\, \mathbf{E} = -\, d\mathbf{B}/dt}$ (4.2)
unipolar induction	general law of induction

Fig. 4.4: *Two formulations for the same law*
*As a mathematical relation between the vectors of the electric field strength **E** and the magnetic flux density **B***

It is replaced by a derivative of **B** with respect to time, hence a change of a magnetic field is necessary for the appearance of an electric field. Therefore Faraday's law of induction does not provide a result in a static or quasi-static case. Thus one usually resorts to Faraday's unipolar induction in such cases (e.g. Hall element, picture tube, etc.). But there is no relevant reason to limit its use to such cases.

The vectors **E** and **B** can be subject to spatial as well as temporal variations. Thereby these two formulations compete with each other and we are prompted to explain the difference, if there is one.

4.5 Different Laws of Induction

For example, such a difference is to usually neglect the connection of the fields when dealing with low frequencies. Whereas the **E** and **H** field depend on each other when dealing with high frequencies of the spectrum of the electromagnetic field, the induction decreases when frequency and field change are small, thus a neglect is permitted. In this case the electric or magnetic field may be measured independently. This is equivalent to the assumption that the other field does not exist.

This is wrong. Looking at "*Faraday's law*" one instantly realizes that both fields exist always, down to a frequency of zero. But the fields are perpendicularly oriented, thus the magnetic field rotates around the electric field in shape of an annular vortex when the electric field is measured and vice versa.
Outwards the enclosed field lines behave neutrally and, therefore, may be disregarded according to the established doctrine.

One must examine accurately whether this justification for the neglect of the non-measurable enclosed field lines is sufficient. And whether these fields, which do exist, do not have an effect.

Another effect concerns the interchangeability of the **E** and **H** field as shown by Faraday's generator. An electric field produces a magnetic field and vice versa due to a relative velocity v. This immediately influences the physical- philosophical question: "*What is the electromagnetic field?*"

4.6 The Electromagnetic Field

The established doctrine based on Maxwell's equations denotes the static field of charge carriers as the cause of the electric field, whereas charge carriers in motion cause the magnetic field [e.g.2]. But this could not be Faraday's conception, who did not know of the existence of charge carriers.

The abstract field conception, which was revolutionary to his contemporaries, was based on the works of the *Croatian Jesuit priest Boscovic* (1711-1778). According to his field description, the field is not so much a physical dimension in a common sense, but rather an "experimental experience" of an interaction.

We should interpret the "*Faraday-law*" in so far that we do experience an electric field, if we move through a magnetic field with a relative velocity and vice versa.

The interchangeability of the electric and magnetic field is expressed by a duality, which is lost in Maxwell's formulation when charge carriers are introduced. Does Maxwell's field only describe a special case?

A lot indicates this, after all a beam of light propagates through a vacuum free of particles. If there are fields without particles, whereas particles cannot exist without fields, then the field as reason for particles should have existed first. Then Faraday's description should be the foundation for the derivation of all other principles.

What is written in the textbooks?

4.7 Contradictory Views of Textbooks

Obviously there are two formulations of the law of induction of more or less equal importance (4.1 and 4.2). Science needs to answer the question: *"which mathematical description is more capable? If one is a special case of the other, then which description is more universal?"*

What Maxwell's equations describe is sufficiently known, thus derivations are unnecessary. Numerous textbook are available, when results should be quoted.

Let us examine *"Faraday's law"* (4.1). One does not find it in schoolbooks. It is only found in sophisticated books under the heading "homopolar or unipolar induction." If one compares the number of pages dedicated to Faraday's law of induction according to Maxwell and the few ones dedicated to homopolar induction, then one gets the impression that the latter only is an insignificant special case when dealing with low frequencies.

Prof. Küpfmüller (TU Darmstadt) refers to a "special form of the law of induction" [2][pg. 228 eq. 22] and mentions the induction inside a brake disc and the Hall effect as practical examples.

Furthermore Küpfmüller derives the *"general form"* of the law of induction according to Maxwell from the "*special form*," a postulated generalization, which yet needs to be explained. But a justification is not stated.

Prof. Bosse (as successor of Küpfmüller at the TU Darmstadt) states the same derivation. But this time, the form according to Maxwell is the special case, whereas Faraday's one was used as an approach [18].

Moreover he denotes "Faraday's law" as *equation of transformation* and indicates the importance and specific interpretation.

On the other hand, he derives the law from the *"Lorentz force"* according to *Küpfmüller* [2] and thereby removes a part of its independence.

Prof. Pohl (University of Göttingen, Germany) is as well of a different opinion. Contrary he derives the Lorentz force from Faraday's law. I suggest to follow this very convincing account [17a].

4.8 The equation of convection

whether the term *"equation of transformation"* suggested by Bosse [18] is justified or not is unimportant. This remains a matter of discussion.

When one talks about equations of transformation, the dual formulation of equation 4.1 should be included. Then one deals with a *complementary pair of equations* that describe the relation between the electric and magnetic field.

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

equations of transformation

of the electric		and	of the magnetic field	
$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}}$	(4.1)	and	$\boxed{\mathbf{H} = -\mathbf{v} \times \mathbf{D}}$	(4.3)
unipolar induction			***equation of convection***	

According to the rules of duality, the equation (4.3) results, which is mentioned in some textbooks.

Whereas both equations are equally important and compared to each other in the books by *Pohl* [17b] and by *Simonyi* (University of Budapest, Hungary) [19]. *Grimsehl* [20] derives the dual principle (4.3) from the example of a thin, positively charged and rotating ferrule.

He uses the term *"equation of convection,"* because charge carriers in motion generate a magnetic field and so called convection currents. Thereby he refers to works by *Röntgen* 1885, *Himstedt*, *Rowland* 1876, *Eichenwald* among others.

Pohl as well refers to practical examples in his textbook regarding both equations of transformation. He indicates that one equation becomes the other one, when the relative velocity v is equal to the speed of light c [17a].

5. The Derivation from Textbook Physics

Using the equations of transformation, we found a field-theoretical approach that is distinctly different from Maxwell's approach, because of its dual formulation. Furthermore, there is the reassuring determination: *The new field approach is wholly based on textbook physics* as the literature investigation proved.

We can completely do without postulates!

Next one has to determine, if the approach is strictly mathematically self- consistent. Especially the question, *which known principles can be deduced under which conditions,* deserves attention. Moreover the conditions and the extent of validity of the derived theories should be fitting, e.g. what the Maxwell approximation is and why Maxwell's equations describe a special case only.

5.1 Derivation of the Field Equations acc. to Maxwell

The equations of transformation of the electric and magnetic field, Faraday's law of homopolar induction (4.1) and the so-called equation of convection (4.3) formulated according to the rules of duality, serve as a starting point and approach.

$$\boxed{\mathbf{E} = \mathbf{v} \times \mathbf{B}} \quad (4.1) \quad \text{and} \quad \boxed{\mathbf{H} = -\mathbf{v} \times \mathbf{D}} \quad (4.3)$$

Applying the curl to both sides of the equations:

$$\boxed{\text{curl}\,\mathbf{E} = \text{curl}\,(\mathbf{v} \times \mathbf{B})} \ (5.1), \ \boxed{\text{curl}\,\mathbf{H} = -\,\text{curl}\,(\mathbf{v} \times \mathbf{D})} \ (5.2)$$

the curl of the cross product is equal to the sum of four terms according the known rules of vector calculus [21]:

$$\boxed{\text{curl } \mathbf{E} = (\mathbf{B}\text{ grad})\mathbf{v} - (\mathbf{v}\text{ grad})\mathbf{B} + \mathbf{v}\text{ div }\mathbf{B} - \mathbf{B}\text{ div }\mathbf{v}} \quad (5.3)$$

$$\boxed{\text{curl } \mathbf{H} = -[(\mathbf{D}\text{ grad})\mathbf{v} - (\mathbf{v}\text{ grad})\mathbf{D} + \mathbf{v}\text{ div }\mathbf{D} - \mathbf{D}\text{ div }\mathbf{v}]} \quad (5.4)$$

Two of them are equal to zero in case of a linear, non-accelerated relative motion $\mathbf{v}(\mathbf{r}) = d\mathbf{r}/dt$ all along the curve given by $\mathbf{r}(t)$:

$$(\mathbf{B}\text{ grad})\mathbf{v} = 0 \qquad \text{resp.} \quad (\mathbf{D}\text{ grad})\mathbf{v} = 0 \quad (5.5)$$

(acc. to the derivation given in the mathematical appendix of the book [8] on page 68 ff.)

and $\quad \mathbf{B}\text{ div }\mathbf{v} = 0 \qquad \text{resp.} \quad \mathbf{D}\text{ div }\mathbf{v} = 0 \quad (5.5^*)$

One of the remaining terms is the vector gradient: $(\mathbf{v}\text{ grad})\mathbf{B}$, representable by a tensor. It is equivalent to the partial derivative matrix of the field vector $\mathbf{B}(\mathbf{r},t)$ with respect to time,

$$\boxed{(\mathbf{v}\text{ grad})\,\mathbf{B}(\mathbf{r},t)\Big|_{\mathbf{r}(t)} = \frac{\partial \mathbf{B}(\mathbf{r},t)}{\partial t}} \quad \text{and} \quad \boxed{(\mathbf{v}\text{ grad})\,\mathbf{D}(\mathbf{x},t)\Big|_{\mathbf{r}(t)} = \frac{\partial \mathbf{D}(\mathbf{r},t)}{\partial t}} \quad (5.6)$$

Easily provable by looking at the components [8] in $\mathbf{r} \in R^3$ and $t \in [0, \infty)$:

$$(\mathbf{v}\text{ grad})\,\mathbf{B} = \left(\frac{\partial x}{\partial t}\cdot\frac{\partial B_x}{\partial x}, \frac{\partial y}{\partial t}\cdot\frac{\partial B_y}{\partial y}, \frac{\partial z}{\partial t}\cdot\frac{\partial B_z}{\partial z}\right) = \frac{\partial \mathbf{B}}{\partial t} \quad (5.7)$$

The last two still unexplained terms are going to be denoted by the vectors $\mathbf{b}$ and $\mathbf{j}$ as an abbreviation.

$$\text{curl } \mathbf{E} = -\partial\mathbf{B}/\partial t + \mathbf{v}\text{ div }\mathbf{B} = -\partial\mathbf{B}/\partial t - \mathbf{b} \quad (5.8)$$

$$\text{curl } \mathbf{H} = \partial\mathbf{D}/\partial t - \mathbf{v}\text{ div }\mathbf{D} = \partial\mathbf{D}/\partial t + \mathbf{j} \quad (5.9)$$

This way, equation 5.9 represents Ampère's well known circuital law (= 1st Maxwell equation).

5.2 Maxwell's Equations as a Special Case

One deals with **Maxwell's equations**, if:

- the potential density $\mathbf{b} = -\mathbf{v}\text{ div }\mathbf{B} = 0$, (5.10)
  (eq. 5.8 ≡ law of induction,
  if $\mathbf{b} = 0$ resp. $\text{div }\mathbf{B} = 0$)!

- the current density $\mathbf{j} = -\mathbf{v}\text{ div }\mathbf{D} = -\mathbf{v}\cdot\rho_{el}$, (5.11)
  (eq. 5.9 ≡ Ampère's law,
  if $\mathbf{j}$ ≡ negative charge carriers of velocity $\mathbf{v}$.
  (ρ_{el} = electric space charge density).

Furthermore, comparing the coefficients (5.11) provides a practical answer to the question of *"what should be understood by the current density j"*? It is the charge density per volume ρ_{el} consisting of negative charge carriers of velocity v, which e.g. move through a conductor.

From a mathematical perspective, the current density $\mathbf{j}$ and its complementary potential density $\mathbf{b}$ are replacement vectors to abbreviate the notation. Whereas the physical meaning of the current density $\mathbf{j}$ could be explained by comparing it with Ampère's law, the interpretation of the potential density $\mathbf{b}$ is still to be done:

$$\mathbf{b} = -\mathbf{v}\text{ div }\mathbf{B} \; (= 0) \quad , \quad (5.10)$$

Comparing equation 5.8 to Faraday's law of induction (eq.4.2) reveals only that this term is equal to zero according to Maxwell's theory. But exactly therein lies Maxwell's approximation and the confinement compared to the new and dual field approach based on Faraday.

5.3 Monopoles as Spherical Vortices

Caused by the approximation, the duality is lost, which is justified by the argument that magnetic monopoles (div **B**) do not exist and could not be proved hitherto, contrary to electric ones (div **D**). The vortices complementary to eddy currents, which are expressed by the neglected term, were not investigated either.

Assuming that a monopole is a special formation of a field vortex, then one realizes why the search for magnetic monopoles was deemed impossible for a long time and why its failure does not serve as a counter-argument. Because of the poor conductivity of the vacuum, current densities, eddy currents and the development of magnetic monopoles cannot occur. Contrary potential densities and potential vortices arise. Therefore electrically charged particles develop in the vacuum without exception.

Let us summarize: *Maxwell's equations can be deduced immediately from the new dual field approach by the use of a confining condition.*

By the use of this confining condition, both approaches are of equal importance and thus error-free. Both obey to textbooks.

Furthermore the confinement (**b** = 0) is meaningful and reasonable in the cases, in which Maxwell's theory is useful. The potential density **b** becomes important in the area of electrodynamics. Here usually the vector potential **A** is introduced and by *calculating a complex permittivity* a loss angle is determined. Mathematically the approach is correct and dielectric losses may be calculated.

However from a physical perspective, this result is highly questionable, because a complex ε leads to a *complex speed of light*

according to the definition: $c = 1/\sqrt{\varepsilon \cdot \mu}$ (3.3).

Thereby electrodynamics infringes all guidelines of the textbooks stating that c is constant, that is, neither variable nor complex.

If the result of the derivation is physically wrong, then the approach is somehow wrong. Maybe the fields inside dielectrics are of a fundamentally *different nature*, maybe dielectric losses are *vortex losses of decaying potential vortices*?

5.4 The Quantisation of the Field

Does the introduction of the vector potential **A** to electrodynamics represent the neglect of the potential density **b**?

Do two ways lead mathematically to the same result?

How about the physical relevance?

Classical electrodynamics is dependent on the use of a complex material constant. This is an insuperable contradiction in itself. The answer begs for the *freedom of contradictions of the new approach.*

This is the point where the decision will be made, when physics decides to use the more capable approach, like it has always done, when there was a paradigm change.

Maxwell's equations are a derivable special case (under the condition that $1/\tau_2 = 0$). However, the new approach, which is based i.a. on Faraday's law, is universally valid and other- wise not derivable. It describes a physical fundamental principle, the interaction of two complementary measures of experience or observation, their interference and swirls caused by a permanent commutation of cause and effect. By this condition, it is a philosophical approach excluding materialistic or quantum-physical conceptions of particles.

In contrast, Maxwell describes the fields of charged particles, the electric field of stationary ones and the magnetic field as a result of charge carriers in motion, without exception. Charge carriers are thereby postulated for this purpose, thus their derivation and interior structure remain unexplained.

Contrary, using the field-theoretical approach, the field is the cause of the particles and their measurable quantization. The electric vortex field initially source-free forms its field sources as potential vortex structures by itself. In this way, the development of charge carriers is mathematically, physically, demonstratively and experimentally comprehensible.

5.5 The Magnetic Field as a Vortex Field

The abbreviations **j** and **b** are further converted, initially the current density of *Ampère's law* is expressed:

$$\mathbf{j} = -\mathbf{v}\cdot\rho_{el} \qquad (5.12)$$

as a motion of negative electric charge carriers.

Using *Ohm's law* $\mathbf{j} = \sigma\cdot\mathbf{E}$ (5.13)

and the *relation of material* $\mathbf{D} = \varepsilon\cdot\mathbf{E}$ (5.14)

the *current density* $\boxed{\mathbf{j} = \mathbf{D}/\tau_1}$ (5.15)

can be described as a dielectric displacement current divided by the *relaxation time characteristic* for the eddy currents

$$\tau_1 = \varepsilon/\sigma \qquad (5.16).$$

The formulation of Ampère's circuital law:

$$\boxed{\text{curl}\,\mathbf{H} = d\mathbf{D}/dt + \mathbf{D}/\tau_1 = \varepsilon\cdot(d\mathbf{E}/dt + \mathbf{E}/\tau_1)} \qquad (5.17)$$

shows clearly why the *magnetic field is a vortex field* and how the eddy currents dependent on the specific electric conductivity cause heat losses. As shown, we are still in the realm of textbook physics with regard to the magnetic field description.

5.6 The Derivation of the Potential Vortex

Let us take a look at the dual relations. Formally, next to the current density **j** (eq. 5.15), there is an *potential density* **b**

$$\boxed{\mathbf{b} = \mathbf{B}/\tau_2} \quad (5.18)$$

according to the duality, using (5.18) which describes the vortices of the electric field by means of a corresponding time constant τ_2. I denote this new discovery as "*potential vortex*".

$$\boxed{\text{curl } \mathbf{E} = -\, d\mathbf{B}/dt - \mathbf{B}/\tau_2 = -\,\mu\cdot(d\mathbf{H}/dt + \mathbf{H}/\tau_2)} \quad (5.19)$$

Contrary, Maxwell's theory demands a *vortex-free electrical field.* This is expressed by the fact that the potential density **b** = 0 and the divergence **B** are set equal to zero. Because of this approximation, the time constant τ_2 becomes infinitely large.

The potential vortices and the dual approach cannot be disregarded . . .

1. because the approach does not need postulates,
2. they are derived from accepted physical laws,
3. therefore all error-free derivations must be accepted,
4. no scientist may disregard a probably significant phenomenon within the approach,
5. one needs to examine Maxwell's approximation with regard to its neglects,
6. an instrument is needed to measure the potential density, which cannot exist according to Maxwell's theory.

6. Consequences of New Electrodynamics

Based on the discovery of magnetic monopoles by the Helmholtz-Center [22] in Dresden and Berlin, we must assume a div **B** not equal to zero, which the use of the vector potential **A** forbids.

It is replaced by the potential density **b** and by the potential vortices and their characteristic relaxation time τ_2. Therefore the Maxwell approximation is history.

Nonetheless we should review the approach with regard to plausibility. Here we are especially interested in the question concerning the calculation of dielectric losses inside capacitors and insulators.

6.1 The Extended Poynting Vector

The Poynting vector $\mathbf{S} = \mathbf{E} \times \mathbf{H}$ (6.1)

represents the energy flux density of the electromagnetic field. Using this abbreviation, it is possible to calculate the complete energy balance. First the power flux density is determined:

$$\text{div } \mathbf{S} = \text{div } (\mathbf{E} \times \mathbf{H}) = \mathbf{H}\cdot\text{curl } \mathbf{E} - \mathbf{E}\cdot\text{curl } \mathbf{H} \quad (6.2)$$

Then the extended field equations are used for [5.8 or 5.19 (curl **E**) and for 5.9 or 5.17 (curl **H**)]:

$$\text{div } \mathbf{S} = -\,\mathbf{H}\cdot d\mathbf{B}/dt - \mathbf{H}\cdot\mathbf{b} - \mathbf{E}\cdot d\mathbf{D}/dt - \mathbf{E}\cdot\mathbf{j} \quad (6.3)$$

By consideration of the material equations and the relation

$$\varepsilon\cdot\int_0^{\mathbf{E}} \mathbf{E}\cdot d\mathbf{E} = \tfrac{1}{2}\varepsilon\cdot\mathbf{E}^2 \text{ resp. } \mathbf{E}\cdot d\mathbf{D}/dt = d/dt(\tfrac{1}{2}\varepsilon\cdot\mathbf{E}^2) \quad (6.4)$$

and accordingly: $\mathbf{H}\cdot d\mathbf{B}/dt = d/dt(\frac{1}{2}\mu\cdot\mathbf{H}^2)$ (6.5)

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

$$\operatorname{div}\mathbf{S} + d/dt(\tfrac{1}{2}\varepsilon\cdot\mathbf{E}^2 + \tfrac{1}{2}\mu\cdot\mathbf{H}^2) + \mathbf{E}\cdot\mathbf{j} + \mathbf{H}\cdot\mathbf{b} = 0 \quad (6.6)$$

Four of the five resulting terms of the complete balance are described and discussed in many textbooks [i.e. 23]. Accordingly div **S** represents the supplied power, $\varepsilon\cdot\mathbf{E}^2/2$ the electrically and $\mu\cdot\mathbf{H}^2/2$ the magnetically stored energy density, whereas the term $\mathbf{E}\cdot\mathbf{j}$ informs about ohmic losses.
The electric energy stored inside a capacitor is equal to:

$$W_{el} = \iiint_V (\tfrac{1}{2}\varepsilon\cdot E^2)dV = \frac{\varepsilon\, U^2}{2\, d^2}\, d\cdot A = \frac{1}{2} U^2 \frac{\varepsilon\, A}{d} = \frac{1}{2} C\cdot U^2 \quad (6.7)$$

using the capacity of the capacitor $C = \varepsilon\cdot A/d$ (6.8)

Analogously the magnetic energy stored by inductivity is equal to:

$$W_{mag} = \iiint_V (\tfrac{1}{2}\mu\cdot H^2)dV = \frac{\mu\, I^2}{2s^2}\, s\cdot A = \frac{1}{2} I^2 \frac{\mu\, A}{s} = \frac{1}{2} L\cdot I^2 \quad (6.9)$$

using the inductivity of a conductor loop:

$$L = \mu\cdot A/s \quad (6.10)$$

One cannot dismiss the certain duality between the electric and magnetic field.

If the stored power is subtracted from the supplied power, then only the losses remain in the energy balance. Thereby the two complementary terms $\mathbf{E}\cdot\mathbf{j}$ and $\mathbf{H}\cdot\mathbf{b}$ describing the losses remain, which demand a closer examination.

6.2 Joule Effect Losses in the Energy Balance

All textbooks on the subject of electrodynamics agree that there appears only _one_ term describing losses. It is about the heat inside an electrically conducting medium particularly caused by currents or generally by eddy currents. To calculate the power converted into heat, one uses the volume integral of the power density $\mathbf{E}\cdot\mathbf{j}$ (using Ohm's law $E = j/\sigma$ according to eq. (5.13)):

$$P = \iiint_V E\cdot j\, dV = \iiint (j^2/\sigma)\, dV = (j^2/\sigma)\cdot A\cdot d = I^2\cdot R \quad , (6.11)$$

because the current density j determines the current

$$I = j\cdot A \quad (6.12)$$

and together with the specific conductance σ

the resistance R: $R = d/\sigma\cdot A$ (6.13)

The relaxation time constant $\tau_1 = \varepsilon/\sigma$ (5.16) represents the eddy currents and describes the vortex decay.
Namely, if we replace the conductivity by the area A representing the capacitor plates and the distance d of the plates (according to eq. 6.8), then the loss resistance has a different meaning:

$$R = \frac{d}{A\cdot\sigma} = \frac{d}{A}\frac{\tau_1}{\varepsilon} = \frac{\tau_1}{C} \quad (6.14)$$

Thus the time constant of the eddy currents is similar to the time constant of a *R-C-circuit*

$$\tau_1 = R\cdot C \quad (6.15)$$

Calculating the loss tangent of an AC capacitor this way is indeed possible [24]

$$\tan\delta = 1/\omega\cdot R\cdot C \quad (6.16)$$

But what is disregarded is the fact that only the heat generated by current is calculated this way (the *Joule effect*) , that an electric conductivity σ is a prerequisite for the formation of currents and eddy currents.

A good insulator does not fulfill this prerequisite, nor does a customary capacitor. And this is only one of many critical points.

If we e.g. supplied the capacitor with alternating current and replace the dielectric with one of a conductivity of almost zero, then the time constant would increase beyond all limits. The opposite is correct.

A derivation that works well in case of conducting materials is completely useless when calculating dielectric losses. In many formularies and books for practice measured loss tangents are listed concerning certain frequencies; these are of restricted validity as they only serve as a guidance to the offered model [2f].

Self-evidently the complex ε and the implied violation of the constancy of the speed of light are hidden behind these loss tangents. Thus one error causes the next and eventually entire electrodynamics are criticized. Fortunately there is a solution to all problems, because the *extended Poynting vector* (6.6) offers, among the known ones, another new term describing losses.

6.3 Potential Vortex Losses in the Energy Balance

The potential density **b** newly introduced to Maxwell's equations represents the formation of potential vortices, like they should be expected inside poorly conducting materials and especially capacitors and insulators. Contrary to the *skin effect* of eddy currents, potential vortices strive toward the *vortex center*, where they decay and produce *heat*.

Again we use the volume integral of the power density **H·b** to calculate the power (eq. 6.3);
(using $H = B/\mu = b\cdot\tau_2/\mu$ according to eq. (5.18)):

$$P = \iiint_V H\cdot b\, dV = \iiint (b^2\tau_2/\mu)\, dV = (b^2\tau_2/\mu)\cdot A\cdot s$$
$$= b^2\cdot A^2\cdot\tau_2\cdot s/\mu\cdot A = U^2\cdot\tau_2/L = U^2/R_2 \,, \qquad (6.17)$$

because the *potential-density* b determines the voltage

$$U = b\cdot A \qquad (6.18)$$

and because the inductivity of a conductor loop L is given by equation 6.10.

The *time constant* τ_2 being responsible for *heat generation by vortex decay of the potential vortices,* implies an ohmic-inductive property:

$$\tau_2 = L/R_2 \qquad (6.19)$$

whereas the parameters R_2 and L are regarded as parameters of an alternative model in this case. But the resistance is this time the denominator, which is closer to reality. If we, by way of comparison, converted the ohmic heat losses using R (according to eq. 6.13):

$$R_2 = \frac{\mu\cdot A}{\tau_2\cdot s}\cdot\frac{\sigma}{\sigma} = \frac{\mu}{\tau_2\cdot\sigma\cdot R} = \frac{\tau_1}{\tau_2}\cdot\frac{\mu}{\varepsilon}\cdot\frac{1}{R} \,, \qquad (6.20)$$

then the losses ascertained in textbooks need to be corrected with regard to the ratio τ_2/τ_1 (i.e. for the purposes of the potential vortices in the dielectric and to the loads of the counter-rotating eddy-currents).

The actual capability of the approach can only be shown by calculating a concrete case. When researching technical literature, one encounters *Simonyi* [19b]. He calculates the special case of a loop antenna using the harmlessly wrong approach of the *vector potential* **A**.

The mathematically obtained result of the radiated power is very similar to the one of a dipole antenna. This then caused Simonyi to conceive his loop supplied with sinusoidal alternating current as a magnetic dipole and to realize the duality to the electric dipole. He writes: *"We may contemplate this in the way that, just as electric charges flow through the dipole, in this case imaginary magnetic currents flow in form of imaginary magnetic charges."*

One should note the lack of duality of this explanation, because a current is never complementary to another current! The complementary quantity of the current density **j** is the potential density **b** (of the dimension V/m^2), which Simonyi misleadingly calls *magnetic current density* $\mathbf{j}_m$.

But mathematically the new approach is perfect, accordingly Simonyi: *"The magnetic charges introduced herein are of course imaginary, but the radiation field can be calculated as if these actually existed."*

Furthermore he describes the introduction of $\mathbf{j}_m$ (= **b**) as *"advantageous, because one can reduce complicated radiation fields to known dipole fields."*

7. Requirements for the Field Theory

7.1 Problems of the Near Field

In the near field of an antenna, according to the established doctrine, there are longitudinal parts of the radiated wave oriented along the field vectors. These are used in transponder technology to wirelessly transmit energy [8].

The problem now is that the accepted field theory, that is, the one by Maxwell, is able to describe only transversal wave parts and no longitudinal ones.
All calculations of longitudinal waves or wave parts, which propagate along the electric or magnetic field vector, are based on postulates [9] without exception.

The near field is not in vain considered as an unsolved problem of the field theory. Experimental proofs may be possible, but no field-theoretical ones.

7.2 Field Equations According to Maxwell

A short derivation shall demonstrate. We start with the known formulation of Faraday's law of induction

$$\boxed{\text{curl } \mathbf{E} = - \delta \mathbf{B}/\delta t} \quad (7.1)$$

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

and: $\mathbf{B} = \mu \cdot \mathbf{H}$ (1st constitutive relation), (7.2)

apply the curl to both sides of the equation

$$- \text{curl curl } \mathbf{E} = \mu \cdot \delta(\text{curl } \mathbf{H})/\delta t \quad (7.3)$$

and substitute curl **H** by Ampere's law:

$$\boxed{\text{curl}\,\mathbf{H} = \mathbf{j} + \delta\mathbf{D}/\delta t} \qquad (7.4)$$

using $\mathbf{j} = \sigma \cdot \mathbf{E}$ (Ohm's law) (7.5)

using $\mathbf{D} = \varepsilon \cdot \mathbf{E}$ (2^{nd} constitutive relation) (7.6)

and $\tau_1 = \varepsilon/\sigma$ (relaxation time) (7.7)

$$\boxed{\text{curl}\,\mathbf{H} = \varepsilon \cdot (\mathbf{E}/\tau_1 + \delta\mathbf{E}/\delta t)} \qquad (7.8)$$

$$-\,\text{curl curl}\,\mathbf{E} = \mu \cdot \varepsilon \cdot (1/\tau_1 \cdot \delta\mathbf{E}/\delta t + \delta^2\mathbf{E}/\delta t^2) \qquad (7.9)$$

using the abbreviation: $\mu \cdot \varepsilon = 1/c^2$ (7.10)

The generally known result describes a damped electromagnetic wave [19b]:

$$\boxed{\underbrace{-\,\text{curl curl}\,\mathbf{E} \cdot c^2}_{\text{transverse}} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{-\ \text{wave}} + \underbrace{(1/\tau_1) \cdot \delta\mathbf{E}/\delta t}_{+\ \text{vortex damping}}} \qquad (7.11)$$

On the one hand, it is a transversal wave. On the other hand, there is a damping term in the equation, which is responsible for the losses of an antenna. It represents the wave part changing into standing waves, also known as field vortices, which decay according to the time constant τ_1 and cause vortex losses in form of heat.

Where in the field equation (7.11) are the longitudinal wave parts proven in the near field of an antenna and technically used in transponders?

7.3 Wave Equation According to Laplace

The wave equation ordinarily used in textbooks is the time dependent Laplace equation. The famous French mathematician Laplace found and formulated much earlier than Maxwell an extensive and to this day valid formulation of waves:

$$\boxed{\underbrace{\Delta\mathbf{E}}_{\substack{\text{Laplace}\\\text{operator}}} \cdot c^2 = \underbrace{-\,\text{curl curl}\,\mathbf{E} \cdot c^2}_{\substack{\text{transverse-}\\\text{(radio wave)}}} + \underbrace{\text{grad div}\,\mathbf{E} \cdot c^2}_{\substack{\text{longitudinal-}\\\text{(scalar wave)}}} = \underbrace{\delta^2\mathbf{E}/\delta t^2}_{\text{wave}}} \qquad (7.12)$$

On the one side of the wave equation, the Laplace operator is stated, which describes the spatial field structure and which is, according to the rules of vector calculus, composed of two parts. On the other side, the term describing the time dependence of the wave is found.

7.4 Comparison of the Wave Equations

If the wave equation according to Laplace (7.12) is compared to the one derived from Maxwell's equations (7.11), then two differences become obvious:

1. The damping term in missing in Laplace's equation.
2. By the divergence **E**, a scalar quantity, occurs, which constitutes a scalar wave, although such a wave propagates directed (because the gradient of a scalar quantity is a vector).

3. The damping term yields by comparing coefficients the conditional equation of the scalar wave part:

$$\boxed{\text{grad div } \mathbf{E} \cdot c^2 + (1/\tau_1) \cdot \delta\mathbf{E}/\delta t = 0} \qquad (7.13)$$

A practical example of a scalar wave is the plasma wave. In this case, according to Gauß's law (3rd Maxwell equation):

$$\text{div } \mathbf{D} = \varepsilon \cdot \text{div } \mathbf{E} = \rho_{el} \qquad (7.14)$$

the volume charge density ρ_{el} consisting of charge carriers is the scalar part. These move forward in form of a longitudinal shock wave and their sum is an electric current.

Because both wave descriptions are equally valid, we are allowed for the purpose of a coefficient comparison (7.13) to equate the damping term induced by eddy currents according to Maxwell (7.11) with the scalar wave term according to Laplace (7.12).

From a physical perspective, the generated field vortices form and cause a scalar wave.

The occurrence of div **E** is an essential prerequisite for the appearance of eddy currents. The expanding eddy currents known for the skin effect [2a] and of damping effect, which are a consequence of the current density **j**, require an electric conductivity (according to eq. 7.5).

7.5 Duality Consideration

In the near field of an antenna, opposite conditions are present. When conductivity is poor, then, for the formation of longitudinal wave parts, correspondingly, a vortex of complementary properties should be demanded. I am going to denote this contractive vortex, contrary to the eddy current, as potential vortex.

If we examined the potential vortex from the perspective of Maxwell's equations with regard to reliability and consistency, the we would be forced to drop it right away. The derivation of the damped wave equation (7.1–7.11) can be done using, instead of the electric field, the magnetic one. Both wave equations (7.11 and 7.12) do thereby not change their form. But in the inhomogeneous Laplace's equation, in the dual case the longitudinal wave part is described by div **H** and according to Maxwell it is equal to zero.

4. Maxwell's equation: $\text{div } \mathbf{B} = \mu \cdot \text{div } \mathbf{H} = 0$ (7.15)

If this proved to be true, then there can be no near field, no wireless energy transmission and, ultimately, no transponder technology. Therefore, one may question the validity (of eq. 7.15) and examine the possible result, if potential vortices exist and form scalar waves in the air around an antenna in form of field vortices forming a shock wave.

Besides, a marginal problem needs to be solved: because div **D** is the generally presumed cause of electric monopoles (7.14), magnetic monopoles (7.15) should be the result of div **B** [6], according to the duality, which were proven 19 years after the successful announcement.

8. Derivation of a World Equation

Hitherto it was shown, how and under which conditions the wave equation restricted to transversal wave parts is derived from Maxwell's field equations (chapter 7.2). Thereby one assumes the common case of an electric field $\mathbf{E} = \mathbf{E}(\mathbf{r},t)$ and magnetic field $\mathbf{H} = \mathbf{H}(\mathbf{r},t)$. We are going to follow this example [10b], but this time without the neglect and considering the potential vortex term.

8.1 Fundamental Field Equation (F.F.)

Both transformation equations used as an approach as well as the therefrom derived field equations (5.17 and 5.19) show two sides of a medal by conversely describing the relation of the electric and magnetic field strength:

$$\boxed{\text{curl}\,\mathbf{H} = \partial\mathbf{D}/\partial t + \mathbf{D}/\tau_1 = \varepsilon\cdot(\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1)} \quad (8.1)$$

$$\boxed{\text{curl}\,\mathbf{E} = -\,\partial\mathbf{B}/\partial t - \mathbf{B}/\tau_2 = -\,\mu\cdot(\partial\mathbf{H}/\partial t + \mathbf{H}/\tau_2)} \quad (8.2)$$

We are going to find out the meaning of the "medal" by substituting the dually formulated equations with one another. Either the **H** field calculated by one equation is inserted into the other, then the result is a conditional equation of the **E** field. The same works vice versa for determining the **H** field. Because the result is formally identical and merely the **E** field is replaced by the **H** field, because the same holds true for the **B** field, **D** field and for all other field quantities, the conditional equation is more than a calculation specification. It reveals a fundamental physical principle.

I denote it as complete or "fundamental field equation."

The derivation is always the same one and starts with by applying the curl operator to one of the equations, e.g. the extended law of induction (8.2):

$$-\,\text{curl curl}\,\mathbf{E} = \mu\cdot\partial(\text{curl}\,\mathbf{H})/\partial t + (\mu/\tau_2)\cdot(\text{curl}\,\mathbf{H}) \quad (8.3)$$

If curl **H** is substituted by Ampère's law 8.1, then in total four terms are formed:

$$-\,\text{curl curl}\,\mathbf{E} = \mu\cdot\varepsilon\cdot[\partial^2\mathbf{E}/\partial t^2 + (1/\tau_1)\cdot\partial\mathbf{E}/\partial t + (1/\tau_2)\cdot\partial\mathbf{E}/\partial t + \mathbf{E}/\tau_1\tau_2] \quad (8.4)$$

using the definition for the speed of light c:

$$\boxed{\varepsilon\cdot\mu = 1/c^2} \quad , \quad (3.3)$$

the fundamental field equation reads:

$$\boxed{\begin{aligned}&\underbrace{-\,c^2\cdot\text{curl curl}\,\mathbf{E}}_{\text{a}} = \underbrace{\partial^2\mathbf{E}/\partial t^2}_{\text{b (electromagnetic wave)}} + \\ &+ \underbrace{(1/\tau_1)\cdot\partial\mathbf{E}/\partial t}_{\text{c}} + \underbrace{(1/\tau_2)\cdot\partial\mathbf{E}/\partial t}_{\text{d}} + \underbrace{\mathbf{E}/\tau_1\tau_2}_{\text{e}} \\ &+ \text{eddy current} + \text{potential vortex} + \text{I/U}\end{aligned}} \quad (8.5)$$

Altogether, four term occur: the wave equation (a-b) with both damping terms, on the one side the eddy current (a-c) and on the other side the potential vortex (a-d) and, additionally, as a fourth term *Poisson's equation* (a-e), which is responsible for the spatial distribution of currents and potentials.

8.2 A Possible World Equation

In no other textbook a mathematical connection between Poisson's equation and the wave equation is given, like it was successfully done herein for the first time. Although it is a prerequisite for describing the transition of an antenna current into electromagnetic waves of a transmitter and likewise occurring conversely in case of an receiver. Numerous model conceptions, like there have been alternatively developed by HF and EMC technology, can be described by the physically established field equation mathematically correctly.

Additionally, even more equations can be derived that were assumed to be impossible. For example, the *Schrödinger* equation could be a special solution once it serves, consisting of the terms d and e, as a diffusion equation to describe field vortices and their structures mathematically.

But because Maxwell's equations in general and the eddy currents (a-c) in particular are unable to form structures, every attempt must fail to derive the Schrödinger equation from Maxwell's equations as a consequence.

The *fundamental field equation* (F.F.), however, includes the newly discovered potential vortices, which from spherical structures due to their concentration effect (complementary to the skin effect), wherefore these are eigenvalues of the equation. There are numerous practical measurements of these eigenvalue solutions, which confirm its validity and, therewith, strongly prove the validity of the field approach and the fundamental field equation.

Because of the absolute spatial and temporal formulation and the interchangeability of the fields, a physical principle is described herewith, which satisfies all requirements of a world equation.

8.3 Mathematical Interpretation of the F.F.

Let us start with a mathematical analysis. We applied the curl to equation 8.2, inserted equation 8.1, and obtained a conditional equation of the electric field **E**. Of course, we could apply the curl to equation 8.1 and insert equation 8.2. in the same manner. The result of this would be the conditional equation of the magnetic field **H**.

If we insert Ohm's law (7.5) and cancel the specific electric conductivity, or if we insert the constitutive relations (7.2) or (7.6) and cancel μ, respectively ε, then the field equations of the current density **j**, the induced magnetic field **B** or the dielectric displacement field **D** can be derived.

Phenomenal is that in all cases the field equation 8.5 does not change its form. Thus the field is arbitrarily interchangeable. This fact justifies the claim of this field equation to be called fundamental.

Introducing a neutral vector ψ representing all possible field quantities **E**, **H**, **j**, **B** or **D** makes sense.

The fundamental field equation 8.5 is composed of three different types of partial differential equations: a hyperbolic one (b), a parabolic one (c and d) and an elliptic one (e).

On the left side, the Laplace operator (a) is found, in each case describing the spatial distribution of the field quantity.

The <u>potential equation of the elliptic type</u> (e) is known as ***Poisson equation***. It describes the stationary limiting case of a faded away temporal process

$(t \rightarrow \infty\ ,\quad \text{resp. } \delta/\delta t = 0)$.

<u>elliptic potential equation</u>:

$$\boxed{\underbrace{-\,c^2 \cdot \mathrm{curl\ curl}\ \psi}_{a} = \underbrace{\psi/\tau_1\tau_2}_{e}} \qquad (8.6)$$

Using this equation, potentials, voltages as well as stationary electric currents can be calculated.

The <u>hyperbolic equation</u> (b) known as ***wave equation*** displays a second derivative with respect to time, thus an invariance with regard to time-reversal is expressed; in other words: the direction of the time line can be reversed by a change in sign of t without influence on frequency response. Therefore wave processes are reversible.

<u>hyperbolic equation</u>:
(undamped wave equation)

$$\boxed{\underbrace{-\,c^2 \cdot \mathrm{curl\ curl}\ \psi}_{a} = \underbrace{\delta^2\psi/\delta t^2}_{b}} \qquad (8.7)$$

This equation makes clear that there cannot be a wave without damping in nature. Because to accomplish this, both time constants (τ_1 and τ_2) would need to become infinitely large, which is practically not realizable.

Undamped waves could, strictly theoretically, defeat our measurement techniques.

Both <u>vortex equations of the parabolic type</u> (c and d) display only a first derivative with respect to time (eq. 8.8). Therewith they are not invariant with regard to time-reversal. The processes of vortex formation and decay, so-called diffusion, are thus irreversible. From this perspective it becomes reasonable that the process of the disintegrating vortex, which releases its stored vortex energy, e.g. in case of vortex losses as heat, cannot take place backwards. This ***irreversible process of diffusion*** increases in a strictly thermodynamic sense the entropy of the system.

<u>parabolic equation</u>:
(vortex equation)

$$\boxed{\underbrace{-\,c^2 \cdot \mathrm{curl\ curl}\ \psi}_{a} = \underbrace{(1/\tau) \cdot \delta\psi/\delta t}_{c \text{ or } d}} \qquad (8.8)$$

including the decay time of the eddy currents

= relaxation time: $\tau_1 = \varepsilon/\sigma$ (7.7)

and the decay time of the potential vortices

$\tau_2 \sim \mu \cdot \sigma$ (8.9)

(and the field vector in space and time dependency: $\psi = \mathbf{E}, \mathbf{H}, \mathbf{j}, \mathbf{B}$ oder $\mathbf{D}$)

The types of equations are often separately treated as an useful simplification for mathematical calculations. But the physical reality is in most cases different.

8.4 Physical Interpretation of the F.F.

In nature, the different types of equations always occur in a combined manner.

1. Let us examine the concrete case of the ***particle-free vacuum***. Here the specific conductivity is equal to zero. The relaxation time constant $\tau_1 = \varepsilon/\sigma$ responsible for the vortex decay approaches infinity according to equation 7.7 and the terms (c) and (e) of equation 8.5 cancel. The wave equation (b) damped by potential vortices (d) remains:

1. Borderline case (inside the vacuum $\sigma = 0$;
is in effect $1/\tau_1 = \sigma/\varepsilon = 0$):

$$\boxed{\underbrace{-c^2 \cdot \text{curl curl}\,\psi}_{a} = \underbrace{\delta^2\psi/\delta t^2}_{b} + \underbrace{(1/\tau_2)\cdot \delta\psi/\delta t}_{d}} \qquad (8.10)$$

without conductivity; (d = damping by potential vortices)

2. The complementary case (with $\tau_2 \longrightarrow \infty$) occurs in materials of zero electrical resistance, that is, ***super-conducting materials***. Now we deal with the case of the wave damped by the eddy current (equation 8.11).

2. Borderline case (inside superconductors $1/\sigma = 0$;
is in effect $1/\tau_2 = 0$):

$$\boxed{\underbrace{-c^2 \cdot \text{curl curl}\,\psi}_{a} = \underbrace{\delta^2\psi/\delta t^2}_{b} + \underbrace{(1/\tau_1)\cdot \delta\psi/\delta t}_{c}} \qquad (8.11)$$

with ideal conductivity; (c = damping by eddy currents)

But practically all materials occurring in nature do not fulfill these limiting conditions, thus both damping terms always accompany each other and, furthermore, the stationary term (e) becomes effective.

Although every *antenna* demonstrates that the electromagnetic wave is convertible to high-frequency alternating currents and voltages, which are then amplified by the receiver. But the fact that this transition takes place by means of a vortex was not understood until the formulation of the fundamental field equation.

Either rod antennae consisting of a well conducting material or waveguides and horn radiators, which are filled with air and are of minimum conductivity, are applied. In fact, the wave transition can take place in two dual manners: by rolling up into an eddy current or potential vortex.

Now we are also able to explain why waveguides make a higher effectivity possible: It is the concentration effect of the potential vortices that absorbs the HF power inside, not like in case of a cable, in which the power radiates before reaching the antenna, because of the skin effect.

Thus, physically, one must imagine this correlation describing the transition of an electromagnetic wave into a vortex in the manner, that the wave is able to spontaneously roll up into a vortex in case of a disturbance. Therefore, the more vortices are generated, the higher is the *damping of the wave* (equations 8.10 and 8.11).

8.5 Vortex Losses of the Diffusion Equation

The lifetime of vortices is limited and determined by the electrical conductivity. The vortices initially stored decay according to the associated time constant τ. This process is described by the ***diffusion equation***.

3. Borderline case, the diffusion equation of the vortex decay:

$$\underbrace{-c^2 \cdot \text{curl curl } \psi}_{a} = \underbrace{(1/\tau_1) \cdot \delta\psi/\delta t}_{c \text{ or } d} + \underbrace{\psi/\tau_1\tau_2}_{e} \qquad (8.12)$$

(c or d = vortex damping)

Finally, Poisson's equation (a, e: equation 8.6) describes the final stage of decaying vortices.

If the vortex decays, then it converts its energy stored inside the vortex into heat. We know these processes from the eddy current. We talk about current *heat losses* that cause the stationary currents inside conducting materials.

But the conception is new that such vortex phenomena can occur as *dielectric losses* inside capacitors or the air. The microwave or high-frequency welding are good examples for this.

What practical effects does *vortex damping* have? First we observe that the radio wave reception becomes poorer. "The useful signal perishes in the noise," the radio engineer says and means that the number of vortices (term c or d) increases to the disadvantage of the wave intensity (b resp. coupled with a).

8.6 Phenomenological Interpretation of the F.F.

Why, the student asks, is cosmic space so cold? After all, the sun shines there every day and night and, additionally, much more intensively than on the earth? The correct answer should be that no diffusion processes can take place in space, because of the poor conductivity.

Contrary, the heat on our earth is caused by the vortex decay here. The conductivity of the atmosphere is responsible.

At an altitude between 60km to 500km from the earth's surface, which is called *ionosphere*, the gases are present in ionized form. A very good conductivity prevails and the result are vortex losses. The measurable temperature are correspondingly high.

Next to the diffusion process, the eddy currents damp the cosmic radiation. We talk about sunlight being filtered and adjusted to an intensity endurable by nature (fig. 8.1).

But not all frequencies are damped to the same extent. We observe a sky blue when looking at the actually black sky. There are no spots or clouds in the blue sky. One searching for the cause should look at the skin effect of the eddy currents, which expand outward. Because there is no conductor edge, no skin is able to form. The vortices can spread equally across the ionosphere.

Contrary, the potential vortex structures itself. It merely needs a poor conductivity, which he find at a low altitude between 1 km and 10 km. It damps the wave and therewith the light, wherefore we say that it is getting dark, the sun disappears behind the clouds.

The clouds form, well visibly, the discussed vortex bales and bands. When solar radiation is intensive, clouds can form practically from nothing.

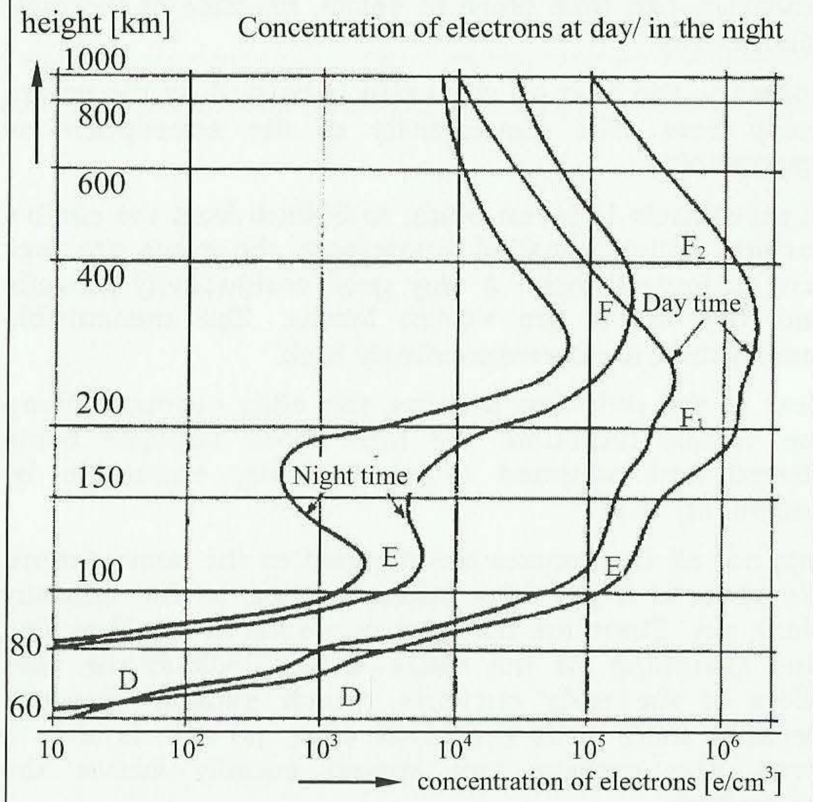


Fig.: 8.1: *The relation between altitude and ionization of the ionosphere for a temperate climate [1d].*

Left curve: *sunspot minimum*
Right curve: *sunspot maximum*

In other words, the waves are able to roll up into vortices. Ordinarily this happens above the world's oceans. Here the transport phenomenon takes effect.

The water surface facilitates the formation of potential vortices, because of the high permittivity. Thereby the vortices absorb single water molecules and carry them away. If a diffusion process takes place, whereby the vortices decay, then it rains. This can happen in two manners:

Either conductivity increases. If air ions form caused for example by an intensive solar radiation, the sun is able to dispel clouds and fog. Or the air is elevated to a higher layer of higher conductivity, because this is forced by a mountain, then it rains at the mountain edge.

Looking at the second manner, the electric field is important, which is oriented perpendicular to the potential vortex. If numerous vortices combine at a location, which causes a cloud to appear especially dark to black, there is the risk that the ionization field strength reached at which a conducting air duct forms, across which the stored charge carriers discharge. The lightning bold, too, is a diffusion process, whereby potential vortices decay and rain can be caused (see the cover picture).

The lighting bolts are still an unsolved problem, because the known models (Wilson) are unable to explain the cause of the potential difference of 100 million volts needed for the ionization of the air reasonably. Also the bolts that strike toward the ionosphere are a riddle.

8.7 Atomistic Interpretation of the F.F.

Let us look at the smaller, atomistic dimensions. Here we find positively charged protons and negatively charged electrons. Both are *matter particles* and, that is, both are of the *same direction of rotation* when observed from the outside.

Because of the opposite charge conditions, they attract each other rotate as a differently heavy pair around a shared mass center. Chemists say: "The lightweight electron revolves around the heavy atomic nucleus." Using small spheres, they try at first to explain the atomic structure.

But the outdated model is obsolete. We need to deal with the problem that, according to the laws of electrodynamics, the centrally accelerated electron should emit electromagnetic waves and lose energy continually to finally crash into the nucleus.

In fact, this state occurs only for a very short time, and then something incredible can be observed: The electron can no longer be determined as a single particle. "It is smeared across the electron orbit," some say; "It is of a dual nature," *Heisenberg* says.

Next to the corpuscular character, the electron is supposed to form, according to its "second nature," a matter wave. *De Broglie* and *Schrödinger* explain that "the position is a resonance, that is, a maximum of a probability of presence."

Hard to believe, because if the electron lost in its second nature its particle character, then it also would lose its typical properties, for example its mass and charge, which is not the case.

The vortex theory does offer an explanation it this point, how the electron as a sphere does not lose any energy. A configuration can be presented that does not have this problem. The transport phenomenon takes effect, when the electron opens its vortex center and absorbs the small atomic nucleus in its inside. Unfortunately, we cannot look inside the particle, wherefore the model developed by conception shall initially be seen as a hypothesis and incitation.

Thus the electron orbit by *Bohr* is no path any longer, but it is occupied by the whole particle as a spherical shell. Now the electron is in its inside of a different direction of rotation than the proton on the outside. As a result, there is a repulsive force, which may be interpreted as a vortex of a current directed outward.

The attractive force counteracts the effect of the potential vortex, because of the opposite charge. *If both vortices are equally strong:*

$$\tau_1 = \tau_2 \tag{8.13}$$

or if *both force are balanced*, as one would ordinarily say, the structure, which we call atom, is in a stable state.

It is probably a result of the incompatible direction of rotation, wherefore the distance becomes larger, when the electron becomes an electron of the shell.

But enough speculation. Maybe a mathematical derivation will bring us closer to the goal.

8.8 Klein-Gordon Equation Derived from the F.F.

The accepted model of the atom poses, to this day, causality problems as explained. An improvement was the equation that the mathematician Schrödinger proposed in 1926 as a model conception.

As a mere postulate, this equation lacked a physical origin, but it still earned international recognition, because it could experimentally be proven to be valid. Starting from the result, the physical interpretation of the probability of presence of the wave resonance could be backwards introduced.

$$i \cdot \hbar \cdot \delta\psi/\delta t = U \cdot \psi - (\hbar^2 / 2\,m) \cdot \Delta\psi \qquad (8.14)$$

The *Schrödinger equation* (8.14) is valid for matter fields (of the mass m), whose interaction with an exterior force field is stated by the energy U. One may derive it from a wave equation, which can be seen as a reason for why it is generally called a wave equation, although it is actually a diffusion equation, that is, a vortex equation.

In its derivation, Schrödinger states as an approach a harmonic oscillation for the complex wave function ψ:

$$\boxed{\psi(\mathbf{r},t) = \Phi(\mathbf{r}) \cdot e^{-i\omega t}}\,, \qquad (8.15)$$

if the entire time dependence can be described by one frequency

$$f = W / h$$

(according the *de-Broglie relation*):

$$\omega = 2\pi f = W \cdot 2\pi / h = W / \hbar \qquad (8.16)$$

The ambitious aim is stated as: If the structure of the atom is determined by the fundamental field equation 8.5, then the experimentally proven Schrödinger equation should be derivable and describe the discussed special case mathematically.

As generally used, we chose an approach:

$$\boxed{\mathbf{E}(\mathbf{r},t) = \psi(\mathbf{r},t) \cdot e^{-\omega t}}\,, \qquad (8.17)$$

using $\qquad \omega = 1/\tau = (1/\tau_1 + 1/\tau_2)/2\ . \qquad (8.18)$

We insert the approach 8.17 and its derivatives

$$\delta\mathbf{E}/\delta t = -\omega \cdot \psi \cdot e^{-\omega t} + (\delta\psi/\delta t) \cdot e^{-\omega t}$$

$$\delta^2\mathbf{E}/\delta t^2 = \omega^2 \cdot \psi \cdot e^{-\omega t} - 2\omega \cdot (\delta\psi/\delta t) \cdot e^{-\omega t} + (\delta^2\psi/\delta t^2) \cdot e^{-\omega t}$$

into the field equation 8.5, whereby div $\mathbf{E} = 0$ can be represented by the Laplace operator

$$\Delta\mathbf{E} = -\text{ curl curl } \mathbf{E}): \qquad (8.5^*)$$

$$\boxed{\Delta\mathbf{E} \cdot c^2 = \delta^2\mathbf{E}/\delta t^2 + (1/\tau_1) \cdot \delta\mathbf{E}/\delta t + (1/\tau_2) \cdot \delta\mathbf{E}/\delta t + \mathbf{E}/\tau_1\tau_2} \qquad (8.5)$$

and divide by the damping term $e^{-\omega t}$:

$$\Delta\psi \cdot c^2 = \psi/\tau_1\tau_2 - \omega \cdot \psi \cdot (1/\tau_1 + 1/\tau_2) + (1/\tau_1 + 1/\tau_2) \cdot (\delta\psi/\delta t)$$
$$+ \omega^2 \cdot \psi - 2\,\omega\,\delta\psi/\delta t + \delta^2\psi/\delta t^2 \qquad (8.19)$$

If as the next step the angular frequency according to equation 8.18 is inserted,

$$\Delta\psi \cdot c^2 = \psi/\tau_1\tau_2 \qquad \text{(a) = (e)}$$

$$- (\psi/2) \cdot (1/\tau_1 + 1/\tau_2)^2 \qquad \text{+(c, d)}$$

$$+ (1/\tau_1 + 1/\tau_2) \cdot \delta\psi/\delta t \qquad \text{+(c, d)}$$

$$+ (\psi/4) \cdot (1/\tau_1 + 1/\tau_2)^2 \qquad \text{+(b)}$$

$$- (1/\tau_1 + 1/\tau_2) \cdot \delta\psi/\delta t + \delta^2\psi/\delta t^2 \qquad \text{+(b)}$$

then summarized the provisional intermediate result is stated as:

$$\boxed{\Delta\psi \cdot c^2 = \psi / \tau_1\tau_2 - \omega^2 \cdot \psi + \delta^2\psi/\delta t^2} \qquad (8.20)$$

The derived equation 8.20 represents formally seen the *Klein-Gordon equation*, which is used to describe matter waves is quantum mechanics and which is especially important for the quantum field theory (e.g. Mesons).

Although it is often seen as a relativistic invariant generalization of the Schrödinger equation, it is, when observed accurately, incompatible with it and, furthermore, as a "real" wave equation, unable to treat vortex problems, e.g. the quantization of the microcosm calculable by the Schrödinger equation.

8.9 Derivation Using the Schrödinger Approach

With the Schrödinger approach 8.15 and its derivatives, the derivation is continued:

$$\boxed{\psi(\mathbf{r},t) = \Phi(\mathbf{r}) \cdot e^{-i\omega t}} \ , \qquad (8.15)$$

$$\delta\psi/\delta t = -i\omega \cdot \psi \quad \text{bzw.} \quad \psi = (i/\omega) \cdot \delta\psi/\delta t \qquad (8.21)$$

$$\delta^2\psi/\delta t^2 = -i\omega \cdot \delta\psi/\delta t \qquad (8.22)$$

The obtained relations concerning a harmonic oscillation stated by equation 8.21 and 8.22 are now inserted into equation 8.20:

$$\boxed{\Delta\psi \cdot c^2 = \psi/\tau_1\tau_2 - 2i\omega \cdot \delta\psi/\delta t} \qquad (8.23)$$

This, already, is the sought *Schödinger equation*, which we are about to comprehend, if we will have analyzed the coefficients. Because of the fact that, next to equation 8.16, the total energy W can be calculated by the Einstein relation (using the speed of light c):

$$W = m \cdot c^2 = \omega \cdot \hbar \ , \qquad (8.24)$$

we can replace the coefficients of the imaginary term by:

$$2\,(\omega / i) = 2\,m\,c^2 / i\hbar \qquad (8.25)$$

In order that equation 8.23 results from the Schrödinger equation 8.14, as demanded, the coefficients of the real part are compared to them:

$$\boxed{1 / \tau_1 \tau_2 c^2 \overset{!}{=} U \cdot 2\,m / \hbar^2} \qquad (8.26)$$

If the kinetic energy of an moving particle of velocity v is equal to:

$$\tfrac{1}{2} \cdot m \cdot v^2 = W - U \,, \qquad (8.27)$$

then this is of wavelength h/mv according to de Broglie. The concept of a matter wave demands a correspond-dence with the wave length c/f of an electromagnetic wave (of the phase velocity c). Thus the particle is of velocity v, which is equal to the group velocity of the matter wave:

$$v = hf/mc = \hbar\omega/mc \,, \qquad (8.28)$$

to insert it into equation 8.27 :

$$U = W - \tfrac{1}{2} \cdot m \cdot (\hbar\omega / mc)^2 \qquad (8.27^*)$$

According to equation 8.24 the total energy is equal to:

$$W = \omega \cdot \hbar \,, \qquad (8.24)$$

and, on the other hand, equation 8.28 applies

$$(\hbar\omega / mc) = c \quad \text{resp.:} \quad m/\hbar = \omega/c^2 \,. \qquad (8.28^*)$$

Eq. 8.28* inserted into equation 8.27* the sought coefficient is (according to eq. 8.26):

$$U \cdot 2m/\hbar^2 = 2\omega/c^2\hbar \cdot [\omega \cdot \hbar - \tfrac{1}{2} \cdot m \cdot c^2]$$

$$= 2\omega/c^2\hbar \cdot [\omega \cdot \hbar - \tfrac{1}{2} \cdot \omega \cdot \hbar]$$

$$= (\omega/c)^2 \qquad (8.29)$$

8.10 Time-Dependent Schrödinger Equation

The goal is reached, when are able to fulfill the comparison of the coefficients 8.26:

$$U \cdot 2m/\hbar^2 = (\omega/c)^2 \overset{!}{=} 1/\tau_1\tau_2 c^2 \qquad (8.30)$$

The angular frequency ω is given by equation 8.18. Therefore has to be valid:

$$\tfrac{1}{4}\,(1/\tau_1 + 1/\tau_2)^2 \overset{!}{=} 1/\tau_1\tau_2 \qquad (8.31)$$

resp.:

$$\tfrac{1}{2} \cdot (1/\tau_1 + 1/\tau_1) \overset{!}{=} \sqrt{1/\tau_1\tau_2} \qquad (8.32)$$

As is generally known, the arithmetic and geometric means only agree in the case that the variables are identical. In this case, similarly to equation 8.13,

$$\boxed{\tau_1 = \tau_2} \text{ must be valid.} \qquad (8.13)$$

Therefore, we may conclude that the Schrödinger equation applies in case of the discussed *special case* (eq. 8.13), *whereby the eddy current, which strives to expand its circular path, and potential vortex, which keeps the atoms together and which, furthermore, is responsible for the stability of the elementary particles, are of identical magnitude.*

As a check, equation 8.23 is divided by c^2. Using equation 8.30 and 8.25, the time-dependent Schrödinger equation solved for $\Delta\psi$.

$$\boxed{\Delta\psi = U \cdot \psi \cdot (2m/\hbar^2) + (2m/i\hbar) \cdot \delta\psi/\delta t} \qquad (8.14^*)$$

8.11 Time-Independent Schrödinger Equation

Next we replace $\delta\psi/\delta t$ according to equation 8.21 by $\omega = W / \hbar$ acc. to equation 8.24:

$$\Delta\psi = U \cdot \psi \cdot (2\,m / \hbar^2) + (2\,m / i\hbar) \cdot \psi \cdot (-\,i) \cdot W / \hbar \tag{8.33}$$

Separating the position variable $\Phi(\mathbf{r})$ from the time using the Schrödinger approach 8.15 results:

$$\Delta\,\Phi = (U\,2\,m / \hbar^2 - W \cdot 2\,m / \hbar^2) \cdot \Phi \tag{8.34}$$

This equation 8.34 using the function of space coordinates $\Phi(\mathbf{r})$ is the *time-independent Schrödinger equation:*

$$\boxed{\Delta\,\Phi = -\,2\,m / \hbar^2\,(W - U) \cdot \Phi} \tag{8.35}$$

The solution of this function that satisfy all imposed conditions (of finiteness, continuity, uniqueness quantification, etc.) are denoted as *eigenfunctions*. The existence of adequate, discrete values of/ the energy W , also called *eigenvalues of the Schrödinger equation*, are the mathematical justification of the various quantum postulates.

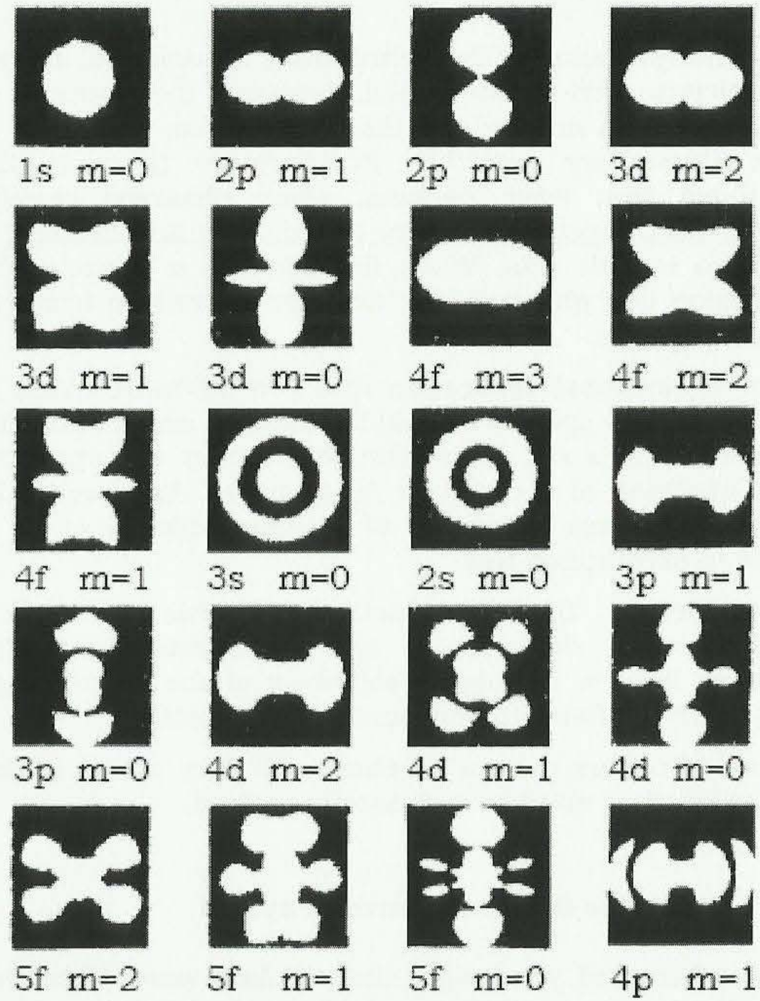


Fig. 8.2: *Vortex-like solutions of the Schrödinger equation for different states of the hydrogen atom interpreted as probability distribution [25].*
(rotationally symmetric with regard to the vertical axis)

9. Conclusion

The interpretation of the Schrödinger equation is, among physicists, still controversial, because the concept of wave packets contradicts the corpuscular character of the elementary particles. Furthermore there is the problem that wave packets, when observed closely, never keep together, more or less diverge and nothing is able to impede this. When dealing with a particle, the cohesion is a physical fact. One cannot talk in terms of causality here.

The monocausal separation into two different layers of reality, into a spatiotemporal localization and a energetic description, is not a solution, but rather the opposite, the abolition of the alleged dual nature. As shown, the potential vortex by means of its concentration effect is able to accomplish this.

Nevertheless the introduction of this new field phenomenon demands a new interpretation of the causes for the calculable solutions of the Schrödinger equation verifiable by measurement technology.

Laws of nature cannot be chosen. If they are identified as valid, they must be necessarily utilized.

9.1 About the Origin of Vortex Physics

Three-hundred years ago, the scholars were disputing, whether a decomposition of physical phenomena was acceptable, as *Newton* proposed, to analyze them apart, isolated from other influences in a laboratory, or whether one should proceed holistically, like *Descartes* did with his cartesian vortex theory. He thought of the celestial bodies floating in ætheric vortices.

One was indeed aware of the fact that the whole must be more than the sum of the single findings, but the vortex conception discussed since *Democritus* had to make room for the overwhelming success of Newton's method and was discontinued after 2100 years to be meanwhile almost forgotten.

Today, where this recipe for success reached the limits of physical possibilities in many areas, we should remember the teachings of the ancients and take up the vortex conception again. Of course, only details are mathematically calculable and nature, the great whole, remains incalculable, which can be problematic.

9.2 Interpretation of the Schrödinger Equation

Looking at the fundamental field equation 8.5, it is indeed confirmed that in fact no mathematician is able to state an universally valid solution of this four-dimensional partial differential equation. Only restricted special cases of harmonic excitation or of spatial limiting conditions are calculable. The derived Schrödinger equation is such a case and especially interesting, because it is an eigenvalue equation. The eigenvalues describe mathematically structure of potential vortices verifiable by measurement technology.

Also other eigenvalue equations are derivable, like the Klein–Gordon equation or Liouville's equation, which are successfully applied is chaos theory. Thus our insight expands, when chaotic systems, like turbulences, are able to be treated as special cases of the same field equation and derived from it.

Thus there are extensive consequences that result from the derivation of the Schrödinger equation from the fundamental field equation 8.5:

1. *Every experiment that verifies the Schrödinger equation verifies therewith the existence of the newly discovered potential vortices and the validity of the field-theoretical approach.*

2. *Properties of the atomic shell and nucleus that are describable by the Schrödinger equation can be interpreted as electromagnetic phenomena from now on.*

3. *There are no particles or wave packets consisting of matter waves, but only configurations composed of potential vortices and eddy currents.*

4. *There is no matter! What we denote as matter is nothing more than an electromagnetic state of oscillation of empty space.*

The relation between the vibrational energy and the mass describes the equation named after *Albert Einstein* (the mass–energy equivalence):

$$\boxed{E = mc^2} \tag{9.1}$$

oOo·oOo·oOo·oOo·oOo·oOo·oOo·oOo·oOo·oOo·oOo·oOo

10. 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
ε	As/Vm	Dielectricity	μ	Vs/Am	Permeability
Q	As	Charge	ϕ	Vs	Magnetic flux
e	As	Elementary charge	m	kg	Mass
τ_2	s	Relaxation time constant of the potential vortices	τ_1	s	Relaxation time constant of the eddy currents

Other Symbols and Definitions:

σ	Vm/A	Specific electric conductivity
ρ_{el}	As/m³	Electric volume charge density
A	m²	area
F	N	Force
h	Nms	Planck's constant
$\hbar$	Nms	Dirac constant: $\hbar = h/2\pi$
s	m	Distance
S	W/m²	Electromagnetic power density
t	s	Time
U	Nm	Potential energy
v	m/s	Velocity
W	Nm	Total energy
ω	s^{-1}	Angular frequency

complex wave function	$\psi(\mathbf{r},t)$	
Local function of position (r)	$\Phi(\mathbf{r})$	
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 (definitions and rules):

Bold print: $\mathbf{A} = \mathbf{e_x} \cdot A_x + \mathbf{e_y} \cdot A_y + \mathbf{e_z} \cdot A_z$ = field vector

Laplace- $\Delta \mathbf{A} = \delta^2\mathbf{A}/\delta x^2 + \delta^2\mathbf{A}/\delta y^2 + \delta^2\mathbf{A}/\delta z^2$

Operator: $\Delta \mathbf{A} = \text{grad div } \mathbf{A} - \text{curl curl } \mathbf{A}$

$\text{div curl } \mathbf{A} = 0$

Divergence $\text{div } \mathbf{A} = \delta A_x/\delta x + \delta A_y/\delta y + \delta A_z/\delta z$

Gradient $\text{grad } V = \mathbf{e_x} \cdot \delta V/\delta x + \mathbf{e_y} \cdot \delta V/\delta y + \mathbf{e_z} \cdot \delta V/\delta z$

Rotation
$$\text{curl } \mathbf{A} = \mathbf{e_x} \cdot (\delta A_z/\delta y - \delta A_y/\delta z) + \mathbf{e_y} \cdot (\delta A_x/\delta z - \delta A_z/\delta x) + \mathbf{e_z} \cdot (\delta A_y/\delta x - \delta A_x/\delta y)$$

$$\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A}$$

$$\text{div } (\mathbf{A} \times \mathbf{B}) = \mathbf{B} \text{ curl } \mathbf{A} - \mathbf{A} \text{ curl } \mathbf{B}$$

$$\text{curl } (\mathbf{A} \times \mathbf{B}) = (\mathbf{B} \text{ grad}) \mathbf{A} - (\mathbf{A} \text{ grad}) \mathbf{B} + \mathbf{A} \text{ div } \mathbf{B} - \mathbf{B} \text{ div } \mathbf{A}$$

$$\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) = \mathbf{B} \cdot (\mathbf{A} \cdot \mathbf{C}) - \mathbf{C} \cdot (\mathbf{A} \cdot \mathbf{B})$$

curl **A** is the rotation or vortex density, not the vortex itself of the field **A** (otherwise there is confusion).

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More publications (papers, books, CDs, DVDs) at www.meyl.eu (or in the Shop of www.etzs.de).

12. Epilogue

The original edition from 1990 included additionally a summary of the steps that led to the discovery of the potential vortices of rather bibliographic value.

12.1 On the Origin of the Theory (epilogue from 1990)

At the beginning, there was the proof of existence of the vortex fields, which the author was able to work out because of his longstanding preoccupation with vortex phenomena and which acted as an initial spark.

As a second step following the discovery of potential vortices, it was necessary to calculate these mathematically to convince the colleagues. For this reason, Maxwell's equations, which are with good reason called the fundament of electrical engineering, needed to be newly formulated and extended. Applying rules of duality, the extension of Faraday's law of induction was rather easy, whereas crucial consequences follow from this action.

As a third step, cases that should be accompanied by the occurrence of potential vortices were examined regarding this possibility. None was found contradicting the new insights. Rather the opposite became obvious, that in many such cases, which have already been explained by science, measurement and calculation show often significant differences.

As a fourth step, it was possible to determine the properties of the potential vortices.

The fifth step was the attempt to imply the influence of the new theory regarding the various disciplines of our science in form of contributions to the discussion.

The sixth step was the development of technical and physical possible applications (i. a. capacitor losses).

As a seventh step, several chains of proof of the potential vortex theory were determined (i. a. the F. F. and the Schrödinger equation).

As an eighth step, this potential vortex theory was made public after its completion by means of submitting excepts from this work to several magazines for release ([26] on 03/06/1990).

12.2 Concerning the New Edition (epilogue from 2012)

To be correct, I must add that some submitted professional articles were defeated by peer reviewers using the argument that the approach invalid, because magnetic monopoles would not exist. Because such ones were detected only in late 2009, the very important discussion was blocked for 19 years.

Today the way is clear and the time has come to carry on the book series about the potential vortex, which started with two volumes. Some partial aspects were already written out in the material collection [27] and in single books and professional publications. These are again found in the potential vortex series and are now newly compiled and completed published as a comprehensive compendium.

12.3 About the Author

The author, born in 1952, occupies himself with vortex problems of electrical engineering since 1978. This topic has been a golden thread through the scientific works of the author. His diploma thesis on the non-linear influence of eddy currents on an according feedback control system at the Technical University of Munich constituted his entry. The logical proceeding was a study visit at the Aston University in Birmingham and the doctorate on the three-dimensional non-linear calculation of eddy currents at the University of Stuttgart.

Today the author is professor at Furtwangen University, leads a laboratory for power electronics and drives and conducts a technology transfer center for drive technology of the Steinbeis Foundation for economic promotion in St. Georgen in the black forest (original text from 1990).

Addendum (2012): The research institute was renamed to "First Transfer Center for Scalar Wave Technology." Furthermore the owner changed and it moved to the technology park of Villingen-Schwenningen.

Both Volumes concerning the discovery of potential vortices obtained acceptance in 1994 by the awarding of a research prize by the German Society of EMC Technology (University of Dresden).

Since 1995, lectures are conducted concerning this topic to an increasing degree on an international level (as an response to invitations of universities from foreign countries).