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# ETHER AND SCHRÖDINGER'S WAVE FUNCTION ψ

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## Abstract

It shall be shown that the „ominous" wave function $\psi$, which is still disputed today, can be interpreted not only as the amplitude of probability waves, without any physical basis (neither material nor energetic), but also as a normalised, quantitative description of the electromagnetic fields of an (ether-) carrier medium, in accordance with the Maxwell equations and the (until today worldwide suppressed) original ideas of Erwin Schrödinger.

**Keywords:** Maxwell, de Broglie, Schrödinger, Dirac, Santilli, Laughlin, wave function, ether, ether waves, probability, material waves, psi

# A NEW APPROACH TO ETHER RESEARCH:

## The fundamental question of quantum mechanics.

Can one hope for an atomic theory that **avoids** the **Copenhagen** interpretation? Answer from a proven „quantum expert": [1]

> **In principle, yes, – but then** all current **quantum field theories** (QED, QCD, etc.), which so well reflect the structure of matter, **had** to be **abandoned**.

As **a supplement** to the Copenhagen interpretation of $\psi$ – and in accordance with Erwin Schrödinger's original view[2] – the following **thesis** is presented and explained below:

**The *psi* - Thesis**

> Schrödinger's **wave function** $\psi$ means: the **electromagnetic field state** – of the ever omnipresent **ether**.

## Erwin Schrodinger: the "secret" ether physicist.

Erwin Schrödinger was – with certainty – a completely "convinced ether physicist", for life.

This statement is a fact, practically unknown today, but it is very easy to understand, because Schrödinger worked for a whole decade as assistant of Franz Exner (1910 until Exner's retirement in 1920)[3] and was there in charge of his students, for whom Prof. Exner gave **each** year **nineteen** fully elaborated **lectures** on **ether physics.**[4]

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[1] **Frage** u. Antwort von **Helmut Rechenberg** (1937-2016) in: Meyenn (1998), (15), **2. Bd.**: Quantenfelder und Kausalität, S. 299-300.

[2] Kumar (2009), (12), „Ein später erotischer Ausbruch", S. 257.

[3] Moore (2012), (16), Der Hochschulstudent, S. 52, Doktorarbeit, S. 59, Assistentenstelle, S. 62.

[4] These nineteen lectures are documented in detail. See: Exner (1919), (7), **Physik Vorlesung**.

In this sense, Schrödinger wrote at that time, among others, a great **treatise** on **dielectrics,** "naturally" (at that time still) **based** on an **ether.**[5]

From about 1920 onwards Schrödinger hardly ever said anything about this "delicate" subject, because from then on,[6] (at the latest) classical mechanical ether theories were generally considered to be overcome, contradictory, etc.[7]

Nevertheless, Schrödinger remained an "ether-believer" throughout his life, in later years especially in the sense of Einstein's unified field theory.[8]

## The great $\psi$-puzzle.

Schrödinger's ominous wave function $\psi$ was introduced in 1926,[9] but even though almost a century has passed since then, its significance remains one of the greatest puzzles in physics to this day, especially the fact that $\psi$ must be described with strangely complex numbers. For example, it has even been claimed that the imaginary part of $\psi$ has no physical meaning.[10]

$\psi$ was - and still is today - regarded as something intangible, even ghostly, but above all immeasurable. Heisenberg found Schrödinger's theory to be "crap", indeed.

It was in this sense that the following, often quoted mocking poem was

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[5] Schrödinger (1914), (20), „Die Maxwellsche Theorie der Dielektrika", S. 157.

[6] 1909 e.g. already Einstein (1909), (6), Zum ... Strahlungsproblem, S. 718. – **Ätherhypothese**: ein **überwundener** Standpunkt.

[7] This view was significantly influenced around **1920** (a) by the Naturalists' Meeting in Bad Nauheim on 23 Sept. **1920**, see Wazeck (2009), (26), 3.2.2 Anschaulichkeit, S. 183-190, and (b) by a book of **Max Born** also published in **1920** (many new editions later): Born (1920), (2), siehe z.B. 15. Die Kontraktionshypothese, S. 192-193.

[8] This is clearly shown by Schrödinger's private correspondence with Born, Einstein and others. See Meyenn (2011), (23), Div. Auszüge von Briefen – From 1917, however, these ideas were probably of a relativistic nature and ended about three decades later – then called affine field theory by him – in an abrupt manner, without any further development. See Moore (2012), (16), Allgemeine Relativität (ab 1917), S. 100-101 – **Das Einstein-Debakel** (um 1946) und die **„Einstein-Schweinerei"'**, S. 368-373.

[9] Schrödinger (1926), (21), Quantisierung als Eigenwertproblem.

[10] Gassner/Müller (2019), (9), 7.10 Zeitabhängige Schrödingergl., S. 382 / Einschub: Komplexe Zahlen, S. 389.

written at that time in "honour of Erwin":[11]

> Erwin with his "psi" can do,
> Calculations many – quit a few.
> But one thing yet, has not been seen:
> What does this "psi" – actually mean?[12]

Finally, Schrödinger's wave function was interpreted as a **"complex-valued probability wave"** – meaning an abstract wave that, **does not even** move **in normal** three-dimensional **space.**[13]

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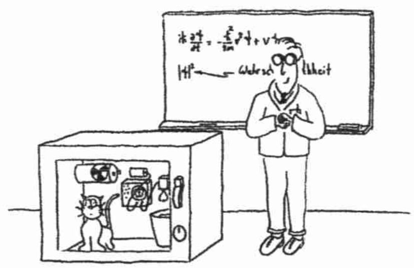
Robert B. Laughlin about Schrödinger's cat:
**The ludicrousness of this idea is self-evident.**



From **Robert Laughlin**'s book (2005), (13):
**A Different Universe – Reinventing Physics**
Chapter 5: **Schrödinger's Cat**, p. 47-57.

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The decision in favour of this **"probability-definition"** proposed by Max Born (at the Solvay Conference 1927) was made against **massive** resistance from Schrödinger, de Broglie, Böhm, Einstein, and others.[14]

[11] Kumar (2009), (12), Die Wirren um Schrödingers $\psi$, Mist: S. 262, Gedicht: S. 264, Geisterhaftes: S. 274.

[12] German Poem by **Erich Hückel** – (partly special translation by GZ.)

[13] Kumar (2009), (12), „Ein später erotischer Ausbruch", S. 271 – und: Die Bellsche Ungleichung, S. 402.

[14] Kumar (2009), (12), **Einwände gegen die Kopenhagener Deutung von $\psi$**, S. 10, Bild 23, 304-305, 314, 318-321, 327, 333, 335, 337, 340, 347, usw., usw.

Nevertheless, it is still **the only** officially **recognized** definition, so that practically all universities – worldwide – still teach today:[15]

> Schrödinger's wave function $\psi$ means the "probability amplitude" of the electron's "whereabouts".[16]

The problem of the "Schrödinger cat", for example, is a direct consequence of this "probability" interpretation[17] (also known as the measurement problem), which involves an, up to today, open question:[18]

**When, where** and **how** does the probability wave, **resp.** $\psi$, … **collapse** … ? [19]

Surprisingly, the Schrödinger equation remained indispensable up to now and became, among other things, the prototype of all quantum mechanical wave equations.[20]

## Schrödinger's original, intuitive derivation.

The actual origin of the renown Schrödinger equation was Schrödinger's idea that, atoms are oscillating systems, whose electrons oscillate around their nucleus in spherical **resonance** with the **ether medium**.[21]

[15] Bleck-Neuhaus (2013), (1), Der **„überzeugende Beleg"** für die Wahrscheinlichkeits-**Deutung** der Wellenfunktion $\psi$, S. 156, Fn. 56: Dieser Fehlschluss liegt nicht fern, S. 205.

[16] Meschede (2010), (14), 15.1.2 Quanten-Fluktuationen stabilisieren die Atome, S. 717 / 15.2.2 Schrödinger-Gleichung, S. 719. / Interpretation als Wahrscheinlichkeitsamplitude, S. 722.

[17] Gassner/Müller (2019), (9), Schrödingers Katze, S. 338.

[18] Mehrere Bücher wurde dazu verfasst, z.B. David Peat (1997) Who is afraid of Schrödinger's Cat?

[19] Kumar (2009), (12), Solvay 1927, S. 323-324. / siehe auch **Gassner/Müller** (2019), (9), **Kann man die Quantenmechanik auch anders verstehen**, S. 400-406.

[20] Meyenn (1998), (15), **2. Bd.**: Schrödingers Wellenmechanik, Quantenfeldtheorie und Kausalität, S. 296-300.

[21] Schrödinger (1926), (21), Quantisierung als Eigenwertproblem: Die Vorstellung, dass die Elektronen von Atomen schwingen, S. 375.

The decisive impetus for this was provided by de Broglie's dissertation,[22] according to which Schrödinger – as Schrödinger's notebooks show – first derived the new wave equation by means of the usual wave equation and the de Broglie relationship $p = h/\lambda$ (which is still unexplained today), "**purely classical**". Since Schrödingers classical derivation is rarely shown nowadays,[23] it is briefly reproduced here.

Starting point is the classical **equation** for **waves of all kinds** (sound waves, electromagnetic waves, etc.)

$$\nabla^2\Phi - \frac{1}{c^2}\,\ddot{\Phi} = 0. \tag{1}$$

For harmonic waves (linear elastic type) generally applies: $\Phi = e^{i\omega t}$, $\dot{\Phi} = i\omega\, e^{i\omega t}$ and $\ddot{\Phi} = -\omega^2\, e^{i\omega t}$.

The following applies too: $c = \lambda\nu$, $k = 2\pi/\lambda$ und $\omega = 2\pi\nu$, also $c = \omega/k$, thus $1/c^2 = k^2/\omega^2$.

Used in (1), these two relationships result in the so-called time-**independent** wave equation:[24]

$$\nabla^2\Phi + k^2\Phi = 0. \tag{2}$$

From the total energy of all mechanical systems $E = T + V = (mv^2/2) + V = (p^2/2m) + V$ **follows** immediately $p^2 = 2m(E - V)$.

From de Broglie's wavelength $\lambda = h/p$ and $k = 2\pi/\lambda$ **follows** $k^2 = 4\pi^2 p^2/h^2$.

The last two relationships together yield $k^2 = (4\pi^2 2m(E - V))/h^2$.

Inserting $k^2$ into the wave equation (2) (with replacement of $\Phi \to \psi$), immediately results the important **time-in**dependent **Schrödinger** equation – where '**as**' stands for atomic system, 'ee' for electrostatic (potential).

$$\nabla^2\psi + \frac{8\pi^2 m}{h^2}(E_{as} - \Phi_{ee})\psi = 0 \tag{3}$$

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[22] Kumar (2009), (12), der Dualitäts-Prinz, S. 186-189 – und: Ein später erotischer Ausbruch, S. 254-255.

[23] Eine der seltenen Ausnahmen ist das Mechanik-Lehrbuch von **Goldstein**, jedoch **nur** die **Auflage von 1972**, siehe Goldstein (1972) (10), 9-8 Wellenmechanik, S. 346-347.

[24] Sommerfeld (1969), (25), Band 2: I. 1.1.11 Das Fundament der Wellenmechanik, S. 5. Gl. (11).

## The solution of the $\psi$-puzzle.

The ground state of the ether, which Schrödinger originally (certainly still 1926) assumed,[25] shall be called $z_0$. Then deviations from $z_0$ cause different scalar potentials $\Phi_i$, whose gradients are called field vectors $F_i$. All $\Phi_i$ can then be represented by the dimensionless space function $0 \leq \psi(x,y,z) \leq 1$ as $\Phi_i = \Phi_0\,\psi$, similarly $F_i$ by $F_i = F_0\,\psi$.

The charge $e$ of electrons causes an electric potential, but if their mass $m$ represents electromagnetic energy,[26] it also represents a charge-related **electric mass potential** $\Phi_{me} = mc^2/e$, increasing the normal zero potential of the ether and enabling "special atomic waves".

With $\Phi_{me}$, equation (3) results the following "**atomic wave equation**":

$$-\nabla^2(\Phi_{me}\psi) = -\frac{h^2}{8\pi^2 m}\nabla^2\psi = (E_{as} - \Phi_{ee})\psi \qquad (4)$$

On the right in (4) is the kinetic energy of the matter waves – i.e. the difference between the total energy of the atomic system $E_{as}$ and the electrostatic potential $\Phi_{ee}$) –, whose amplitude varies in space (especially radially) according to $\psi$.

On the left side of (4) is the negative gradient or force increase which "drives" the **atomic waves** of the ether – in accordance with the **electric mass potential** ($\Phi_{me}\,\psi$) of the **electron mass** $m$ acting in an atom.

The usual electromagnetic energy **density** $e$ does not cause any change anywhere, also not inside atoms. Only the force fields $E$ and $H$ do this according to **Maxwell's equations**.[27] Correspondingly, $e$ ought to be a function of these two fields ($E$ und $H$).

The energy density $e$ of the fields **E and H**, which is significant for electromagnetic waves (e.g. light) – but also that within atoms – can

[25] Schrödinger did not miss the opportunity to refer in his "Heisenberg work"(from March **1926) twice explicitly** to **ether-wave lengths**. See Schrödinger (1926), (22), *Über das Verhältnis der Heisenberg-Born-Jordanschen Quantenmechanik zu der meinen* – Schlussteil der Abhandlung, S. 755-756.

[26] Feynman considered an inverse possibility, see Feynman (1972), (8), **3. Band**, 28.3 **Elektromagnetische** Masse, S. 520-521.

[27] Equations (25) und (26) on the following page 14 show one of the possible representations.

(and often is) represented, taking into account the relations $D = \varepsilon_0 E$ and $B = \mu_0 H$, by the two vectors **E and H**, as follows:[28]

$$e = \frac{1}{2}(ED + HB) = \tag{5}$$

$$= \left(\sqrt{\frac{\varepsilon_0}{2}}E\right)^2 + \left(\sqrt{\frac{\mu_0}{2}}H\right)^2 = \frac{\varepsilon_0}{2}E^2 + \frac{\mu_0}{2}H^2 \tag{6}$$

Since the two vectorial fields $\vec{E}$ and $\vec{H}$ (according to Maxwell's equations) are strictly **perpendicular to each other**, the overall state of an electromagnetic field can also be represented by combining the two field variables $E$ and $H$ into a **single complex-valued** field variable $\psi(E, H)$ – (**attention**!) with an "**unreal** complex" **physical** unit:

$$\psi = \left(\sqrt{\frac{\varepsilon_0}{2}}\,E + i\sqrt{\frac{\mu_0}{2}}\,H\right) / \sqrt{\Phi_{me}} \tag{7}$$

The conjugate-complex product (resp. square) $\psi^*\psi$ (for $\psi^2$) then gives for the energy density $e(E, H)$ of the ether – now again with **correct** and real **physical** unit [E/Q]):[29]

$$e = \Phi_{me}(\psi\psi^*) = \Phi_{me}\,\psi^*\psi = \tag{8}$$

$$= \left(\sqrt{\frac{\varepsilon_0}{2}}\,E + i\sqrt{\frac{\mu_0}{2}}\,H\right)\left(\sqrt{\frac{\varepsilon_0}{2}}\,E - i\sqrt{\frac{\mu_0}{2}}\,H\right) \tag{9}$$

$$= \left(\sqrt{\frac{\varepsilon_0}{2}}E\right)^2 + \left(\sqrt{\frac{\mu_0}{2}}H\right)^2 = \frac{\varepsilon_0}{2}E^2 + \frac{\mu_0}{2}H^2. \tag{10}$$

According to **exactly this mathematical method** of conjugated complex multiplication[30] – referring to the wave function of Schrödinger $\psi(r, t)$ –

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[28] Meschede (2010), (14), 8.4.4 Energiedichte und Energieströmung, S. 448 – Erste (nicht nummerierte) Gleichung für $e$. – Unter Bezugnahme auf Gl. (7.36) oder (7.54) auf S. 334 bzw. 338 und Gl. (8.12), S. 400.

[29] Meschede (2010), (14), 8.4.4 Die Energiedichte, S. 448.

[30] Meschede (2010), (14), 14.6 Grundzüge der Quantenmechanik, siehe dort bezüglich Matrizen, Vektoren und Operatoren, S. 698.

the so-called **probability density** $P(r,t) = \psi^*\psi = |\psi(r,t)|^2$ is defined and calculated.[31]

This **perfect analogy** of the calculation method, as well as the equality of the results for $e$ shown in (6) und (10), leads to the following **conjecture**:

Schrödinger's wave function $\psi$ can **not only** be interpreted "exclusively" as the probability amplitude[32] $\psi$ of a complex-valued probability density $P(\psi)$ of so-called probability waves $P(\psi)$,[33] **but also** – according to (7) and fully in the sense of Schrödinger – as a very **real electromagnetic state** of the omnipresent material **ether**, which is elegantly represented in form of a single **complex-value**d variable $\psi(x,y,z,t)$ – representing an "**energy distribution factor**", normalised to 1.[34]

Now it could be argued that the complex-valued combination of two field strengths of fundamentally different nature is inadmissible, because this would "lump apples and pears"together – whereby the latter is actually true. In this respect, however, it should be noted that the sign (+ or -) of complex-valued numbers **does not** mean **addition or subtraction**, but is merely intended to represent the fact of combined or **joint action**, in this case with respect to the **acting energy** of an **electromagnetic** field.

What really matters in the context of Schrödinger's wave mechanics of **matter waves** is **the energy** acting in electromagnetic fields, which is simply given, completely "legal" and correct – as shown above –, by the usual conjugate complex multiplication of Schrödinger's complex-valued wave function $\psi$.

This fact means among others: The matter waves postulated by de Broglie, which shortly afterwards were also theoretically explained by

[31] In this sense $P(r,t)$ is the probability of finding an electron or other particle at the locationis the probability of finding an electron or other particle at the location $t$ at Ort $r$. See Meschede (2010), (14),15.2.2 Schrödinger-Gleichung für das Wasserstoffatom, S. 719, und auch 15.6 Wie strahlen Atome, S. 740-742.

[32] Meschede (2010), (14), 15.2.2 Schrödinger-Gleichung für das Wasserstoffatom, S. 719, eine Gleichung vor (15.8): $\psi$ als Amplitude elektronischer Wahrscheinlichkeitsverteilung.

[33] For reasons of experimental experience, it is impossible to dispute the so-called Copenhagen interpretation according to Max Born, which is currently the only accepted one – it is even indispensable for experimental physics.

[34] This is, in short, exactly what the "psi-Thesis" (on page 2) says.

Schrödinger, are **scalar energy waves** with properties completely different from the vectorial electromagnetic waves. The equations of Maxwell resp. Schrödinger describe two different fields (of the ether) – roughly comparable with speed- and temperature-fields of any gas.

This essential difference between the two states (of the ether) just considered, is clearly shown by the fact that, Schrödinger's "wave packets" – unlike electromagnetic waves, which is often regretted – dissolve rapidly and are thus inconsistent. The cause of this kind of behaviour is simple:

Schrödingers more general, time-**dependent** wave-equation[35], describes the equalisation process of differing energy states (of the ether) and therefore is of a mathematical form similar the general diffusion-equation (for gases and liquids).[36]

Also within atoms electromagnetic fields waves of different material density in form of small vibrations (of ether) do exist, similar to sound vibrations of common substances. The accumulations of increased material density (of the material ether), which vibrations always produce, can be interpreted as masses, quite in line with Einstein's idea of matter. Einstein distinguished matter and fields as follows:

> **Matter is** where **much energy** is **concentrated**;
> a field is where there is little energy.[37]

Actually – in accordance with Einstein's so-called energy-**mass** equivalence **E = mc2** – Einstein should have said:[38]

**Mass is** where there is **much energy** – because the matter of the omnipresent ether medium is not only the base of all fields, **but also** the base of **all masses**.

This possibility of confusion is a consequence of the currently common refusal of authoritative physicists to accept or acknowledge the existence of a material ether medium, so that even famous physicists – also e.g.

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[35] Meschede (2010), (14), 15.6.1 Atomare Antennen, S. 743, Gl. (15.47).

[36] Meschede (2010), (14), 6.5.5. Diffusion in Gasen und Lösungen, S. 278, Gl. (6.49).

[37] Infeld (1969), (11), Feld un Materie, S. 223.

[38] Meschede (2010), (14), 13.8.2 Der 4-Impuls, S. 649, nach Gl. (13.34), siehe auch S. 617 unten.

Einstein and Heisenberg – often "lump together" the two actually very different terms **mass** and **matter**, leading to general confusion.[39]

## The hardly known „Maxwell-Dirac-Analogy".

The Dirac equation represents a significant improvement of the Schrödinger equation.[40] However, in standard textbooks of physics this theoretically very important equation only in exceptional cases is assigned a similarly high significance as the world-famous equation of Schrödinger.[41]

Therefore, a brief formal overview of the Dirac equation will be given here, also showing a following surprising fact: The **Dirac-equation** with $m = 0$, i.e. for an atom without electron, represents nothing else but an alternative formulation of **Maxwell's equations** for the "empty space" – respectively the empty **ether**.

## The "original" Dirac equation.

Dirac chose the following mathematically very elegant and compact formulation for his relativistic wave equation of quantum mechanics:[42]

$$[p_0 + \rho_1(\sigma, p) + \rho_3 mc]\,\psi = 0. \tag{11}$$

The usual quantum mechanical operator definitions for momentum $p$ and energy $W$ ($W \equiv p_0$) were used (in the spatial representation).

$$p = -i\hbar\frac{\partial}{\partial x} \quad \text{and} \quad W = i\hbar\frac{\partial}{\partial t}, \quad \text{with} \quad \hbar = \frac{h}{2\pi} \tag{12}$$

[39] See Mutschler (2002), (17), 3.4 Der Begriff der Materie, S. 108-110 – Here, among other things, the fact is regretted that, physics does not know, or more precisely **physicists do not know**, what matter is. The philosopher Stegmüller called this the "staircase **joke" of the 20th century**. Schrödinger, Debye and other famous physicists wrote long treatises on the topic "What is matter? – but a conclusive answer to this question is still missing. See e.g. Schrödinger (1953), (24), 8. Conclusions, p. 145.

[40] Explained in detail in the great Monography of Sommerfeld (1969), (25), Band 2: 4. Kapitel, Die Diracsche Theorie des Elektrons, S. 209-341 – 42 pages just on the Dirac Equation.

[41] A typical example is the 1100-page compendium **Meschede** (2010), (14), Dircs euqtion is only mentioned twice: 4.5.2 Klein-Gordon-Gleichung, S. 183 – und 15.4.3 Feinstruktur im Einelektronen-Atom, S. 732.

[42] Dirac (1928), (5), § 2.The Hamiltonian for No Field, S. 615, – Gl. (9)

Thus, this relativistic wave equation (11) for an electron with rest mass $m_0$ reads – somewhat less compactly expressed:[43]

$$\frac{h}{2\pi i}\left\{a_1\frac{\partial\Psi}{\partial x}+a_2\frac{\partial\Psi}{\partial y}+a_3\frac{\partial\Psi}{\partial z}-\frac{1}{c}\frac{\partial\Psi}{\partial t}\right\}+m_0c\;a_4\Psi=0, \qquad (13)$$

The four expressions $a_1 \ldots a_4$ mean the four-row Dirac matrices shown immediately below.[44]

$$\begin{pmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix};\begin{pmatrix} 0 & 0 & 0 & -i \\ 0 & 0 & +i & 0 \\ 0 & -i & 0 & 0 \\ +i & 0 & 0 & 0 \end{pmatrix}; \qquad (14)$$

$$\begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{pmatrix};\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix}. \qquad (15)$$

These four-row matrices (14) and (15) are complex-valued and were first derived by Dirac based on sophisticated mathematical considerations from the following three two-row spin variables $\sigma_1$, $\sigma_2$ und $\sigma_3$.[45]

$$\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} \text{ und } \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \qquad (16)$$

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[43] Schaefer (1937), (19) Relativist. Verallgem. d. Wellenmechanik: Diracsche Theorie, S. 451, Gl. (17)

[44] Schaefer (1937), (19) Relativist. Verallgem. d. Wellenmechanik: Diracsche Theorie, S. 451, Gl. (16)

[45] Dirac (1928), (5), Introduction S. 610 und § 2.The Hamiltonian for No Field, S. 613 resp. Equ. (7[-1]) — Dirac was very familiar with these Spin or Pauli matrices – as they are usually called today – because he himself had introduced them together with Pauli on the occasion of a discussion held in Copenhagen in early 1927 in order to be able to describe the three components of the angular momentum or spin of electrons. Pauli carried out this project immediately afterwards in a non-relativistic theory, Dirac, however, only a little later, but then within the framework of his relativistic quantum theory. – See Dirac (1972), (4), Recollections of an Exiting Era, S. 138

**The *empty* Dirac equation.**

If in Dirac's equation of the form (13) the parameter $m_0 = 0$ is set, i.e. the Dirac equation without electron is considered, the **empty Dirac equation** results.

Because the four Dirac matrices (14) and (15) each have four rows and are of complex-valued type, the Dirac equation (13) represents a system of four complex-valued equations for four complex-valued components $\Psi_1 \ldots \Psi_4$ of a complex wave vector (resp. spinor) $\mathbf{\Psi}$.

Accordingly (because of $m_0 = 0$), the "empty" system of equations Dirac's reads (fully expressed):[46]

$$-\frac{1}{c}\frac{\partial\Psi_1}{\partial t} + \frac{\partial\Psi_4}{\partial x} - i\frac{\partial\Psi_4}{\partial x} + \frac{\partial\Psi_3}{\partial z} = 0, \tag{17}$$

$$-\frac{1}{c}\frac{\partial\Psi_2}{\partial t} + \frac{\partial\Psi_3}{\partial x} + i\frac{\partial\Psi_3}{\partial x} - \frac{\partial\Psi_4}{\partial z} = 0, \tag{18}$$

$$-\frac{1}{c}\frac{\partial\Psi_3}{\partial t} + \frac{\partial\Psi_2}{\partial x} - i\frac{\partial\Psi_2}{\partial x} + \frac{\partial\Psi_1}{\partial z} = 0, \tag{19}$$

$$-\frac{1}{c}\frac{\partial\Psi_4}{\partial t} + \frac{\partial\Psi_1}{\partial x} + i\frac{\partial\Psi_1}{\partial x} - \frac{\partial\Psi_2}{\partial z} = 0. \tag{20}$$

These four complex-valued equations are – which may surprise some physicists – nothing else than Maxwell's equations in a strange guise.

This becomes apparent after a short calculation, as the four components $\Psi_1 \ldots \Psi_4$ are replaced by the following complex expressions:[47]

$$\mathbf{\Psi}_1 = i\,(\mathbf{E}_z) \qquad \mathbf{\Psi}_3 = \;(\mathbf{H}_z) \tag{21}$$

$$\mathbf{\Psi}_2 = i\,(\mathbf{E}_x + i\mathbf{E}_y) \qquad \mathbf{\Psi}_4 = \;(\mathbf{H}_x + i\mathbf{H}_y) \tag{22}$$

When the substitutions (21) und (22) are applied to (17) und (18), they

[46] Schaefer (1937), (19)Relativist. Verallgem. d. Wellenmechanik: Diracsche Theorie, S. 455, Gl. (30).

[47] Schaefer (1937), (19)Relativist. Verallgem. d. Wellenmechanik: Diracsche Theorie, S. 456 Gl. (31)

are transformed to the following relationships:[48]

$$-i\frac{1}{c}\frac{\partial E_z}{\partial t}+\left(\frac{\partial H_x}{\partial x}+i\frac{\partial H_y}{\partial x}\right)-$$
$$-i\left(\frac{\partial H_x}{\partial y}+i\frac{\partial H_y}{\partial y}\right)+\frac{\partial H_z}{\partial z}=0 \tag{23}$$

und

$$\left(-i\frac{1}{c}\frac{\partial E_x}{\partial t}+\frac{1}{c}\frac{\partial E_y}{\partial t}\right)+$$
$$+\left(\frac{\partial H_z}{\partial x}+i\frac{\partial H_z}{\partial y}\right)-\left(\frac{\partial H_x}{\partial z}+i\frac{\partial H_y}{\partial z}\right)=0 \tag{24}$$

After separation of the real and imaginary components of the two complex-valued equations (23) and (24), the following four real-valued relationships, known to every physicist, become apparent:[49]

$$\frac{\partial H_x}{\partial x}+\frac{\partial H_y}{\partial y}+\frac{\partial H_z}{\partial z}=0;\quad \frac{1}{c}\frac{\partial E_x}{\partial t}=\left(\frac{\partial H_z}{\partial y}-\frac{\partial H_y}{\partial z}\right)$$

und

$$\frac{1}{c}\frac{\partial E_y}{\partial t}=\left(\frac{\partial H_x}{\partial z}-\frac{\partial H_z}{\partial x}\right);\quad \frac{1}{c}\frac{\partial E_z}{\partial t}=\left(\frac{\partial H_z}{\partial x}-\frac{\partial H_y}{\partial z}\right)$$

After applying the same substitutions (21) and (22) to the two equations (19) and (20) using the same procedure, the then resulting two equations, together with (23) und (24) result in the known four Maxwell equations for empty space (i.e. without the presence of electrically charged bodies.) In short: The complete set of empty Maxwell equations is obtained. Those equations are, in a notation that is commonly used today:

$$\operatorname{div}\boldsymbol{E}=0;\qquad \operatorname{div}\boldsymbol{H}=0 \tag{25}$$
$$\frac{1}{c}\frac{\partial \boldsymbol{E}}{\partial t}=-\operatorname{rot}\boldsymbol{H};\qquad \frac{1}{c}\frac{\partial \boldsymbol{H}}{\partial t}=\operatorname{rot}\boldsymbol{E} \tag{26}$$

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48 Schaefer (1937), (19)Relativist. Verallgem. d. Wellenmechanik: Diracsche Theorie, S. 456 Gl. (31a)

49 Schaefer (1937), (19)Relativist. Verallgem. d. Wellenmechanik: Diracsche Theorie, S. 456 Gl. (31b)

This highly significant physical fact is **not** a novelty. It has been documented in the German physics literature (at least) since 1937 in a formerly well-known (and here already repeatedly cited) textbook on theoretical physics by Schaefer. However, a detailed footnote there expressly warns against overestimating this result.[50]

The first hint to such an analogy was already given by **Darwin only two months** after Dirac presented his famous equation.[51]

Also in today's literature this important intrinsic connection between **quantum mechanical and electromagnetic** waves is still mentioned, but extremely rarely.[52]

**The ominous complexity in physics.**

Imaginary numbers have even been called magic and supernatural. But actually they are simply a consequence of $(+1)(+1) = (-1)(-1) = +1$, so that $\sqrt{-1} = \sqrt{+1}$ should be true, which is impossible.

So, in order to be able to operate mathematically "logically"with roots, the root of $-1$ had to be assigned a number $i$ with "special meaning".

The use of $i$ provides an additional, **purely mathematical** dimension – **without** any **physical** meaning or significance.[53] Therefore, the expression $\sqrt{-1}$ can be assigned many **different** meanings – **without** explicitly **naming** them. The **only** required **condition** is:

The real and the imaginary part of complex-valued numbers must stand **at right angle** (in space) **to each other**. In Schrödinger's $\psi$ it is $E$ and $H$, who stand normal, but in Dirac's case it is the **spatial components** of $E$ and $H$ , which stand at right angle to each other.[54]

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[50] Schaefer (1937), (19) Relativistische Verallgemeinerung der Wellenmechanik: **Diracsche Theorie**, S. 456, **Fussnote** 1.

[51] **Darwin (April 1928)**, (3), The electromagnetic analogy, p. 658

[52] One example found was in **Sakurai** (1967), (18), **Derivation of the Dirac equation**, S. 80, Two-component Neutrino, S. 169, Eq. (3.465) / footnote ++

[53] Siehe z.B. Taschenbuch der Mathematik von Bronsten et al, Verlag Harri Deutsch, 7. Auflage 2008: 1.5 Komplexe Zahlen, S. 35.

[54] The **Schrödinger** equation concerns **one** scalar **energy**, whereas the **Dirac** equation concerns **six** vectorial **momentums**.

**Conclusion**:

The Dirac equation was created by **complex-valued decomposition** of the **Schrödinger** equation.

A **corresponding** decomposition of Schrödinger's **wave function** $\psi$, into a real and an imaginary part, makes it possible to interpret the conjugate complex "**square of** $\psi$" as a **scalar energy** state. This fact then allows an explanation of the experimentally proven **atomic waves** and the still very mysterious **matter waves** of Schrödinger described by $\psi$:

**Schrödinger's matter waves** are:
longitudinal **scalar waves** of **electromagnetic energy**,
of the ever omnipresent **material medium**,
called **ether**.

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The author would like to thank **Ruggero Santilli** for the many very **inspiring** discussions and suggestions in about **twenty** years.

* * *

# APPENDIX:

**Seven comments by the referee.**

In this Appendix, the author would like to outline the following **seven aspects** indicated by the referee **during the submission** of this paper. Their presentation in an appendix, rather than via revision of the paper itself, was suggested by the referee him/herself.

**1. Santilli's early concept (1956).**

The first paper written by R. M. Santilli in 1956 (see Rf. [27] and its review at the beginning of Chapter 3 of Ref. [34]), was devoted to the existence of the **ether** as a **universal substratum** for the creation and propagation of **electromagnetic** waves.

As established experimentally, **electromagnetic** waves are "**transversal** waves" (in the sense that the oscillations are perpendicular to the direction of propagation) and, according to Santilli, that feature is only possible if the **ether** has characteristics similar to a form of "**rigidity**,"hence the title of paper [27]: «Perchè lo spazio è rigido» ("Why space is rigid").

This point is important for the analysis presented in this paper because scalar waves may one day prove to be **superluminal** that, in turn, is **only** possible for **longitudinal** waves (with oscillations parallel to the direction of propagation) that, in turn, is only possible for a "rigid" ether, otherwise **scalar** waves **would be** conventional electromagnetic waves.

## 2. No "etheral wind".

Santilli published paper [27] for the primary intent of **dismissing** the old criticism of the ether as a universal substratum given by the "ethereal wind".

From the quantum law $E = h\nu$, the electron is an "oscillation" with $0.829 \ 10^{20} \ Hz$, but of a **point** of the **ether**, and **not** of a "**little mass**" (inside the electron).

This **eliminates** the **ethereal wind**, because the motion of an electron implies **no motion** of any **mass**. What in reality happens is a motion of the structural oscillations from one point of the ether to others. The same holds for all elementary particles and, therefore, for matter.

According to Santilli [27], **inertia** is the **resiliency** by the **ether** against changes of motion.

It appears that this second point is significant for the paper because nobody will accept the ether as a universal substratum unless the ethereal wind is dismissed.

## 3. World creation by oscillation.

Santilli also points out in paper [27] (as well as in subsequent works, see review [34]) the thought provoking consequence of the above view to the effect that "**space** is completely **filled** up by the **ether**", while "**matter** is completely **empty**", to such an extent that, in the event "time could be stopped" (i.e. no oscillationsions), the entire universe would disappear.

## 4. No privileged reference frame.

The **ether** as a universal substratum is additionally dismissed on grounds that, the existence of a universal substratum would imply the existence of a **privileged** reference **frame** with consequential violation of special relativity.

By contrast, Santilli points out in [27] and [34]: A universal substratum implies no violation whatsoever of special relativity, because one would **never** be able to ascertain **theoretically** and **experimentally**, weather a mass is **at rest** with the universal substratum – with the consequential lack of existence of a privileged reference frame.

## 5. The beginning end of incompleteness.

The referee also suggested the quotation of Einstein's claim in [28] of the "lack of completeness" of **quantum** mechanics according to the (**probabilistic**) Copenhagen interpretation, because the above shown paper in fact presents a form of "completion" of **quantum** mechanical **waves**.

## 6. "Quantum waves" and the Hamiltonian.

Another general criticism of the **ether** as a universal substratum is that it is "**external**" (in the sense of being outside) of our world (of classical "**mass-points**"). Mathematically this means that, the ether **cannot** be represented with the **Hamiltonian** in the Schrödinger equation $H(r,p)\psi(t,r) = E\psi(t,r)$ since the Hamiltonian can only represent matter.

Santilli's confirmation of Einstein's criticisms of quantum mechanics [29] [30], including the "**completion**" of quantum mechanics into the covering **hadronic** mechanics [31] [32] [33], have been conceived to **represent the ether** via the **isotopic** element T in the **Schroedinger-Santilli isoequation**

$$H(r,p) \,.\, T(\psi,...) \,.\, \psi(t.r) = E\ \psi(t,r).$$

## 7. Interaction by "isotopic ether mechanics".

The last point mentioned by the referee is the indication that, the interactions characterized by the **isotopic** element $T$ (outlined just above) carry **no potential energy** that, in turn, can only be interactions between **matter** (oscillations) and the **ether**.

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