Quantum Physics & the Mind

About the previous 2022 book 'Quantum Physics is NOT Weird':

"Paul van Leeuwen's book Quantum Physics is NOT Weird is a wonderful, very readable book that will convince thousands upon thousands of serious readers, including students of science, why consciousness is necessary to understand quantum physics and why materialist science is not adequate. I give the book my highest recommendation. This book will also give the inquisitive reader an introduction to the aborning quantum science of consciousness."

— Amit Goswami, PhD, author of The Self-Aware Universe, The Everything Answer Book, and with Valentina Onisor, The Quantum Brain

The monumental book of Paul van Leeuwen on "Quantum Physics is Not Weird", by title, is a masterpiece in disguise. Of course, Quantum Physics is not easy to digest and even weirder than we sometimes can imagine. Yet, this book should be praised due to its transparent treatment and related educational illustrations, that highly facilitate the mastering of the intriguing contents. Many of the 15 chapters, in a critical manner, treat the historical experiments that supported the very creation of this crucial field in physics, that evidently represents the best theory we currently have for understanding the fabric of reality. The cunning explanations also include the dangers of misinterpretation of such studies, clearly exhibiting the professional insights of the writer. An aspect of reader self-control is integrated by ending each subject with "What did we learn from this Chapter". The chapters, may here and there, require re-reading and re-thinking, but ultimately will make sense not only to more experienced scientists, but also for students and interested laymen. By all this, the book almost offers a crash-course into proper scientific thinking, and it reminded me of the famous book of Fritjof Capra on "the Tao of Physics" of about 50 years ago, that became a classic in academic education. Conclusion: the book of Paul van Leeuwen is unique through its superb writing and educational strength and is highly recommended for a broad circle of readers. As a result of their rewarding study efforts, they will see the world in an entirely different perspective, since the writer is not afraid to finally touch upon the implications for Near Death Experiences and other Psi phenomena.

— EM Prof. dr. Dirk K.F Meijer, University of Groningen, The Netherlands

Quantum Physics & the Mind

A Crash Course

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I. Preface

“To know that we know what we know, and to know that we do not know what we do not know, that is true knowledge.”

Nicolaus Copernicus

“To know, is to know that you know nothing. That is the meaning of true knowledge.”

Socrates

My first book on quantum physics and the mind – “Quantum Physics is NOT Weird” – was aimed at physics students and laymen with a good understanding of physics principles. There is a lot of confusion in the world, and especially on the internet, regarding the meaning of quantum physics. This book is meant for the more spiritually engaged curious persons who would like to understand the message that quantum physics has for us, that consciousness is primary, that the there-is-only-matter stance does not work anymore and hampers us severely in understanding our being in the world. For those people the message of quantum physics will give them ample arguments to explain their position. I have avoided as much as possible the cryptic language physicists use to explain their work.

A great part of this book consists of a thematically ordered selection of my essays on quantum physics and the mind, which were published on my website in the years 2020 to 2023. After having finished the crash course chapter you should be able to read them with enough understanding and in any order and time you like.

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III. Introduction

I think we are only at the beginning of science. We are at the beginning of studying the complexity of Nature. The classics universe was a simple, quiet universe. And now we see, we only conceive the extraordinary complexity of nature, like for example the complexity of the gene expression. We still don't understand completely the structure of the gene. Yet I don't think that once we understand the structure of the gene we shall see the meaning of man, because the genetic content of a mouse and a man are very similar. Therefore, the non-genetic part of biology is very important. But we know little about it . . . In addition I would say there is no fundamental science . . . why do we have so many elementary particles? Nobody knows . . . we still don't know the origin of the Universe. The theory of the Big Bang is the most widely accepted theory, but what is the Big Bang?. .. We are at the beginning. I always say that we are at the beginning of a new, not at the end of science.

Ilya Prigogine – Nobel Laureate - 2003

Richard Feynman, a quantum physicist who has made immensely important contributions to quantum mechanics, once said: "*Anyone who thinks he has understood quantum theory has not understood it.*" With this statement he actually blocked any attempt by his students – including himself – to really understand quantum physics in a profound way. Which is very unfortunate and actually the reason that, in the 125 years that this branch of physics has existed, no real progress has been made in the way we understand reality and that the layman – for whom the underlying message of observer dependency is in fact quite important – is thoroughly confused by the reports about quantum physical experiments. He therefore gives up any hope to understand something of quantum physics. Examples of confusing messages are:

- entangled particles that should be instantaneously connected despite their galactic distances,
- real particles that follow **all** possible paths through space and time to their destination,
- particles that are also waves at the same time,
- light waves that are also consisting of particles at the same time,
- particles that didn't exist before measurement,
- and so on.

Well, giving up hope to understand this weird behavior of reality is absolutely unnecessary. Quantum physics has an important – and I think quite understandable – message for those who use their critical mind and are willing to relinquish the – there is only matter and energy – vision on reality and dare to open up to new ideas about reality.

That's not as challenging as it may seem to you. First start is to become aware that many phenomena that are considered as fully understood are only described in a mathematical way, so that we can use this mathematics for accurate predictions. However, being able to make accurate predictions is not the same thing as understanding what you are talking about. Simply said, it is the difference between quantity and quality. To give you an excellent example of holding quantity for quality: you have probably already accepted the idea of oscillating fields of electromagnetic energy as a phenomenon that is nowadays fully understood. It's considered everyday stuff. Light, radio waves, GPS. However, did you ever ask yourself what a field of energy really is? If you really muse a little more on that, it should become clear to you that an electromagnetic field is a purely abstract concept, just a label, for something that we don't understand at all.

Yes, we physicists can do mathematics on EM-fields successfully. But that's quantity, it's not the same as understanding the quality. Yet we apply oscillating electromagnetic fields everywhere, radio, mobile phones, GPS, fMRI, Wi-Fi, laser, etc. We have somehow accepted as an everyday fact that EM forces can reach and act through empty space. But I ask you, do spend a little bit more time thinking about it. How does it do that? What **is** it? Even Einstein had no answer. So anyway, become aware that you took the label for an explanation of a lot of everyday experiences, like taking radio waves for granted when listening to your car radio.

In my opinion, a real explanation for quantum phenomena should not be about quantitative predictions resulting from pure mathematics. First start is to see what is not really explained but just only labeled, such as happened the idea of a field of electromagnetic energy. That's the first step. Next step is to accept as a possibility that there exists something beyond matter and energy that informs and creates our reality at every moment in close collaboration with the contents of your mind. An ubiquitous quantum-field. That's a good start. You will see that quantum phenomena like wave-particle duality, entanglement and observer dependency will become much more understandable. We will see that we will even get a grip on that elusive phenomenon, time.

A thorough analysis of quantum physics experiments and what the conclusions thereof should be, can be found in my first book 'Quantum Physics is NOT Weird'. The crash course you'll find in the next chapter is meant to reach a much wider audience. I'll present you there in a comprehensible language the conclusions and how science arrived to them, without using deep logical analysis of the complex experiments, but be assured that these conclusions of 20th century physics research, like the one that matter doesn't exist until observed, are nonetheless theoretically and experimentally thoroughly founded. I'll summarize the most important conclusions here already. Hold your seats.

- Matter does not exist before it is being observed.
- Before observation reality is a wavelike field of probabilities, or potentialities, that is not bounded in space and time.
- Any observation triggers the universe to make a unique choice from this boundless field of probabilities, so that it becomes instantaneously an object of matter or energy. This is verily creation.
- Observation does not only create matter or energy, but it does so in space and time.
- Space and time are therefore not independent of our observation but are also created by observation.
- The outcome of any experiment is reduced by the information that the experiment can deliver, but also by the information that is already available to us.
- Quantum Physics is not limited to atomic dimensions, it applies to any object of any size. This applies without exception to all above statements.
- If observation creates reality, then the observing mind is very probably necessary to create reality - including history.
- All objects are, already before their creation by observation, independent of their mutual distance in space and time, immaterially instantaneously connected. This is called entanglement.
- If two objects have a common history, which is information, they will be verifiably entangled.

If you tend to dismiss these statements as too weird or too unbelievable, be aware that all of them are scientifically confirmed if not proven facts. Your automatic dismissal comes from a lifelong education (call it brainwashed) in the materialistic view of the universe.

Try to recognize that and postpone your automatic rejection of these facts by staying curious and keeping your mind as open as possible. This will be rewarded by the insight that the universe is not as indifferent to you as you were told, and that mind is the primary stuff of the universe. You were meant to be here.

IV. A Crash Course

What is an electric field? We don't know. If we knew, we would know why field and charge are connected in the particular way in which they are. .. when I was a child people would say ‘Electricity is very mysterious.' Now we say it's not so mysterious, but still nobody knows what electric force really is. We're used to it, that's all, by giving it a name and getting used to handling it ... What is a gravitational potential, what is an electrical potential, what is a quantum potential? You see, you would have to explain all the forces and explain why they act on particles. Now, nobody has done that.'

David Bohm – a privately recorded conversation by Robert Temple.

“Those who are not shocked when they first come across quantum theory cannot possibly have understood it.”

Niels Bohr, Essays 1932-1957 on Atomic Physics and Human Knowledge

Well, according to Niels you are in for a real shock. Really understanding quantum physics, and I’m not referring to its mathematics which is quantum mechanics, will indeed turn your worldview upside down. But that’s not a negative thing, on the contrary.

Sabine and the shaman

From ‘Existential Physics’ [1] by Sabine Hossenfelder:

> “Can I ask you something?” asked a young man when he heard that I was a physicist. “About quantum physics,” he added timidly. I was ready to elaborate on the measurement problem in quantum physics, but I was not prepared for the question that followed:
> “A shaman told me that my grandmother is still alive. **Because of quantum physics**. Only not in the here and now. Is that true?”

Her answer is that the shaman is – in her opinion – **not totally wrong**. That’s remarkable. Sabine is a dedicated reductionistic thinking physicist, albeit with a very critical mind concerning the farfetched wild ideas of a lot of her contemporary colleagues. I can really recommend her book. Reductionism is the idea that everything that exists can be completely described and understood when all its components are completely described and understood. So, how is it possible that a reductionistic thinking physicist considers such an idea to be even not totally wrong? To answer that, we must look at the history of physics, the way physics became the all-important science it is today.

Modern physics starts with Galilei

Galileo Galilei is considered the first modern physicist by most physicists. He stressed the importance of mathematic calculation in studying nature. Mathematics would be the eminent way to study nature and reveal her secrets. Isaac Newton followed in his tracks and developed mechanics, a mathematical tool which became an all-important instrument of physics. Newtonian mechanics is still taught to physics students in the beginning of their study.

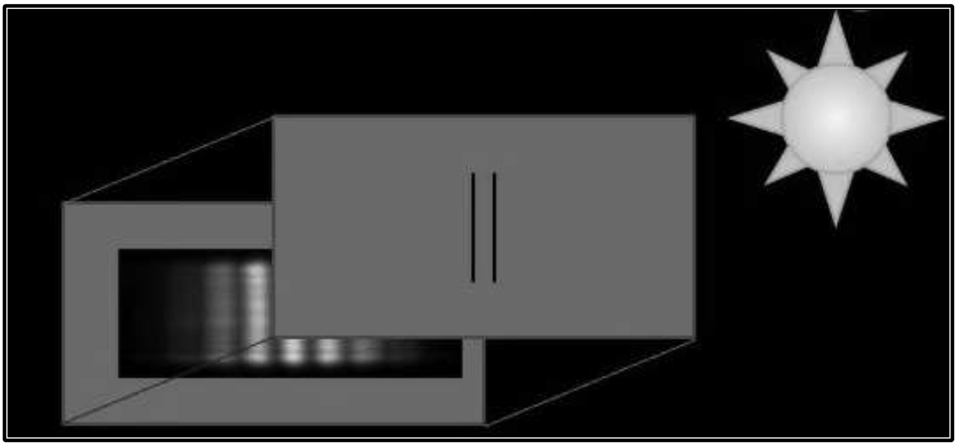
Newton and Wilhelm Leibnitz created – independently of each other - an entirely new and important new branch of mathematics, differential calculation. It was extremely well suited for doing predictions on the behavior of objects that experience forces such as heavenly bodies. Newtonian mechanics was the instrument by which Edmund Halley could successfully predict the day that a comet – now Halley's comet - would reappear in the sky.

By such successes mathematics became the way we meant to understand nature. This is however the root of a confusing misconception that leads us away from a real understanding of nature. Being able to do precise predictions is not the same as understanding. Think of a computer. Newton admitted this partly by acknowledging that he could predict the effects of gravity, but not tell what gravity is. Be aware that gravity is intrinsically a 'magic' phenomenon because it is able to effect distant matter without really touching it. Becoming aware of this magic quality of nature might help you greatly to come to a better understanding of quantum physics. Anyhow, gradually, because we became better and better in our mathematical descriptions of nature's behavior, we lost touch with the 'magic' quality of nature.

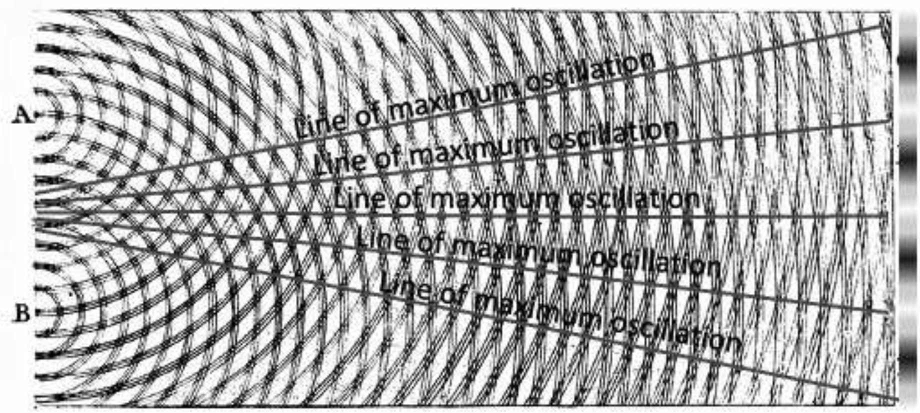
We started to regard more and more our descriptions of nature as nature itself. At the end we confused the map for the territory. Currently some physicists are even taking the position that reality is only a mathematical construction itself. Taking our mathematical descriptions of nature for the real thing is reification, taking abstractions for the real thing. Clear examples of reification are the force fields, such as gravity, electric and magnetic fields, and also the waves that are supposed to propagate in these fields. What is it really that is oscillating there? Nobody knows. Acknowledging your lack of real understanding of such concepts is a good start in this crash course.

Light is a wavy phenomenon

This question of what stuff it was that was oscillating was also one of the arguments expressed against Huygens's wave theory of light that he proposed in 1690. Newton's idea of light as utterly tiny colored particles, corpuscles, was better to visualize. It explained in a visual way how light could travel through vacuum, the utterly (assumed) empty space between the sun and its planets. However, in 1800 Huygens's idea of light as waves was confirmed in an experiment by Thomas Young.



Thomas Young covered a glass plate with soot, drew two parallel scratches in the soot, mounted the glass plate in a box, mounted a sheet of frosted glass at the other end of the box and exposed the scratched glass plate to sunlight. You will perhaps expect that he saw the projection of the two slits on the frosted glass plate. However, he saw a pattern of rainbowlike colored bands instead. The only way to explain these bands – interference fringes - is that light behaves as waves do. Each slit becomes a source of synchronous oscillations from which then two synchronous wavefronts expand. Where these expanding wavefronts meet, they will either extinguish each other - when they wiggle in opposite directions - or they will reinforce each other when they wiggle in the same direction. Young showed that reinforcing and extinguishing locations stretched along certain continuous lines, as you can see in the image below. For a visually real understanding of this wave effect, I recommend the YouTube presentation '*The Original Double Slit Experiment, by Veritasium*' [2].



Thomas Young original drawing of the waves expanding from the two slits.

But the question what it is that is oscillating in light remained unanswered. In 1850 James Clerk Maxwell proved mathematically that oscillating electric and magnetic fields – EM-waves - propagated through vacuum with the speed of light. He also proved that they carry energy. Now I ask you to consider again if a mathematical predictive device is the same as a real understanding of nature. I hope you see that Maxwell's electromagnetic wave correctly described and even predicted the behavior of light, but it didn't explain it in the way of understanding its real magical quality.

So, by more and more advanced mathematics in describing nature the 'magic' quality of light gradually disappeared from our perception of the world and became replaced by mathematical quantitative descriptions. Almost everybody takes electromagnetic waves nowadays for granted. We can send and receive them easily, … but they are not really understood in the way you understand for instance the behavior of a billiard ball. It is fairly easy to create EM-waves, just jiggle some electric charges. When this wave encounters other electric charges, it will jiggle them. This is the way we send and receive radio waves and energy is transported. But we don't know what they are, what their substance is, and how they do what they do.

Since Young's double-slit experiment and Maxwell's confirmation of the electromagnetic wave-behavior of light by his theory, electromagnetic waves are considered to be a substantial part of the material world, **despite nobody ever observed the actual waves**. This will become important because it is the root of the particle-wave confusion that will emerge in the 20th century. Be aware that wave behavior of light is not definite proof of light being actual waves. Wave behavior of water is not proof that water consists of waves. It is proof that water can carry waves. We don't confuse the waves with the water, don't we?

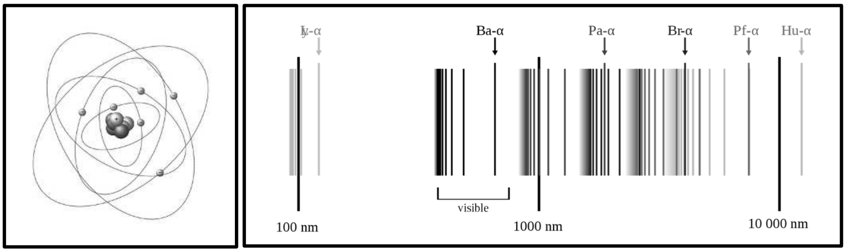
The first quantum physicist

In 1900 a small but essential part of the way how to really understand EM-waves and their propagation was discovered by Max Planck, an unassuming but daring physicist who was stubbornly searching for an explanation of the behavior of glowing hot bodies. His explanation conflicted however in a fundamental way with Maxwell's theory of continuously and spherically expanding waves, diminishing gradually in intensity according to the distance from the source. When you increase the distance to a light source for example tenfold, the perceived intensity will be diminished hundredfold. Planck assumed however the existence of discrete packages of EM-energy that did not diminish with their distance from the source. His assumption collided head-on with the apparent continuity of EM-waves and their diminishing intensity with distance.

Newton's idea of discrete colored particles of light seemed to be back with Planck's particle-like exchanges of EM-energy between oscillating electric charges. Each Planck particle exchanged an energy packet proportional to the frequency of the oscillation of the source, the jiggling charges. Planck called these discrete energy exchanges quanta. Quantum physics was conceived but not born yet. Almost nobody took Planck's idea seriously until Albert Einstein entered the stage and explained the – until then enigmatic - photoelectric effect, using Planck's quanta of EM-energy exchanges. Planck merely thought of quanta as energy exchanges, but Einstein pictured them as particles of light. These soon became known as photons. Quantum physics was born, delivered by Einstein, and Planck the father. But how can a particle of energy also be a wave?

The empty atom

Around 1900 physicists started to investigate the atom, whether it was an indestructible basic component of matter or whether it was composed of still smaller parts. Ernest Rutherford found positive proof that the atom consisted of an utterly tiny positive core surrounded by a rather unsubstantial shell of almost at lightspeed circularly whizzing electrons. The atom turned out to be 99,999999 % empty within its electron shell. The impermeable concreteness of matter was exposed as an illusion. A problem, however, was that Maxwell's theory of EM-waves predicted that these circularly around the core whizzing electrons would almost immediately radiate all their energy away. So, each negative electron would crash almost immediately on the positive core and the atom would collapse to 0,0000001% of its normal size, but with the same mass as before the collapse. Of course, in reality this didn't happen. The stability of the atom was a big question.



Almost empty Rutherford atom (left) and hot hydrogen spectrum (right).

Another nagging question was that hot hydrogen emitted EM-waves with very distinct frequencies instead of a continuous distribution over a range of frequencies. This is called a hydrogen spectrum. A rather simple numerical relation was already discovered between these distinct frequencies. Such a mathematical relation begged of course for an explanation. Both questions were partly 'solved' by a proposal from Niels Bohr. He merged Planck's discrete quanta of energy with Rutherford's atom. Bohr assumed that nature only allowed very distinct energy levels for these circling electrons and that an absolute lowest level of energy existed for these energies.

Jumping of electrons between these distinct levels resulted then in distinct energy changes. These changes were radiated or absorbed as Planck's quanta. According to Planck the distinct energies of these radiated or absorbed quanta corresponded exactly with their frequencies. Bohr's model of the hydrogen atom, combined with Planck's quanta, provided a simple mathematical formula for these frequencies. This resulted precisely in the already found mathematical relation between the frequencies in the hydrogen spectrum. Admirable job, but the next question was obvious. Why did nature allow only these distinct energy levels for the hydrogen electrons?

The electron is also a wavy phenomenon

Some light in this darkness arrived by a seemingly absurd proposal by Louis de Broglie. If waves could be particle-like, could particles also be wavelike? When an electron circling the atom core would also behave like a wave, the head of this wave would meet its own tail. This could only result in a stable standing wave around the core when both meeting ends of the wave fitted precisely, oscillating at the same moment in the same direction. Therefore, only certain orbits with certain discrete energy levels would fit. This would indeed result in a lowest possible energy orbit where only a single wavelength fitted, just like the lowest possible frequency on a piano string. Could this idea be confirmed by experiment? Soon indeed, by a serendipitous experimental discovery, De Broglie's idea was confirmed. Moving electrons behave indeed wave-like. Next question.

What do wave-like electrons do when we send them one by one as single particles - so they can't interfere with each other, - through a double slit? That experiment is done repeatedly and the result, after shooting a sufficient number of electrons, was every time the same pattern of interference fringes that Thomas Young saw. Conclusion: Each electron behaves in some way like a single wave that travels through both slits and that interferes subsequently with itself like waves do. The result of this interference is a pattern of fringes like Thomas Young observed with sunlight, but these fringes are now composed of little dots where the electrons finally did hit the screen. This applies also to photons, to atoms, even to molecules when we send them through a double slit. Each photon, atom or molecule behaves like a single coherent wave that travels through both slits meeting and interfering with itself behind the slits and thus finally producing an interference pattern of fringes.

We do not see the wave itself, never. According to the early quantum physicists, in particular Bohr and Heisenberg, this coherent wave is not material. It's a probability wave.

Erwin Schrödinger found by erotically stimulated inspiration the mathematical expression for this strange electron wave. It could, perhaps unsurprisingly, also be applied to photons. However, his expression does not describe the path that the electron or photon