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Why the light changes direction in entering the water

(This article is about teaching physics)

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Abstract: **Confined Quantum Field Theory, gives a simpler and at the same time stronger formulation of the elements of physics. Therefore it suggests that we give to the students already from the beginning the simple formulation that comes from this basic theory.**

A short introduction;

Because of the nature of this article I need to be more informal and refer to my private experiences during the developing "**Confined Quantum Field Theory**". This is justified since objects and examples always possess local and global aspects. Of course this article is concerned about educating physics, but we cannot avoid touching those fundamental problems we are encountering in science which naturally is the global or universal aspects of this article.

Last night my daughter asked me to explain to her in simple words "why the light changes direction when entering the water", without complicating the explanation with index here and index there.

I answered; think of the photons or elements of light as balls.

The wave is not fundamental in physics;

In fact waves in physics are not so fundamental. The reason that wave behavior has such a great impact on the physicist mind is the following; mostly we detect elements such as photons in form of light and charge particle let say some electron after its collision with our sensor which is an electronic devise or simply our eyes. The energy of the photon for example absorbs by the electrons in the surface of the electronic devise and causes these electrons to vibrate and in turn creates some waves due to the correlations between electrons. This correlation is possible because electrons are charged particles and interact with each other. In the case when the photon collides with cells in our eyes or photo films, its energy directly absorbs in form of chemical reaction. Therefore before these collisions we do not have a direct documentation about how a photon may look like. To give a picture of photon before collision we must rely on more fundamental roles in physics. There we go to the energy conservation principle which is the strongest principle. These suggest that photon poses energy before collision exact the same amount that it delivers the sensor. This may be no surprise but we must go deeper and question what energy is.

Energy is related to the symmetry of the space time. Most of the physicist agrees about it. But in fact energy is the broken symmetry of the space time. This is therefore that for symmetry to be physical must be broken (Empty flat space has no energy.). Therefore energy must be some type of curvature in the space time. The other fact about element of the nature as photon is that we cannot divide a photon. We cannot in some process just take some part of energy of the photon. We must take the whole photon or let it goes. This suggests that a photon is a package of energy or in advance mathematical language bounded connected manifold. Ultimately these fundamental analyses bring us to the conclusion that photon and in general all fundamental elements in nature are bounded connected manifolds with a metric related to the energy density(Remember that we said energy is the broken symmetry of space time, more change of the metric from the flat space time …more energy density.).

*In "**Confined Quantum Field Theory**" we say that all fundamental elements in nature are bounded manifolds with metric of the manifold represent the energy density and the topology represents the type of particle.*

Therefore think of the photons or elements of light as balls. This is more correct and simpler.

What happens when a photon inter the water?

At the moment a ball enters the water part of it is inside the water and part of it outside the water. The part that is inside the water experiences different forces than the part outside the water. This is the reason why it changes its direction. It is like when you brake in a car. If the car brakes only work, let say, on the left wheels it changes the direction of the car. She was convinced. Then came the discussion why sometimes teachers have difficulties explaining some problems in physics.It is customary to say, if the teachers themselves understand the problem well in physics, they can explain it to the students in a way that they can understand.Or equally it is said that we can claim that we understand the basic of physics if we explain it to our kids and they understand it too.These statements are partially true. However this is not the whole truth.

In this example I used objects like balls and cars, both of them exist in the student's world, and may they have some experience of a car changing direction because of bad brakes. The teachers on the other side have another background. They have taught themselves that the light is a wave and they themselves have difficulties to see it as a boll. Who is right?

One lives and sees a limited part of the world with roles they learn about and the behavior of balls and cars.The other has a wider world and learned that light behaves like waves with different frequencies and will explain the phenomena by using waves and frequencies.

Is the teacher always right? Is the student always right?It is not always so simple.

Let go deeper into the question - How do we know that light is waves?

The immediate answer is the Young's interference experiment. The teacher's loyalty is to the Young's experiment but the kid's loyalty is to the ball.

Physicists once did the interference experiment and established some universal law and no matter what happens later then, they want to explain the world in this way and when they come in to conflict with the world of the student that still does not have the same loyalty, they want to push the student to accept the picture.

The problem goes deeper

In the same conviction Feynman did the single photon experiment.Since there is two slit in Young's experiment, the single photon must choose one of the slits and therefore we should not have interference. But experiment showed that there is interference and Feynman concluded that photon is in two places at the same time. This leads to a conflict with the world of poor student and with many other people's experience of real life.

Such a conflict between universal laws and local experience is in fact one of the basic motors developing science. This is valid also about the development of "Confined Quantum Field Theory" that we later take a closer look.

The loyalty to this universal law with time becomes stronger and stronger. On the other hand it was another loyalty towards the theory of relativity that there is a universal speed limit and that is the speed of light, which apparently is in conflict with the possibility of physical object being present in two places at the same time. However, let's go back to the poor student.

The student must accept that an object can be at two places at the same time. Where the student asks himself how do they measure the velocity of an object that can be at two places at the same time? This is how the conflict between the student and the teacher is often like.The teachers have learned a lot and took some conclusion explaining theirs world and reluctant to change it. In this case the student, at least in the beginning must follow the teachers trace and does not have the capacity to make own conclusions. Since we all live locally, too much conflict between general roles and local experiences causes questioning the general roles.

Let's answer some of these questions

What really happens in Young's experiment?Does light affect the light? Can we change the direction of light by using other light? Where ever we are, lights go from one point to another point and crossing the path of other light. If they could affect one another paths how comes that we always have a clear picture of our surrounding?

To solve this conflict we must think twice. I will give some hints to help us to proceed in a better direction.First of all we must recognize that we never register the light directly. Our eyes, cameras, detection apparatus or whatever it is not direct. In the process there are always electrons or charged particles involved. In another words, we cannot conserve the light or change its direction without help of electrons or charged particles.Therefore in the study of Young's experiment we must ask ourselves.
Is what we see in Young's experiment the interaction of light with light? Or is it the effect of light on electrons in the slits? I know that it is difficult for people to digest such types of questions. It is a giant effort to change the picture that people have about physics and lived with it for about a hundred years.It is about ten years ago I introduced "Confined Quantum Field Theory".

Of course I have received some recognition in some places but it is far away from what it should be.But is it necessary to change people's mind? Sometimes ask myself why I don't leave it be?Why not just smell the flowers, look at the sky and enjoy life?And let people think that an object can be in two places at the same time.But the life does works not like that. Sooner or later someone comes to you and wants some simple explanation to **why the light changes direction when entering the water**, or more seriously hear this. I hope the reader sees the connection between different part of this article that mainly concern about education in general and education in physics in particular.

For some times ago I was invited by Chinese government to attend AP-SUMMIT (GOS) in Kungmin, China. One of the speakers was Dr. Yuh-HueiShyu.

He talked about a method to extract energy from earth's gravity something that reminds us of the (eternity machine).Of course I could let it be, but two things forced me to engage myself to start a discussion with him.

One was his beginning statement, which was;"In for the global warming the human has two ways to go, distinction or paradigm shift."

Paradigm shift

The main goal of this article is to show the connection of physics education and the fundamental research.In the sense that when a teacher has difficulty in explaining a problem to the students, he must questions its own paradigm.

It does not mean that the student has to throw away whatever the teacher has to teach and go on his own way.What we want to say is that the paradigm shift does not come of itself but is the result of history of science itself. When we or student study the history of a discipline and recognize the strong parts and weak parts, then we are able to establish a new and stronger base.

Let's do a short review of quantum

Lets mention a problem that physics suffers much of it. And that is division of physics into two parts. Classical and quantum. We have only one physics. Please dear physicist, if you cannot solve some problem do not blame that this problem belong to the quantum or classical physics and they are different worlds with different laws.

Question of quantum appeared when people studied the behavior of the electrons in the atoms. The common picture was that electrons move around the nucleus like the earth revolves around the sun.But an electron is a charged particle and going around the nucleus is a type of acceleration and a charged particle in acceleration loses energy, which in turn causes instability in atoms.

This was a legitimate question, but we will see that the answer to this question was not the best.If we go farther back the picture was the following; People saw the electron as a particle and electricity and magnetism as field.

When dealing with charged objects it was practically suitable to see them as amount of charges concentrated in a point. Here the students must recognize what historically was legitimate and what went wrong.

To see a particle as a point is practically accepted but is fundamentally wrong. A mathematical point alone has no physical meaning, has no internal structure and cannot represent an electron.No matter if we say that “that point with some probability can be anywhere”. Of course when we come to this point people see it as a philosophical question without practical significance, which is totally wrong.

We will see if we choose a right basic that is what is done in "Confined Quantum Field Theory" many problems get an easy solution.

A paradigm shift may look like something exotic, fascinating and belong to the philosophical domain. But with the problem we are confronted with at our time is also a question of extinction or survival.

Later we will show that with the ”Confined Quantum Field Theory" that electrons are not point particles but confined field, and from this base very primitive and simple follows that **"Disorder to order transition"** is possible.

Why is that so important? That is important because it is the key to our survival.It is reversing the entropy.In another word bringing back balance to nature is possible.

Some relevant story

As almost everybody knows recently some people claimed that they found some particle moving faster than the velocity of the light.For about eight years ago I was supposed to talk about "Confined Quantum Field Theory" in a conference in France.According to the schedule we were four people to have a speech in some afternoon and each one had 20 minutes.

As you may know it is not popular in a conference to speak longer than your time. But the one before me talked about 40 minutes with the motivation that proving the way that a particle moves faster the velocity of the light.

The basic of "Confined Quantum Field Theory" is just that a particle lives in a limited space. It is just the word *confined* wants to say. It is also in agreement with the theory of relativity that in a limited time a particle cannot be anywhere. One of basic of "Confined Quantum Field Theory" is just that there is a limit to the velocity. If we allow unlimited velocity then we must accept that physical objects emerge from nowhere. This is just the difference between *physics and metaphysics*.

In about three years ago I delivered an article with the title "Complex Science"[Ref1] and also delivered a speech about it at "World Emerging Industries Summit" in China. There I argued in a solid way this fact that there is a limit for the velocity of the physical objects. This is also a strengthening of the theory of relativity and also a door to a simpler and stronger physics.

Why "Confined Quantum Field Theory" simplifies problems in physics

Let us explain this by some example;

Later I attended the AP-SUMMIT (GOS) in Kungmin, China. There in one of the meeting two people from some computer company asked exactly this question. One of the immediate problems they talked about was the heat generated by the computer and why a computer works better when it cools down?

In spite that they were not expert in theoretical physics during half an hour I could explain most of the functions in the language of "Confined Quantum Field Theory" and they understood most of it.

Dear reader, let me explain it to you too, and you judge it for yourself.

Most of the jobs in a computer are done by electrons that move around from one part to the other.These electrons have a size that we call radius of confinement. This radius depends on the energy of the electron. The electron with higher energy is more compressed and have shorter radius of confinement and electrons with lower energy on the contrary has larger radius. On the other hand we have the bulk material; cooper wires, silicon semi-conductors, and so on that the electrons move in. Since these bulks consist of atoms siting together more or less in a periodic way they create a periodic potential or force on these electrons. The size of the area that an electron covers, which we can call it, the quantum area is very important. If this area covers exactly some number of the periods of the bulk we can easily see that the total force that an electron experience is zero. In such cases when the bulks are perfect and clean crystals and there is no heat and impurity, then these electrons (Those with specific radius.) can move practically with no resistance. This is the base of how a computer works and also the base of the phenomena we call super-conductivity.Of course the periodicity and the size of the domain of the electron do not need to be very exact.

I will explain why; we know that when electrons accelerate it loses energy by emitting a photon and can be accelerated by receiving a photon.

In Confined Quantum Field Theory we give a better picture of this process than the standard theories.

In our picture both the electron and the photon (Are bounded manifolds) has their own domain covering some parts of the space. Think of it as two balls. They interact when these two domains comes in contact with each other and have overlap. When electrons accelerate, the process of emitting a photon takes some amount of time before their domain is totally separated. If during this short time the electron de-accelerates it absorbs the same photon again and the electron neither loose nor gains energy.

Whenever the situation is perfect for an electron, “we have perfect periodic potential” electron with adjusted radius of confinement moves without resistance. Until it comes to some area that this periodicity is not valid or the radius of confinement of the electron is not suited for this periodicity.

This can be a defect, impurity or when an electron goes from one material to another material. Different materials have different type of periodicity. This is because simply the distance between the atoms of different material is different and so on.

Therefore it happens something "special", when an electrons goes from one material to another material.This is fundamentally the way that semi-conductors work.When an electron moves in one material with some type of periodicity, it loses and gains energy until achieves that energy corresponding to some covering radius which is some number of periodicity, and then it moves without resistance (in standard physics they call it discrete energy levels of solids). When it enters another material with

another potential periodicity, cannot moves without resistance. It must either gain extra energy or loses some in order to be able to inter the new area. But this extra energy is not always available. Therefore some electrons are reflected. This is the base of how junctions work in electronic devises.

Dear students, this article is mostly for you, there exist a lot of disinformation in teaching the poor students which create lot of confusion and whenever the students need an explanation, those who created these confusions are not around to explain.

One of the repeated questions and confusion is about **"Conservation of energy".**

Conservation of energy is one of the strongest principles of physics.It comes from the symmetry and homogeneity of space-time and as far as we know this would be valid for some billion years and the billion light years distance around us, as far as we do not go to big bang. Don' worry.

There are two places that this confusion arises. One is when people talk about energy crises in the world and needs of energy. The problem is not lack of energy. This is in fact when ordered energy (what we need) goes to disordered energy; we will comes back to this later.

The other is in quantum, which they say that for short amount of time this principle is not valid. This is more the lack of knowledge rather than law of nature. In fact when an electron is accelerated emits a photon. In "Confined Quantum Field Theory" neither electrons nor photons are points, but bounded connected manifold covering some parts of the space. When photon is due to be separated from the electron because of acceleration under a short time their domain have overlap and cannot be considered as the process is accomplished. In fact during this time if electron is de-accelerated the photon will go back to its original position which is the sub-manifold of the electron. One may think due to the fact that electron is accelerated but no photon is emitted, the energy conservation is violated under this short time. But "Confined Quantum Field Theory" says that conservation of energy is not violated.

Let's go back to our discussion about the behavior of semi-conductors and junctions in general.We said that in such a situation the electron exchanges some extra energy. If this extra energy is not available, because the conservation of energy is the strongest principle we know. This electron has no chance other than to go back. This is therefore that at the junctions some electrons are reflected.

Disorder to order transition

One of the greatest challenges of the twenty first century in physics is right here. What is that and why it is so important? In the question of energy crisis we mentioned that the energy is conserved and do not vanish. It goes only from one form to another form. If we put a glass of hot water beside a glass of cold water, some heat goes from the hot water to the cold water until the both glasses reach the same temperature. We call the first situation energy in order form and the second situation energy in disorder form.

Is the reverse possible?That we put two glasses of water with the same temperature beside each other and see if the heat goes from one to the other and one becomes hot and the other cold.

This has been one of the thermodynamics most important principles.But if this principle is so strong, why does our universe not obey this law. After billions of years we should have the same temperature everywhere. So this law is not as strong as some people believe. We are now entering the most exciting part of this article. Order to disorder and disorder to order transition; let's first describes something that is more touchable.

Super conductivity

What is super conductivity? Super conductivity is when there is no electric resistance at all and this happens in very low temperatures.

When an electron moves in a metal, since the atoms of the metal are sitting in the same distance from each other, the electrons feel a periodic force from the atoms. If the space that electron cover is exactly the same to the number of atoms, the force that the electrons feel from atoms part that attract it compensates with those forces that reject it. In this situation when electrons possess exactly the same amount of energy necessary to give it that covering space the total force on electron is zero and it can move in the metal without resistance.

Electrons do not feel only forces from the atoms, but also repulsive forces from the other electrons. In order that individual electron feels periodic force all electrons must move in an order form like marching soldiers.This is in fact our first touchable experience of disorder to order transition.

We are in principle at the end of this article, but I feel that you as the reader are not totally satisfied.How it happens that someone questions something as obvious and basics as Young's experiment and gives itself the right to describe physics. For this category of people lets go back again to Young's experiment and Feynman's single photon experiment.

In Young's experiment we see some interference pattern which obviously comes from some wave. On the other hand it is as obvious that light do not react with light; we cannot change direction of light only by another light or part of light. We must here think about the role of electrons.

If a photon or let say the domain of photon, (which is a connected manifold in advance mathematical language) comes in contact with the domain of an electron or have overlap. The photon which we know is a package of energy absorbs by electron. If electron is bonded some where the extra energy causes the electron to vibrate. This is exactly the source of wave we experience in Young's experiment. This extra energy in form of vibration brings the electron to an unstable state. The construction of atoms is in a way that only some discrete stable states are allowed. Therefore if this extra energy has no place at that atom it is rejected as a secondary photon.

The lights that we observe in the interference pattern are not the original photons, but secondary photons originated by the vibration of the electrons at the slits.

This process, namely absorption of photon and emission, is more common around us than we believe.

In fact when the light or photon travels through the air or water, stay and absorbs, and emitted a short time by each atom in its path. And if the photon possesses the energy that the atom has no empty

available energy level, the photon is emitted as secondary photon but by exactly the same energy and we see no difference. Since the energy is the same.

This is also the reason that the velocity of the light is less in air and water than vacuum.

Summery and conclusion

By taking the simple question in physics that probably most of the students have, "Why light changes direction in entering into water? "We discussed the root of such problems. Meanwhile informed about historical misunderstanding in physics as the reason for problems between the teachers and students in the question of educating physics.

[Ref.1]; Universalities in the Complex Science. Prof. Mohammad Fassihi, Pinnacle Advanced Physics (ISSN:2360-9443)