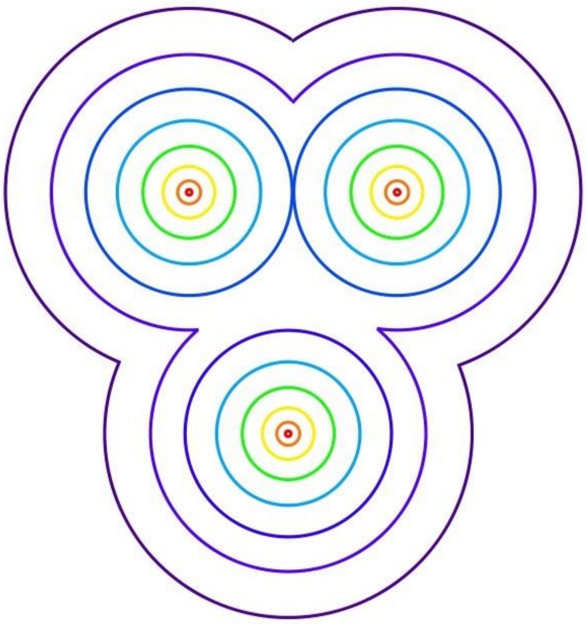
# Solved! Mysteries of Modern Physics



# Introduction

This little summary explores a comprehensive model of the physical Universe which is beginning to have significant practical application.

Previous physics models do not provide a unified model of physical phenomena. There are separate models of nuclear, electromagnetic and gravitational forces, as well as separate models of gravitational and inertial masses. The model exposed here resolves these issues.

The New Physics is not the only model in physics, but it is definitely the only one which has ever covered such a broad domain and solved so many long-standing important puzzles. And it is without a doubt the simplest and most intuitive. There is room for many models: some are better than others under various conditions. The best model is one that is the most elegant, covers the broadest set of physical phenomena, and has the strongest predictive power.

We assume little or no prior knowledge of these matters, in the hopes that our explanations will be accessible to the widest possible audience. Four peer-reviewed papers have been published covering the initial results. Much of the more recent work has been withheld from publication to protect current efforts to commercialize products based on The New Physics (TNM).

If you have ever seen the television show *The Big Bang Theory*, then the following light-hearted introduction to The New Physics should be a bit of fun (or else just skip it):

# With Apologies to Chuck Lorre

## TNP at The Big Bang Theory

(Sheldon is working on the whiteboard, filled with complex String Theory formulas. Leonard is playing a console game on the TV.)

(Knock on door)

Sheldon: Come in!

Penny: Hi, can I borrow a tea bag?

Leonard: (moving to kitchen) Sure…

Penny: (To Sheldon) What's that all about.

Sheldon: (Distracted) You wouldn't understand.

Penny: I've been studying. Try me.

Sheldon: (Exasperated. Leonard brings over the tea bag) I'm just about to use String Theory to explain how the nuclear forces are related to gravitation and light. It's called the Grand Unified Theory.

Penny: But The New Physics model did that already.

Leonard: (Trying to be patient) No, it's String Theory, and it isn't quite worked out yet. That is just what Sheldon thinks he has almost done here.

Sheldon: (Penny starts to lean against the whiteboard: Sheldon panicking) DON'T TOUCH THAT!!! It's taken me weeks to get this far!

Penny: (Glances back at the board, disinterested) Well sorry, guys, but it's and it's already sorted by TNP.

Leonard: Sorted?

Penny: An Australian expression for "all worked out." The New Physics model was discovered in Australia.

Sheldon: (Turns back to the board) Don't be ridiculous.

Leonard: (Sceptical) Where did you find out about this?

Penny: The Internet, where else?

Sheldon: (Over his shoulder) Well that explains it. You can't believe everything you find on the Internet.

Penny: (On her way out) Oh, I know that: all _your_ work's on the Internet….

(Break)

(Sheldon is at the board. The three boys are playing a console game. Penny in the armchair is nibbling on a salad. During the next dialog, the boys stay focused more on the game than on the discussion.)

Leonard: Penny discovered The New Physics.

Rajesh: Never heard of it.

Leonard: You should have. It's a new unified model of the Universe.

Penny: I didn't discover anything. I was just reading about it. But it's interesting.

Howard: Never heard of it. What's so interesting?

Penny: Well for example it explains what makes things fall.

Leonard: Gravity. Newton explained that.

Rajesh: Well actually no, Newton discovered a formula but he was very upset he did not understand why all things should be attracted to each other by some mysterious force.

Leonard: Well maybe. But Einstein explained it.

Rajesh: Well actually no, Einstein's Theory of General Relativity extended Newton's Laws so they would work in gravity, but he also could not explain why matter seems to bend space.

Sheldon: (Sarcastic) So Penny, enlighten us: why *do* things fall? According to *TNP*.

Penny: (Done with her salad, getting up to leave) Well it's a simple idea. When a particle is created, it forms a bubble in space. This creates its quantum levels. Then the quantum levels of the particles join up and then draw together like rubber bands as they restore to their natural size.

Leonard: (Hopeful) Is that why you're attracted to me: all our quantum levels are drawing together?

Penny: (At the door) Oh yes. But of course, I'm more attracted to Howard because he weighs a little more. (Leaves)

(Howard smiles broadly. Rajesh is looking at himself and over at Howard, measuring size. Leonard looks disappointed. Sheldon is working at the whiteboard, oblivious as usual.)

(Break)

(The lunchroom. The boys.)

(Penny brings Leonard's order.)

Sheldon: (Very sarcastic) So Penny, how's *TNP*?

Penny: (Nonplussed, correcting him) The *New Physics model?* Fascinating.

Howard: (Still glowing from being more attractive than Leonard) How so?

Penny: (Balancing the tray) Well Leonard, aren't you working on that experiment showing that tiny particles can travel faster than light? TNP easily explains that.

Sheldon (Disdainful) He's only *repeating* someone else's experiment. And everyone knows nothing can travel faster than light. I have no idea why he's bothering.

Leonard: (Ignoring Sheldon, genuinely curious) What do you mean explains it? I'm probably going to find that nothing can travel faster than light.

Penny: That's true. Nothing *can* travel faster than light. *In a vacuum*. But the original experiment was through a mountain. That's another story.

Howard: (Curiosity growing) You're saying the neutrinos go faster through matter?

Penny: Of course. Remember I told you particles are just bubbles in space? Well inside those bubbles there is no limit to the speed of light: the particle wave goes through the center of all the atoms instantly. Add up the savings from all the atom centers on the path: you get the exact speed-up observed.

(Eyes go wide. Leonard is especially impressed. Sheldon is simply incredulous.)

Sheldon: You never studied physics!

Penny: I know. It's been a real advantage.

(Break)

(The apartment. Pizza night. Penny and the boys.)

Penny: Sheldon, I don't know why you are so hostile to the ideas of The New Physics model.

Sheldon: Well it happens to contradict all the theories of modern physics.

Penny: True. But you have to admit your so-called modern physics has failed to answer a lot of questions.

Sheldon: Such as?

Penny: Well aren't you *still* trying to bend String Theory into a Grand Unified Theory?

Sheldon: (Wistful) Almost got it.

Penny: Yeah, right. And Rajesh, isn't it true that all the matter we see is only 4% of the Universe?

Rajesh: That's right.  22% is Dark Matter, and rest is Dark Energy.  No one knows what they are, though.

Penny: Well according to TNP, Dark Matter is just collections of neutrons…

Rajesh: (In wonder, the light going on) …and Dark Energy is what you get when the particle bubbles in the middle of a giant black hole of Dark Matter are crushed: this leaves the energy trapped, their gravity disappears, and you get the expansion of the Universe!

Penny: Exactly.  (To Sheldon) So you see, TNP may contradict everything you know about physics, but it also explains everything your physics can't.

(Sheldon goes to his whiteboard and stares at his formulas.)

Leonard: And you found all this on the Internet?

Penny: TikTok was down.

(Break)

(Sheldon at the whiteboard, not making much progress.  Amy, Bernadette, and Penny nibbling salads.)

Bernadette: Sheldon, I don't see why you don't take Penny's TNP more seriously.

(Sheldon does not deign to answer.)

Amy: (Considering) Yes, I can see it might have some merit.  There are lots of neural phenomena we can't really explain.   TNP shows how quantum entanglement of particles might create the effects we see.  My Gosh, Sheldon, any theory with such far-reaching implications must be considered.

Sheldon: (Finally turning) But it has nothing to do with physics as we know it!

Penny: Which is having no success.  C'mon, girls, I know a great late-night burger joint.  This salad isn't cutting it.

(The girls get up to leave)

Penny: Sheldon, didn't Einstein have to *assume* that Gravitational Mass, the mass that falls, is the same thing as Inertial Mass, the mass that is hard to push?  If he didn't assume that, then there would be no General Relativity Theory, right?

Sheldon: (Surprised) Well yes, actually, that's right.  How do you know that?

Penny: Wikipedia.  Anyway, TNP shows how these both are different effects of the particle's quantum levels restoring to their home positions.

Amy: Sheldon, didn't Einstein say you didn't understand it until you could explain it to your Grandmother?  (They leave)

(Sheldon returns to his elaborate whiteboard and, shaking his head, slowly starts to erase his painstaking work.)

# Why Bother

The New Physics model (TNP for short) provides a simple, unpretentious model of the physical Universe. It unifies our understanding of how the Universe works. Many of the mysteries that have not been explained by other models for many decades (in some cases centuries) are provided a simple physical interpretation by TNP.

Does The New Physics model really describe how the Universe actually works? It seems to, but it's hard to be sure. As we write, the model is only about 10 years old. It has been extended to explain the problems in physics summarized in this section, which makes the circumstantial evidence pretty convincing. But over the past 110 years many observations of subatomic to intergalactic phenomena have been made, and there has not yet been time in just 10 years to extend TNP to explain every observation.

In physics models survive for a while until they are extended or replaced by more sophisticated models that cover a wider range of phenomena (we call this coverage the "scope" of the model.) The earlier models are frequently still useful in their applicable domain. For example, Newton's Law of Gravitation was supplanted by Einstein's General Theory of Relativity, but Newton's formula is still very useful (TNP actually started with it, for example.) Even if The New Physics model is accepted as useful, no doubt it will one day be supplanted by a more accurate model, or one with more scope.

Although the jury is still out on TNP, it solves many of the most pressing problems in physics. We thought it was time to share its insights with a wider audience. While we all wait to see how it pans out, we can use the model to help us gain further insights into how the Universe fits together. As for the rest, well, as we say around here, "she'll be right on the night!"

So, what insight can we gain from The New Physics model? Let's review some of the problems the new model resolves; later in this paper we will give TNP explanation for each puzzle.

## What is the physical basis of the strong force?

The atoms that make up the solids, liquids, and gases in our Universe have a tiny nucleus around which particles called electrons orbit. The nucleus is made up of protons and neutrons. When fundamental particles like protons and neutrons are broken apart in high-energy collisions, they are found to contain even smaller particles called quarks.

The proton for example has two "up" quarks and one "down" quark. The up quarks each have a 2/3 "positive" electric charge. The down quark has a 1/3 negative charge. The result is that the proton has a charge of +1 (2/3 + 2/3 – 1/3 = +1.)

Since like charges repel, you can see that even with the help of the down quark, the two up quarks are repelling each other inside the proton. The force that is holding them together is called the Strong force.

The New Physics model (TNP) gives us a firm understanding of the physical nature of the Strong force.

## Why is the proton more massive than its quarks?

When a proton is broken up the only particles that emerge are the two up quarks and one down quark. Similarly, when a neutron breaks apart it only yields its two down quarks and an up quark. (In terms of charge, the neutron is +1/3 + 1/3 – 2/3 = 0, that is no charge or a neutral charge; hence it's name: neutron.) But the masses of the quarks account for only 1% of the masses of the particles.

TNP postulates a structure for the proton and the neutron that accounts for the missing mass.

## Why is a neutron only stable in a nucleus?

A free neutron disintegrates in about 14 minutes and 42 ± 0.01 seconds, always. Since neutrons make up more than half of the mass that we stand on (not to mention half of ourselves!) this is at best disconcerting: will you still be here in 15 minutes?

Luckily TNP model has a simple explanation for why a neutron lives virtually indefinitely inside the nucleus of an atom, at least for our common, smaller atoms. (Much larger atoms are subject to a variety of radioactive decays, and some forms do involve neutrons.)

## Why is the Hydrogen nucleus larger than the proton?

The only thing in the nucleus of a simple Hydrogen atom is the proton. The proton has a radius of about 0.8 femtometers (1 femtometer = 0.000 000 000 000 001 meter.) But the nucleus of the simple Hydrogen atom is observed to be about 1.2 femtometers. TNP model explains this discrepancy.

## Why do electrons only live at quantum levels & not radiate?

Early in the 20$^{th}$ century it was discovered that an electron orbiting the nucleus in an atom can only do so at distinct radii from the nucleus. There is a schematic diagram of quantum levels in Figure 11, below. The electron cannot exist in between these “quantum levels”. This seemed to contradict our understanding of motion through space, which appears to us to be continuous, not first appearing here, then there, and never in between. TNP model explains what traps the electrons and what determines the quantum of energy they require to get to the next quantum level.

A subtler effect exists. When a charged particle like the electron accelerates, it emits electromagnetic radiation. This is the origin of all radio and television signals. Electrons are accelerated up and down the transmitting antenna, and the resulting wave is picked up by electrons in the receiving antenna. But when electrons accelerate in their orbit about the nucleus, they do not emit electromagnetic radiation. TNP has an explanation for this as well.

## What is the physical basis of the wave-particle duality?

The wave-particle duality is the observation that behavior of subatomic particles cannot be fully described by treating them as a particle, nor as a wave. The common interpretation of quantum mechanics (the Copenhagen interpretation) is that a particle can be observed to be either a wave, or a particle, but not both, and the true nature of the particle depends on not on the particle but on the method of observation.

TNP model provides a simple physical interpretation for the wave and the particle. In TNP the particle is found to always be both a particle and a wave, and observation does not impact this reality. This model is more consistent with recent experiments observing individual particles as both particle and wave.

## What causes gravity?

Isaac Newton discovered a formula that describes the attraction between two large objects which we call gravitation, but he was distressed that he could find no mechanism that would make two objects attract each other. Albert Einstein reformulated Newton’s Laws so they would work in a gravitational field, which he characterized as distorting space itself, but also could not explain why an object should have this effect on space.

TNP was discovered in the search to find the long missing mechanism of gravitation. After 40 years TNP research finally arrived at a clear and simple explanation for the cause of gravitation.

## What causes inertia?

As mankind has so often found, the solution just changes the problem. TNP model of gravitational attraction is partly predicated on the notion that protons and neutrons are 99% empty. Not just full of space: they are so empty there is no space inside them at all.

So, that leaves us with a new question: if there is nothing inside the particles that form what we think of as the mass of our atoms, why are they hard to accelerate? In other words, what causes inertia?

Luckily the very TNP model that created this problem for us also provides us with the solution.

## Is gravitational mass equal to inertial mass?

One of the longest standing puzzles in physics is the apparent equivalence of the mass we think of as gravitational mass and the mass we call inertial mass. You see, the formulas that describe these two things are not directly related. That's why Einstein had to *assume* they were equivalent to develop his theory of General Relativity.

TNP explains the mechanisms of both gravitation and inertia. This clarifies how the two phenomena are related.

## Why does mass increase with velocity?

One of the puzzling results of Einstein's Special Theory of Relativity is that when an object moves faster it gets heavier. This is initially a small effect which only becomes apparent at speeds near that of light. TNP shows why the mass of an object increases when it moves faster.

## Why does mass defect increases non-monotonically as nuclei grow?

Since the mid-20$^{th}$ century physicists have known that when a particle is added to the nucleus of an atom it loses some of its mass. This is called the mass defect. Following the equivalence of mass and energy derived in the famous formula from Special Relativity, $E = mc^2$, this is often called the binding energy. For the past 60 years, physicists have been struggling to explain how the binding energy grows as particles are added, because the amount of binding energy per particle does not grow uniformly as particles are added.

TNP model of the nucleus is 7.6 times better fit to measurements of binding energy than the next closest model, and an order of magnitude better correlation coefficient (meaning it matches the shape of the experimental curve about ten times better.)

The new insights provided by this model might lead us more rapidly to a fusion energy source.

## Why do the electrostatic and gravitational forces have the same form?

One of the longest standing mysteries in physics is why the formula for the gravitational force has precisely the same form as the one for the forces between electrical charges, the electrostatic force. Now the gravitational force is only attractive, whereas the electrostatic force is attractive for opposite charges but repulsive for like charges. But both forces are inversely proportional to the distance between them squared.

Is this just a coincidence? Physics to date has had to claim only that, because there is no relationship between the two formulas. But TNP gives physical meaning to both, showing they interact via the same mechanism, which gives rise to the similarity in their formulas.

## What constitutes dark matter?

The matter we see every day is only about 4% of the total mass-energy in the Universe. (Not to make you unduly nervous, this is a declining percentage!) 22% of the mass-energy of the Universe is so-called dark matter: matter that seems to be present but cannot be observed. Modern physics has not reached consensus on what constitutes dark matter.

TNP has a ready physical explanation for what constitutes this dark matter.

## Where is the dark energy?

The remaining 74% of the mass-energy of the Universe is the even more mysterious dark energy. TNP model provides a ready explanation for dark energy.

## Why do neutrinos go faster than light through a mountain?

Neutrinos are tiny particles that normally travel at the speed of light. Unlike light photons, neutrinos are not absorbed and then emitted by electrons: they pass through even the nuclei of atoms unimpeded.

A team of 179 physicists launched the OPERA experiment to measure the speed of neutrinos passing through the Alps from the CERN accelerator near Geneva, Switzerland to a detector at the Gran Sasso laboratory near Rome, Italy. The experiment spanned some 6 years. In September 2011 results of experiments showed the neutrinos arrived some 58 nanoseconds faster than a beam of light would have. The result was reaffirmed in a paper released in November 2011.

This result literally turned the physics world on its head. The constant speed of light in a vacuum is central hypothesis of Special Relativity, a theory which has been confirmed through many experiments for over 100 years. The theory is clear that nothing can go faster. So, how could the experimental results show that neutrinos go faster than light?

At first it did not seem like the work on TNP which had led to an understanding of gravitation and the structure of the nucleus could shed any light on the dilemma facing physics. But on further consideration it became clear that the central hypothesis of TNP model, that particles are bubbles in space, did indeed provide a ready explanation. The unintuitive conclusion was that the speed of light in a vacuum could not be exceeded, but in the OPERA experiment the neutrinos passed through matter, not a vacuum. TNP has gone on to predict that passing neutrinos through twice as much matter of the same density would result in double the time gain, a nonobvious prediction that could be verified.

In May of 2012 the OPERA experiment published a retraction of the original results. Faulty connections in the equipment were to blame for the observation that neutrinos traveled faster than the speed of light in a vacuum.

This leaves TNP in the dubious position to explaining something that apparently did not occur. We might be inclined to throw our explanation in the rubbish bin and pretend the whole thing a bad joke. But one thing is very odd about all this. TNP model shows the amount of time gained by the neutrino wave passing through the nuclei on the 732km path is exactly the amount of time observed in the OPERA experiment! It depends only on the density of the matter and not on its specific composition.

Either this is a truly staggering coincidence, or the original OPERA observations and TNP are both correct. Since there is a plan to repeat the experiment afoot, it seems prudent to await results before binning the paper.

As you can see, if you continue reading you will be rewarded with an understanding of your physical Universe that has never been available before. Not only do we hope you enjoy the result, but that you will help us extend The New Physics model into an even more powerful tool for the future.

# Particle creation

## The texture of space

Partially fill a clear glass with water, put a pencil into it, and look at it from the side. The pencil appears to bend at the surface. If you have never done this, you really must try it: it is truly amazing.

The angles that light makes with the surfaces of water and glass are caused by the light travelling at a slower speed in water and in glass than in air. But what determines the speed of light in a material?

Light is a wave of electricity and magnetism. The speed that light propagates in a material is related to two properties of the material. One is the permittivity of the material; this is the ability of the material to store an electric charge when in the presence of an electric field.

The second property is the permeability of the material, which is the ability of the material to store a magnetic field. Since a wave of light is a propagating electric wave and at right angles to it, a magnetic wave, both properties of the material play a role in slowing the speed of light through the material. The higher the permeability and permittivity, the slower light will propagate through the material.

When the light wave enters the material, some of its energy is stored in the material. This slows the light down in transit. When the light leaves the material, the energy is restored, and the original speed of light is resumed.

You will see that we can describe The New Physics model without resorting to mathematical derivations, but occasionally we will cite a fairly simple formula to make the ideas more concrete. We will always explain the formulas. The formula for the speed of light in a material *m* is

$$c_m^2 = \frac{1}{\mu_m \varepsilon_m} \qquad (1)$$

Here $c_m$ is the speed of light in the material, $c_m^2 = c_m \text{ x } c_m$, and $\mu_m$ the permeability and $\varepsilon_m$ the permittivity of the material.

Why is this important? Because the same formula applies when the material is space. The speed of light in a vacuum is determined by the permittivity and permeability of the vacuum. The vacuum is acting like a material, albeit a very lightweight one.

For example, if we take the permittivity of the vacuum as 1, then the permittivity of air is 1.000 589, that of water is 1.77. Similarly, if the permeability of the vacuum is taken as 1, the permeability of air is 1.000 000 37 and of water 0.999 992. Applying Eq. (1) tells us that the speed of light in water is 75% of that in a vacuum.

This means space, what we think of as a vacuum, is behaving like a material. This is an important notion that sets the stage for the basic hypothesis of The New Physics model:

When a particle is created, it *displaces* the space that used to exist where the particle now exists.

In the past whenever anyone considered the creation of a particle, they always assumed the particle *replaced* the space newly occupied by the particle, but TNP says, “No, the space is displaced, not replaced.”

The basic idea is that the creation of a particle pushes space aside. Although counter-intuitive at first, if you accept the evidence that space is acting like a material, then this notion is not so strange.

The effect is much like placing a ball bearing in a foam block.

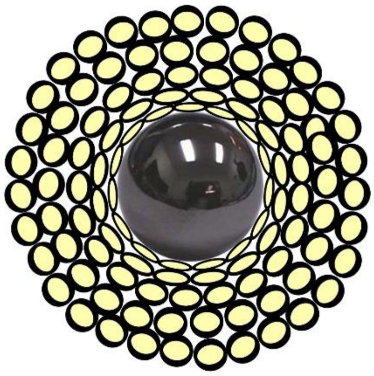


Figure 1. Creating a particle is like inserting a ball bearing into a foam block.

TNP model is that about 1% of the energy used to create a proton or neutron is used to create its quarks, and the rest of the energy pushes space outwards, much like cocking a spring (hence the name of the theory.) The displaced space pushes in on the particle, holding the quarks together. According to TNP the strong force is simply the spring of space pushing in on the particle, holding the quarks together.

The New Physics model as given us a simple physical model of the strong force. And this is just the beginning.

## Why proton is more massive than its quarks

Figure 1. is illuminating but slightly misleading. If you break up a ball bearing, you find that inside it is made of iron atoms alloyed with atoms of other metals. But if you break up a proton, it only has quarks inside. Although the amount of energy needed to make a quark is not known very precisely, the three quarks making up a proton take only about 1% of the energy needed to make the whole proton. Despite many thousands of observations of proton destruction in particle accelerators, nothing else has been observed.

If we will just permit the evidence to hold sway here, it is pretty clear the proton is, but for the quarks, quite empty. It's actually pretty obvious that the 99% of the energy not devoted to making its quarks is devoted to pushing space aside.

This notion that fundamental particles are hollow is the second hypothesis of The New Physics model, and it is just as startling and important as the hypothesis 110 years ago that atoms are mostly empty space, composed of a tiny nucleus holding most of the mass, orbited at relatively great distances by a very small number of much lighter electrons. An atom has electrons orbiting at radii that are 10,000 to 100,000 times larger than the radius of the nucleus. That is a lot of empty.

How empty? If a gold nucleus were as large as our Sun, then the outermost electrons of the gold atom would be orbiting half the distance to Pluto. In that giant sphere the sun would be the gold nucleus, and there would be 79 electrons orbiting spherically, each the size of the Earth. We emphasize that they have the entire sphere to orbit in, unlike our planets which orbit nearly in a plane about the Sun. So, really a *lot* of empty.

Now we are saying that that tiny, heavy part, the nucleus, the part where we thought almost all the mass was, is 99% hollow particles as well! It's making me afraid to jump up and down: I might just blow away or fall through the floor! Figure 2 shows a more accurate picture of TNP model of a proton or a neutron:

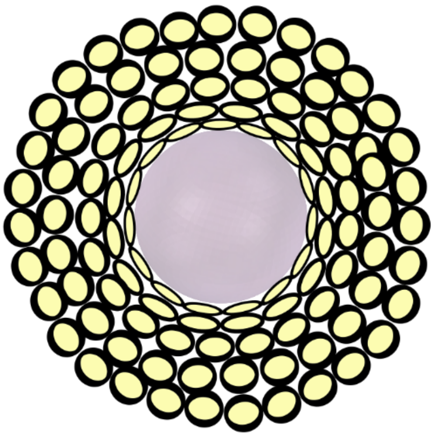


Figure 2. The proton pushing space aside is apparently a hollow balloon.

There is some recent evidence that thinking of a particle as a balloon in space is not as crazy as it seems at first. Recently the extent to which the electron is a sphere has been carefully measured. If the electron were as large as the solar system, it would be round to the thickness of a human hair! How better to explain this result, than to assume the electron is a bubble?

But wait a minute! If the proton and the neutron are hollow, why are they heavy? Why do they fall, and why are they hard to push? Before we answer these questions (and we will), is there anything else we can say about the structures of protons and neutrons?

## The structure of protons and neutrons

If the quarks require just 1% of the energy to create a proton or a neutron, and the rest of the energy goes into making a balloon pushing space aside, then isn't it reasonable to think the quarks form a bracing structure that help to support that balloon? We can get some idea how this might look if we consider more of the facts about protons and neutrons (the first 11 facts are well-known, but numbers 12 & 13 are really TNP hypotheses):

1. A free neutron (outside the nucleus) decays in 14.75±0.01 minutes into a proton, an electron, an anti-neutrino, and some energy in the form of motion of these three particles.
2. The proton lives essentially forever, so must be highly stable.
3. The neutron must be demonstrably unstable compared to the proton.
4. The quarks that comprise protons and neutrons amount to only 1% of the mass of the particles they support.
5. A proton is made up of two up quarks and one down quark.
6. The down quarks have -1/3 charge and the up quark has a +2/3 charge.
7. A neutron is made up of two down quarks and one up quark.
8. The inside of the neutron has a positive charge.
9. The down quark is about twice as massive as the up quark.
10. When a neutron decays, one down quark becomes an up quark. This transition leaves a total of 2 up quarks and one down quark: a proton.
11. There must be some reason why the neutron has a long life within the nucleus, but a short life as a free particle.
12. The quark combinations must be fairly strong and self-bracing to stand the considerable pressure from the compressive spring that is the surrounding space.

And we must explain one more thing: the mass defect. When particles combine in the nucleus of an atom, some of their mass is lost.

TNP would contend that when two particles are adjacent to each other in the nucleus, the pressure from the spring of space would force their bracing structures to touch. If we visualize a bubble with an internal bracing structure, the volume of the spherical cap that flattens when the bracing structures touch might be the mass defect (also called the binding energy or fusion energy.)

So, our final constraint is this:

13. The spherical caps that are cut off when the bracing quarks of two particles are forced together must be equal to the mass defect of the resulting nucleus; said mass defect must also overcome any repulsive electromagnetic forces whilst being assisted by any attractive electromagnetic forces.

If we take all these issues together to postulate an internal structure for protons and neutrons, we find the structures shown in the next two Figures:

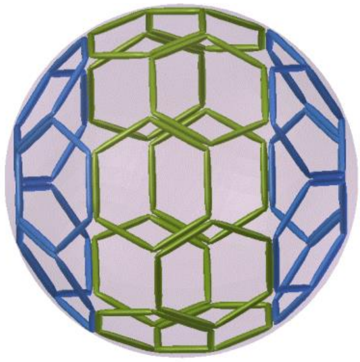


Figure 3. New Physics model of the proton: a bubble in space, two up quarks and a down quark.

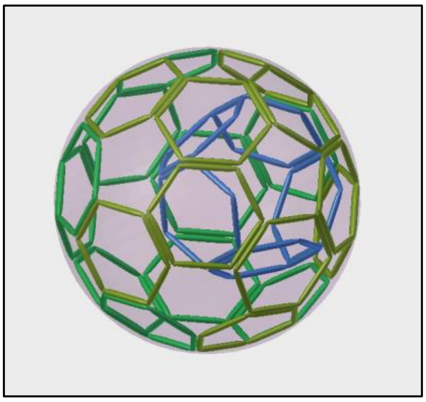


Figure 4. New Physics model of the neutron: a bubble in space, two down quarks and an up quark.

(The structure we are using for the proton is known as a soccer ball or a "buckyball", named for Buckminster Fuller. The buckyball is so-named because it is reminiscent of Fuller's geodesic domes, but these were actually made up of triangles, not pentagons and hexagons. The internal proton bracing structure is formally called a truncated icosahedron. There is a naturally occurring molecule of this structure called buckminsterfullerene. But there are a number of other geometric shapes which might fit the data better; we have not had time to investigate all the alternatives.)

## The architecture of the nucleus

Notice the blue up quark inside the neutron in Figure 4. We think it rattles about in a free neutron, shaking it apart in the observed 14.75 minutes. Inside the nucleus, this positively charged up quark is pinned to the side by the opposing positive charge from the proton, so it cannot rattle around and the neutron (luckily for us) is stable inside a nucleus.

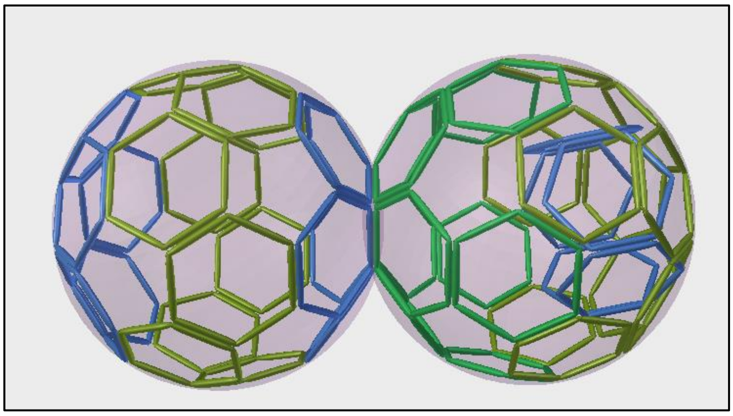
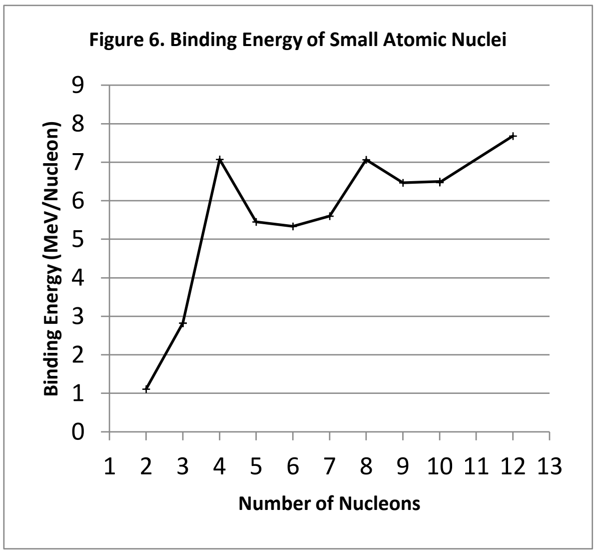


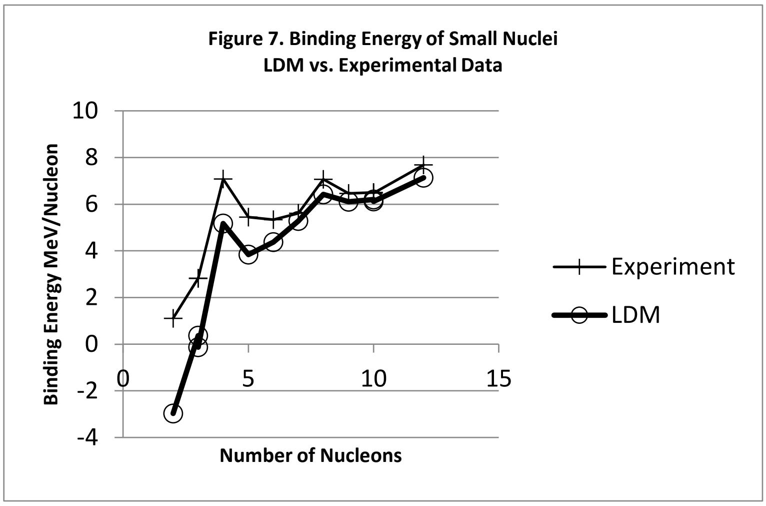
Figure 5. In the nucleus, the neutron's up quark is pinned and does not rattle. Notice the spherical caps cut off where the particles touch: this loss of mass when the nucleus is formed is the mass defect.

It is probably worth pointing out that no one has ever seen the interior of protons and neutrons, so there is no way to verify these structures are realistic, not yet anyway. We only know they fit pretty well the facts that we do know. Until we know more these models are the best that have been found, by far.

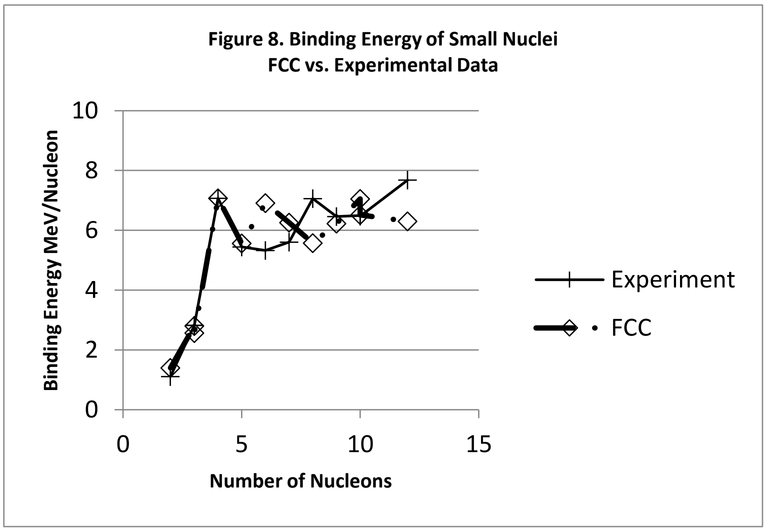
How can we make this claim? One of the great physics mysteries of the past 80 years has been the odd way that mass defect increases when new particles are added to the nucleus. Here is the widely published experimental data, showing the change in mass defect per particle as nucleons (protons & neutrons) are added from deuterium (leftmost) through carbon (rightmost) atoms:



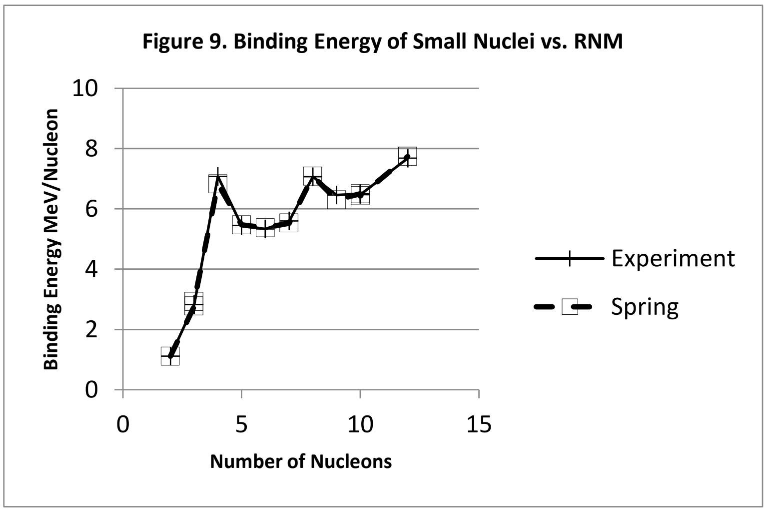

Since the 1950's two other theories have tried to explain the wavy shape of this curve. One model considers the nucleus to behave like a liquid drop. Here is how the Liquid Drop Model (LDM) measures up:




Not bad, but another model which is about five times more accurate postulates that the nucleus behaves like a regular, face-centered cubic crystal. (Face-centered cubic is one of two ways that spheres can pack closely together.) Here is how the Face-Centered Cubic (FCC) model stacks up to the experimental data:




But The New Physics model matches the experimental data 7.6 times better than that:



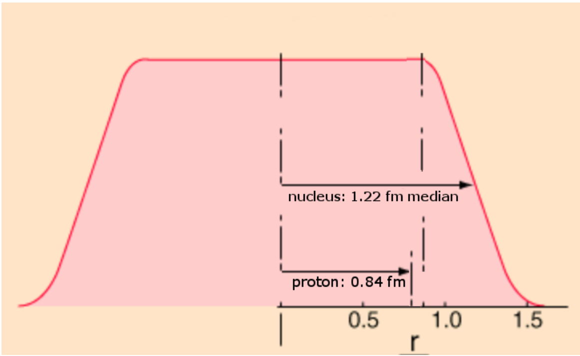
## Why photons are light

According to the hypotheses of The New Physics model, photons of light are created in the same way that particles are: lots of energy at one point in space creates a bubble or balloon in space, pushing space aside. In this case the skin of the balloon is strong enough to maintain its shape without an internal quark structure.

Apparently, the lack of an internal quark structure is precisely what is needed to permit photons to travel at the speed of light. The unification of the creation of photons with that of other particles is an important conceptual step in understanding our physical Universe.

## Why the Hydrogen nucleus is larger than the proton

Despite the fact that the proton radius is only 0.84 femtometers, the ordinary hydrogen nucleus is routinely measured to be between 0.9 and 1.5 femtometers, with the media at about 1.22 fm.




(Figure adapted from a diagram in hyperphysics.org.) But the only thing in the nucleus of ordinary hydrogen is the proton! Nonetheless the electrons fired at the nucleus of hydrogen to measure its radius bounce off some larger object.

Until now there has not been a satisfactory explanation of this discrepancy. But according to TNP the space that used to be in the volume where the particle now resides is pushed out to surround the particle.

The space that was where the particle is now amounts to 2.5 cubic femtometers ($fm^3$). The space occupied by the measured nucleus at an average radius 1.2 femtometers is 7.24 $fm^3$. The difference is 4.74 $fm^3$. So now we have 7.24 $fm^3$ of space compressed into 4.74 $fm^3$. This makes the space immediately around the proton 53% (= 4.74/7.24) denser than the original space before the particle was created. Denser, hence greater permittivity and permeability, and therefore more resistance to the passage of light waves (or electrons for that matter. The relationship between the particle and its wave will become clear shortly.)

All nuclear radii are larger than their nucleons by about 0.4 fm. This is known as the nuclear skin, and until now lacked an adequate explanation.

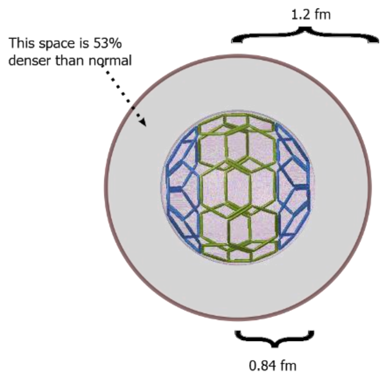



Figure 10. According to TNP the space between the "nuclear skin" and the proton is denser than normal.

By introducing the concept of a denser layer of space compressed around a created particle, TNP explains why the hydrogen nucleus measures larger than the proton, its sole occupant.

## Will the particle or the wave please stand up?

There is a simple formula that computes the wavelength of the wave that is associated with any particle:

$$\lambda = ch/E \quad (2)$$

Here $\lambda$ is the wavelength, $c$ is the speed of light in a vacuum, $h$ is Planck's constant, and $E$ is the formation energy of the particle. This tells us the wavelength of the proton is 1.32141 fm.

This is close enough to the fuzzy measurement of the nuclear skin (0.9 – 1.5 fm) for us to conjecture that the wave associated with the proton is none other than the compressed space around the particle shown in Figure 10! The reason the edge is fuzzy is because it is a denser region of space, not a hard object like the proton itself.

According to this model every particle is surrounded by a layer of compressed space that forms the wave characteristic of the particle. In the quantum mechanics model of the particle-wave duality the observer sees the event become either a particle or a wave, depending on the method of observation. But TNP says the particle carries the wave with itself, and this is consistent with recent experiments that have observed the same item as *both* a particle and a wave.

## Quantum level entrapment

Electrons are known to orbit the nucleus at discrete quantum levels, and apparently never appear in the space in between the quantum levels. This is represented in this cutaway view of the spherical Bohr model of the atom:

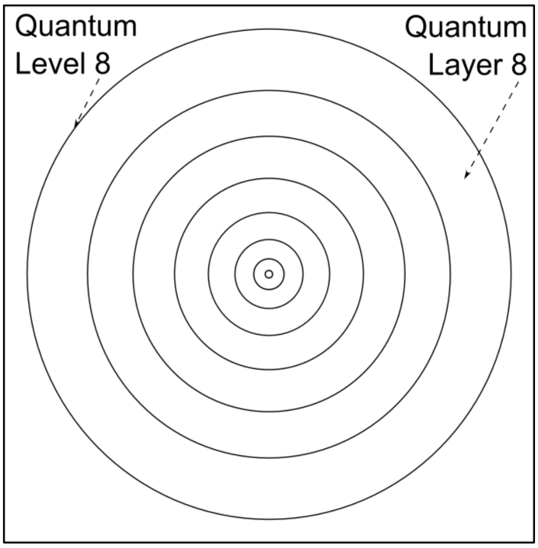



Figure 11. The Bohr model of the atom, where electrons only live at quantum levels.

It is generally agreed that the Bohr model of the atom is an accurate representation when the atom has been stripped of all but one electron. The spherical electron quantum levels continue infinitely, even though an electron in level 8 would escape the nucleus. The quantum levels propagate out across the Universe from the time of particle creation, presumably at the speed of light. (For this reason, TNP model holds this representation remains accurate even for more electrons.)

Figure 11 shows the innermost electron quantum level in the middle. That is not the nucleus, which is 100,000 times smaller than that inner circle. We can't see it in the scale of Figure 11.

Each quantum level is larger than its predecessor. If we call the radius of the first (innermost) electron quantum level $r_1$, then quantum level $n$ is at radius $r_n$, where

$$r_n = r_1 n^2 \tag{3}$$

In addition to being trapped in their quantum levels until struck by a photon of just the right energy to bump them up a level or two, the electrons do not radiate electromagnetic energy even though they are accelerating about the nucleus as they orbit. Normally, electrically charged particles do radiate electromagnetic energy when they are accelerated; this is the basic principle behind all radio and television antennas.

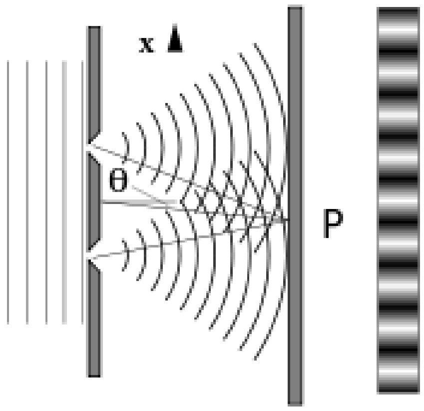
According to The New Physics model, this lack of radiation is because of the altered density of space from one quantum layer to the next. In this model, the quantum levels are interfaces between the layers of space with decreasing permittivity and permeability as they go out from the nucleus. This increase in density suppresses the electromagnetic wave that would normally be emitted by the electron and also traps the electron in its orbital until it gets enough energy from a photon of light to jump to another level. Then at some later point, it emits that photon towards some other direction, causing the scattering of the photon of light: what we see with our eyes as the color of the object.

## Diffraction at an edge

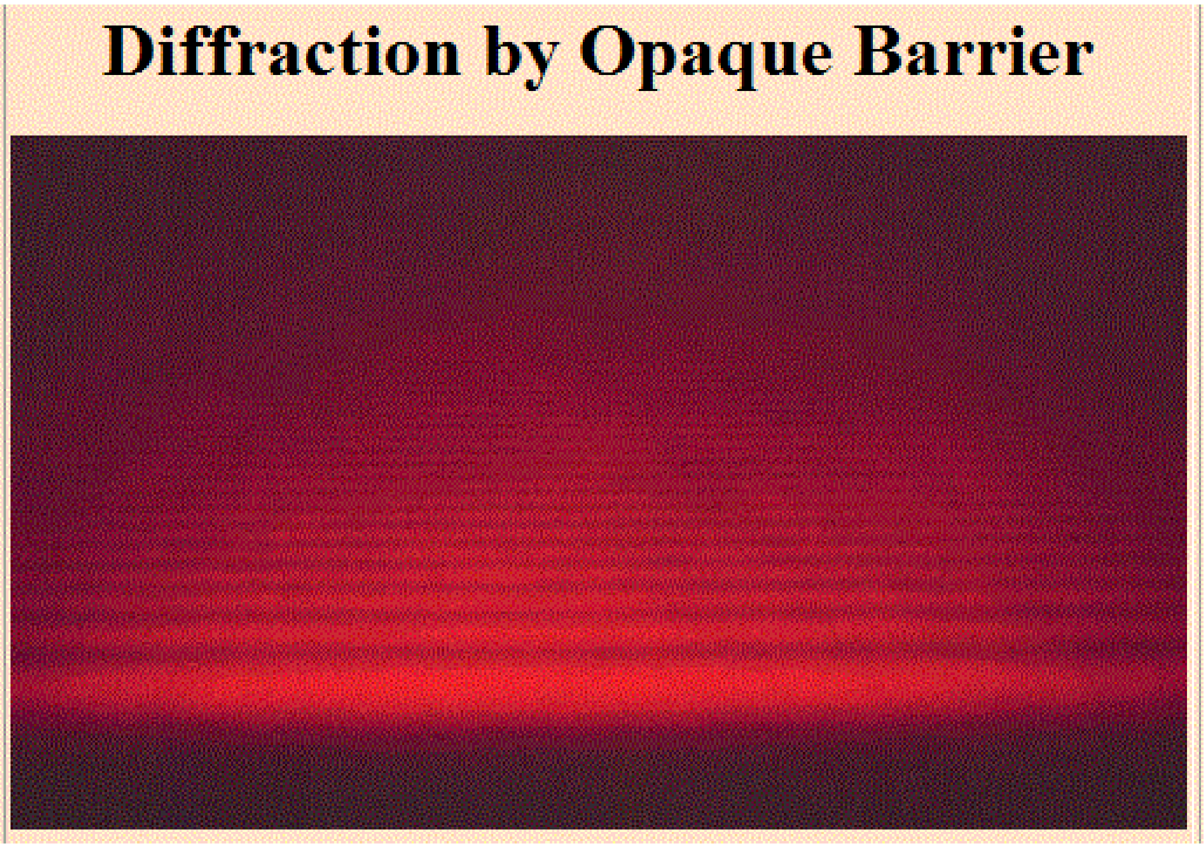
We have just taken a look at the Bohr quantum levels for electrons. But there is evidence that there might be nuclear quantum levels as well. Remember that we can detect the wavelength of the proton as an area of denser than normal space resulting from its creation. We think this may actually be the first in a series of quantum levels originating at the particle. Here's why:

Many of us remember the double-slit diffraction experiment from high school physics. Light shown through the slits forms light and dark bands on the opposite wall:




The pattern is usually explained as the interference of the peaks and valleys of the waves passing through the slit: when a peak overlaps a valley, the two waves cancel and a dark band is produced.

But look at the following photo, which shows diffraction bands from shining a laser at a single edge (no slits):

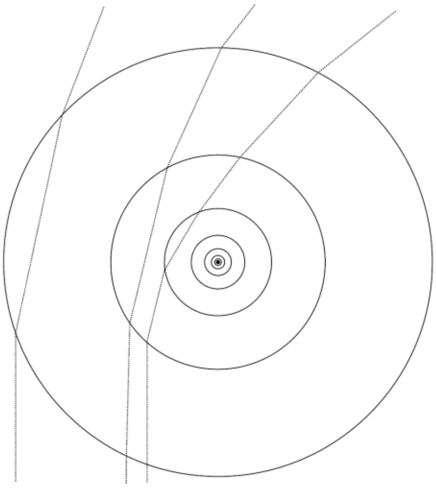


Here there is no second wave to interfere with the first one to produce the diffraction pattern. Even more mysterious is the fact that if you take individual electrons and throw them at the edge one at a time, they form the same pattern!

To understand what is going on here, first take a moment to observe how a sphere of glass refracts light:

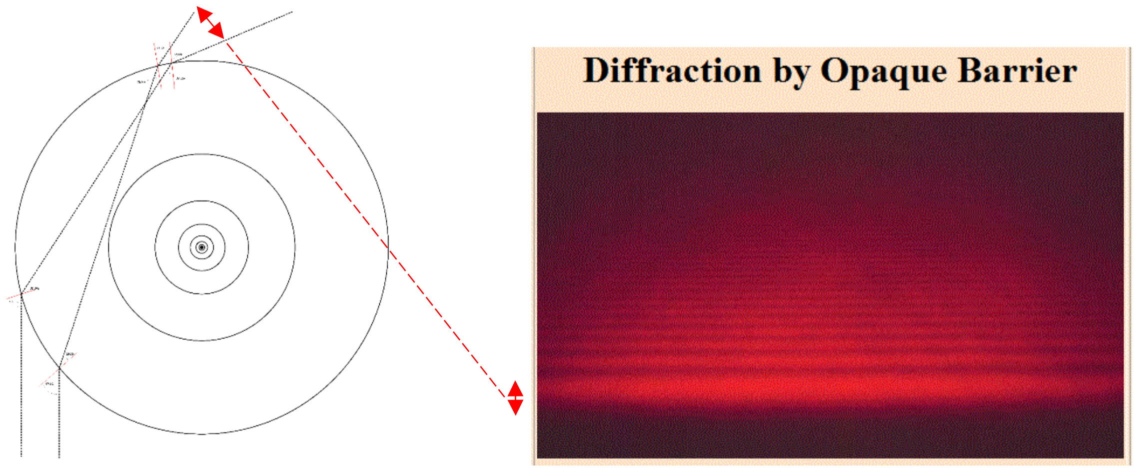
Light is bent by first encountering the "denser" glass, then bent again on exit. Here, "denser" is shorthand for higher permittivity/permeability. Knowing this, we think the reason a single edge makes light (or electrons) form a diffraction pattern is because they are encountering successively denser nuclear quantum levels in the atoms at the edge of the material:



We hypothesize that the nuclear quantum levels have the same relationship to each other that the Bohr quantum levels have, equation (3) above, with $r_1$ in this case being the wavelength of the proton (about 100,000 times smaller than the first electron quantum level.)

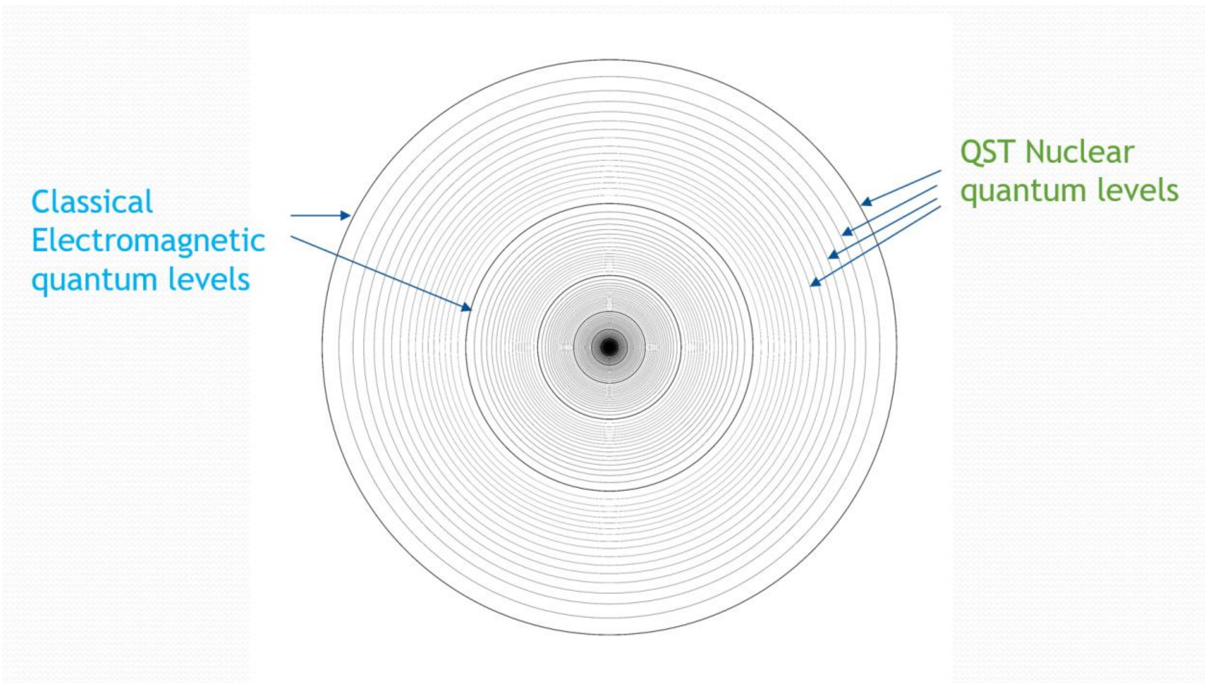
By carefully calculating the angles of entry and exit to each quantum level, we can also account for the dispersion of the bands:




## Coincidence of nuclear and electron quantum levels

There is a striking relationship between the nuclear quantum levels of a single proton and the quantum levels of the electrons that surround it:




These line up rather precisely, at least for a single proton. Let *r* denote the radius of the electron quantum level as in (3), and let ρ denote the radius of the neutron quantum level. Then for all quantum levels *n* (to within 0.12% by current measurements):

$$r_n \ electon\ level = \daleth_{(206*n)}\ nuclear\ level$$

We need to know more about nuclear quantum levels as we increase the number of particles, so until we have more measurements, for the time being, this is about as much as we can say.

This might be a good time to take an inventory of our progress. In our model the energy of particle formation creates a bubble in space which has several profound effects. These include an increase in the density of space immediately around the particle accounting for the wave nature of the particle, and the fractures lines we observe as quantum levels which extend from the point of creation out to the edge of the Universe. We have gained some insight into the structure of the nucleus, the instability of free neutrons, and a number of other issues that have puzzled physics for some time. If this were all we had achieved, surely we would say this is enough. But we are only just beginning on our journey of understanding. Fasten your seatbelt.

## The cause of gravity

The New Physics model came from a simple question: what is the cause of gravitation? Isaac Newton was dissatisfied with his formula for gravitation because he could not explain why objects should attract each other. Albert Einstein's General Theory of Relativity could not explain why objects should curve space; he could only describe the result.

Yet with our TNP hypotheses, you must think we have made our job even harder now. After all, TNP claims the particles that we thought of as massive are 99% hollow, so empty they don't even have space inside of them! Why, then, should they feel heavy or be hard to push?

The secret lies in our simple equation (3). Each quantum level has a natural size. If we distort that size, it will try to return to its natural size. We think this is a very fundamental property of space: it is what happens to space when you create a bubble inside it by concentrating a lot of energy in a single spot.

When two particles come together in the nucleus, as in Figure 5, we know there will only be one quantum level for each integer: one level 1, 2, 3, … and so on.

In Figure 12 we illustrate what is going on when the two particles approach each other. We only show a couple of the innermost quantum levels joining up, but don't forget the nearly infinite number that have already joined together far from the nucleus:

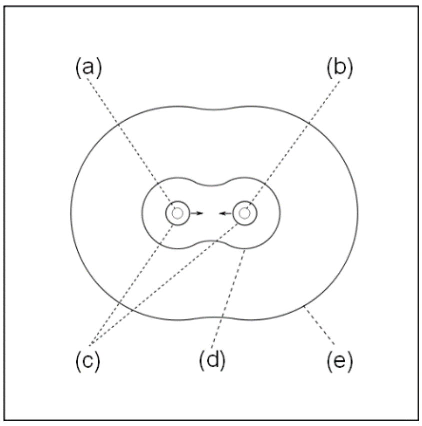



Figure 12. Two approaching particles: (a) Proton. (b) Neutron. (c) Nuclear quantum level 1, the nuclear skin. (d) Nuclear quantum level 2. (e) Nuclear quantum level 3. As the joined quantum levels strive to attain their Eq. (3) "natural" size, the cumulative restoring forces of all the joined quantum levels results in what we observe as gravitation.

Imagine all the atoms in your body with their quantum levels merging with all the quantum levels of all the atoms in the earth, all attempting to restore to their natural radius at once. Gravitation!

Such a simple notion. Why did it take us so long to figure out? Perhaps nature is the ultimate magician. The mechanism of gravitation has been wrapped in misdirection. Gravitation is only measurable with large objects. Despite the very large number of quantum levels involved, each pair contributes only a very small restoring force. But large objects are, after all, only made of atoms. It is reasonable to consider the gravitational mechanism would somehow arise from the creation of particles. Despite the evidence, until now no one has considered the restoring effects of Eq. (3).

Here is a view of a couple of particles drawing together due to the restoring force of quantum levels having a "home position":

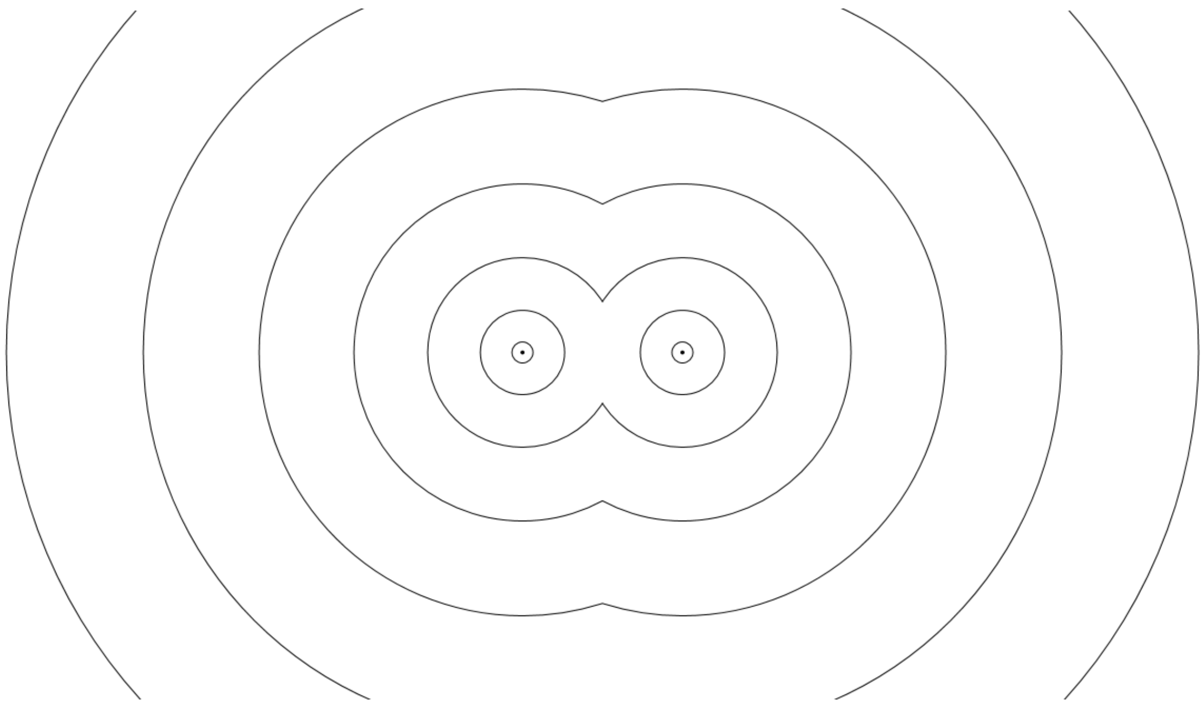


Figure 13. The gravitational restoring force between nuclear quantum levels of two particles.

## The cause of inertia

OK, we see why things might fall. But in the absence of a gravitational field, it still takes force to accelerate an object. If it's just a bubble, why is that?

In Figures 12 and 13 we show the quantum levels near the nucleus, well inside the first electron quantum level which is 100,000 times the radius of the nucleus. But the typical atom has electrons in its orbitals. These electrons repel the electrons in the orbitals of other atoms. If they are not sharing electrons, i.e., in the same molecule as each other, we think of the atoms as belonging to separate objects. When the atom of one object hits another, the electrons repel each other. In turn, this moves the proton but leaves the nuclear quantum levels behind. The nuclear quantum levels then try to get back into their original position (home position) with the proton in the center, and this restoring force is what we experience as inertial mass.

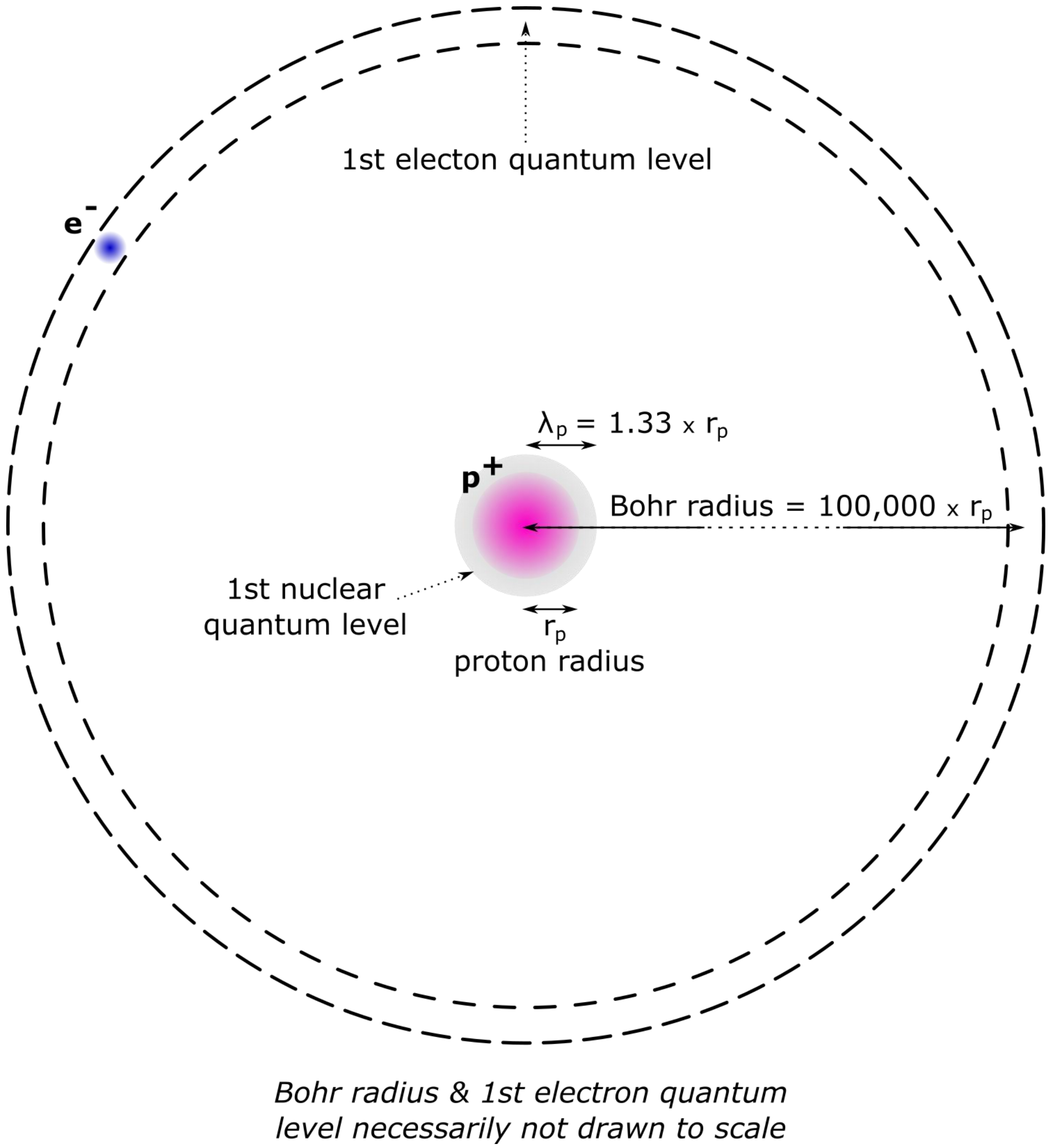



Figure 14. A Hydrogen atom with one electron and one proton. The radius of the orbit of the electron is 100,000 times larger than the radius of the proton, so this cannot be drawn to scale (if the proton were the size of the period at the end of this sentence, the diameter of the electron's orbit would be over 40 meters.) The electron quantum layer inside the electron orbit has space denser than the layer outside the electron, which traps the electron in its orbit. This renders the distance between the electron and the proton fixed, so when the electron is pushed by another electron, the proton is moved in the same direction.

In the next figure, we show how moving the proton by pushing on the electron distorts its normal position with respect to its nuclear quantum levels.

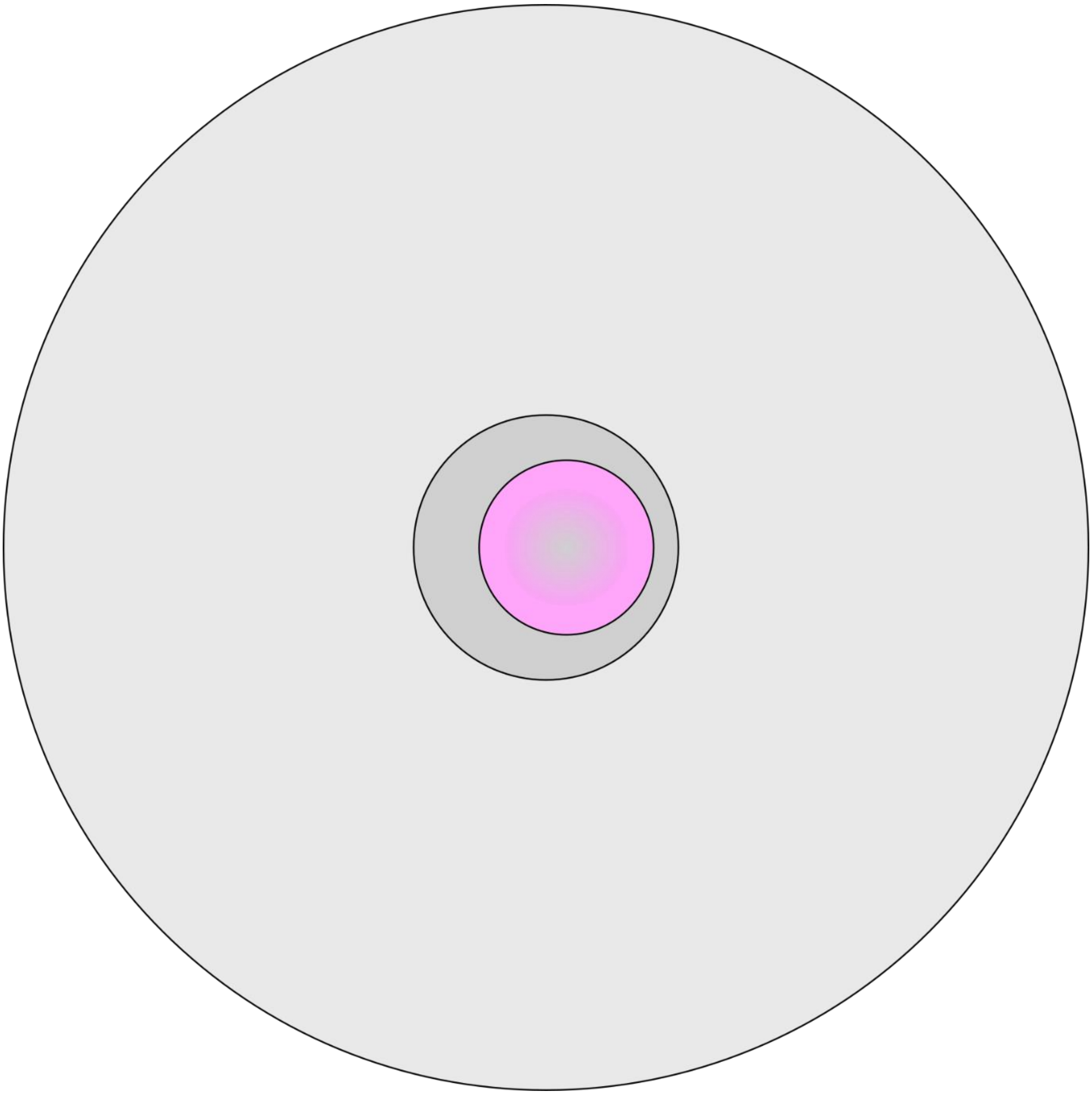


Figure 15. A scale drawing of a single proton in the nucleus of a Hydrogen atom and its first two nuclear quantum levels, with the proton being forced to the right by its electron, itself is being pushed to the right.

Keep in mind that even though the above Figure only shows the first two nuclear quantum levels, the distortion as a result of the collision and the restoring force of Eq. (3) involves all the nearly infinite number of quantum levels of the atom. The distortion creates a force counter to the push to the right as the nuclear quantum levels try to return to home position. As soon as the acceleration of the push stops, the nuclear quantum levels return to home position and the counter-force stops. It effects a retarding force on the atom's rightward motion: inertia.

## Will the gravitational or the inertial mass please stand up

In order to develop the General Theory of Relativity, Albert Einstein had to *assume* that inertial mass was equal to gravitational mass. The problem he had was that the formula for inertial mass came from Newton's 2nd Law of Motion,

$$F = ma \qquad (4)$$

where $F$ is the force needed to accelerate the mass $m$ with acceleration $a$. But the formula for gravitational mass came from Newton's Law of Gravitation:

$$F = G\frac{m_1 m_2}{r^2} \tag{5}$$

where $G$ is the gravitational constant, $m_1$ is the gravitational mass of one object, $m_2$ is the gravitational mass of the second object, and $r$ is the distance between them.

Both formulas are correct, but the problem is neither relates directly to the other. This difficulty has spawned a great deal of clever experimentation, which has demonstrated that both forms of mass are equivalent to 15 decimal places.

TNP model shows us that the mass is not just the particle. It is the interaction of the quantum levels that are created when the particle is created. When we are asking if the gravitational mass and the inertial mass are the same thing, the simple answer is "No." The same particles are involved, but the two *mechanisms* are quite different.

Nonetheless, according to TNP they both come from the same fundamental phenomenon: the tendency of each quantum level to keep to its natural radius. In gravitation, we see the merged quantum levels restoring to this natural radius. In inertia, we see the disrupted relationship of the quantum levels to the nucleus being restored.

## E = mc$^2$

One of the conclusions of Special Relativity is the equivalence of mass and energy. But it never really made a lot of sense. How could energy turn into matter, or matter into energy? The New Physics model has finally shed light on the mystery. Now we see how when energy is focused on a point in space, a bubble in space is created and that is the particle (or photon of light.) Mass comes not from something heavy in the particle, but rather from the relationship of the bubble to the nuclear quantum levels created when the particle is created. The interchange between mass and energy is now not just understandable: it's intuitive.

There is a way to think about the speed of light as depending on the properties of space as a material. The square of the speed of light in a vacuum is inversely proportional to the product of the permittivity and permeability of space. The permittivity is the ability of a material to retain (and potentially later release) the energy of an electric field. It is demoted by the Greek letter *epsilon* (ε). The permeability is the ability of a material to retain (and potentially later release) the energy of a magnetic field. It is denoted by the Greek letter *mu* (µ). This has been known for over 100 years and is denoted by the formula:

$$c^2 = \frac{1}{\mu \cdot \varepsilon}$$

The "·" here means multiply. Therefore $E = mc^2$ can be written as

$$E = m \cdot \left(\frac{1}{\mu \cdot \varepsilon}\right)$$

Multiplying both sides of this equation by $(\mu \cdot \varepsilon)$ gives

$$E \cdot \mu \cdot \varepsilon = m$$

which we can turn around and rewrite as

$$m = E\mu\varepsilon$$

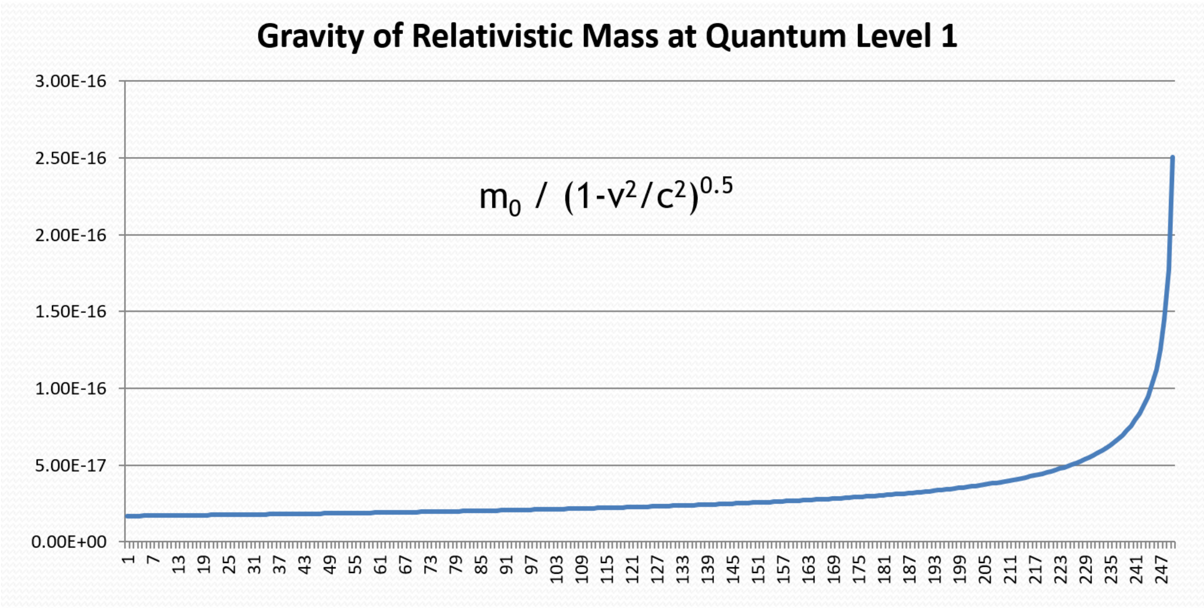
Since $\mu$ is pronounced as *m*, and $\varepsilon$ is pronounced as *e*, this spells meme. This is why the amount of energy it takes to create a particle depends on the square of the speed of light in a vacuum: that is just another way of saying it depends on the properties of space. Since TNP posits that particles are merely bubbles in space, this makes perfect sense. Finally. And it gives us the ultimate *meme*, from which everything in the universe flows.

There do seem to be two types of bubbles: those that can travel at the speed of light in a vacuum (photons, neutrinos) and those that cannot (larger particles like electrons, protons, and neutrons that make up atoms, to name those we know best.) If they are all formed by putting a lot of energy into one spot in space, why are there two such different outcomes?

It seems one set of particles are simply bubbles in space and have no internal particles carrying electrical charge like the quarks or the quark segments we find in protons and neutrons. Once a bubble has internal components that carry charge, the bubble formed is limited in its speed by the laws of special relativity as described in part in the next section.

## The cause of relativistic mass increase

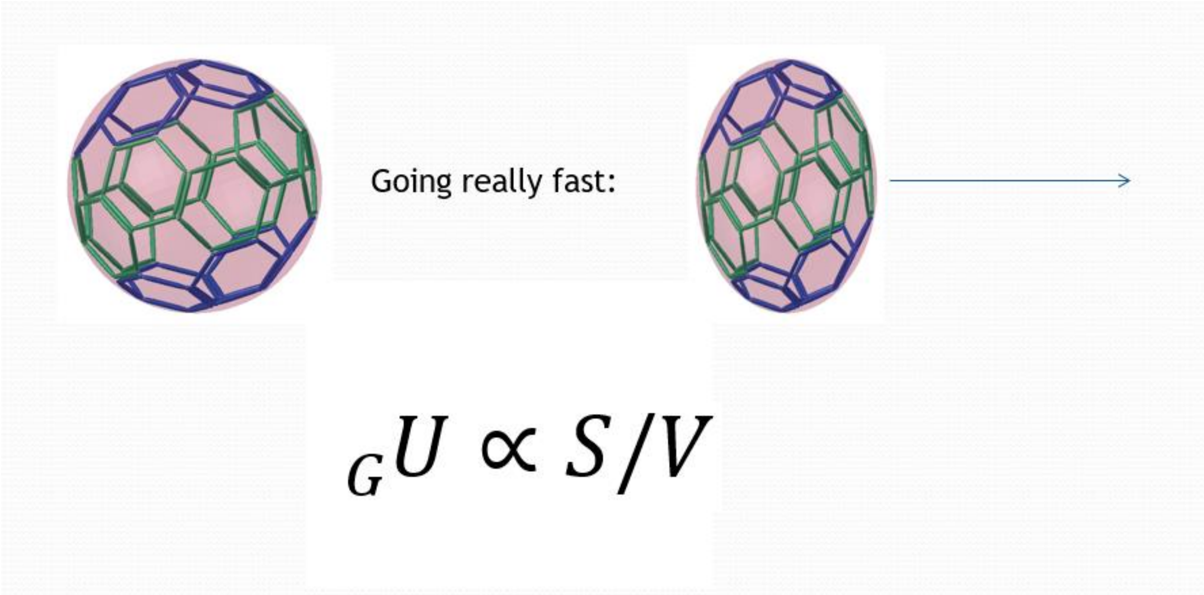
When objects travel near the speed of light relative to an observer, they undergo some interesting changes. These include getting shorter in the direction of travel, and heavier. Einstein was able to make some convincing diagrams that fully explain why the object should appear shorter, and why time slows down. But heavier? The mathematics are convincing, but it is hard to form an intuitive picture of why something that is getting squeezed in length and hence smaller should be getting heavier! Here is Einstein's formula and how heavy it gets ($m_0$ is the rest mass, v is the speed and c is the speed of light in a vacuum):



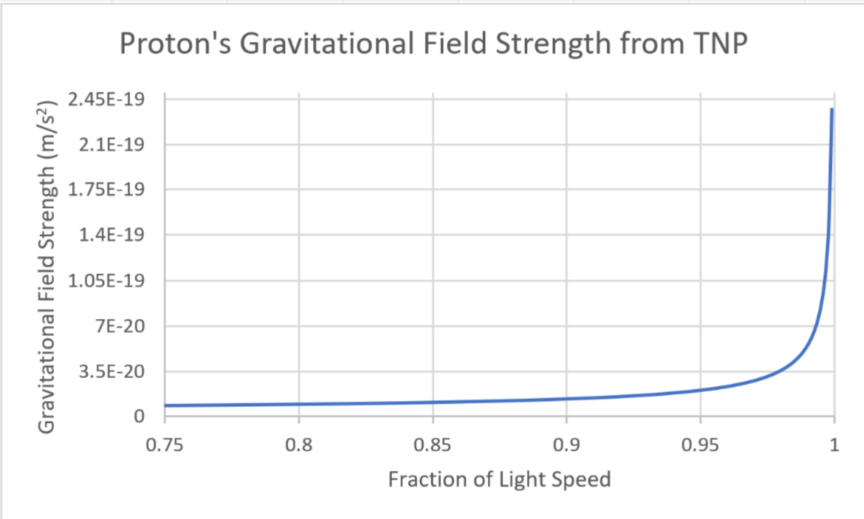

(Raising that expression to the 0.5 power is just taking the square root of the expression.)

When the spherical particle goes fast, its diameter along the direction of motion contracts. The sphere becomes an oblate spheroid. The volume declines, so the pressure increases. The surface area also gets smaller, but not as quickly as the volume. There is thus an increase in the particle's gravitational acceleration. It looks like the picture below.




The formula from TNP states simply that the gravitational field, $_GU$, produced by a particle is proportional to the surface area of the particle, $S$, divided by its volume, $V$. The Special Relativity formula is over 100 years old and is explained in sources like Wikipedia. The New Physics formula's elements are explained in our paper on The Mechanism of Quantum Gravity. The really big deal here is that the following TNP chart is point for point in a nearly constant ratio to the above chart from Special Relativity, even though the formulas that produced each of them have nothing to do with each other! This is not just a lucky coincidence. It is because The New Physics provides—for the first time—a physical explanation for why mass increases with speed.




Okay, we admit it: that was a lot to follow. But if you got it, now you have an intuitive understanding of why mass increases when particles go fast.

## Why the electrostatic and gravitational forces have the same form

Eq. (5) is the formula for the gravitational force. Now look at the formula for the electrostatic force:

$$F = C\frac{q_1 q_2}{r^2} \tag{6}$$

Here $C$ is Coulomb's constant, and $q_1$ and $q_2$ are the electrical charges on the two objects. The similarity between Eqs. (5) and (6) is striking. For centuries, this similarity has had no basis in theory.

The New Physics model says the answer is straightforward. At least for a single proton, the 200$^{th}$ nuclear quantum level is coincident with the first electron quantum level, and all the rest of them are also coincident (2 to 400, 3 to 600, ….)

Where does the electrostatic relationship come from? From the same place it comes from in gravitation. The effect of the charge is spread around the surface area of the spherical quantum level. That surface area is proportional to the square of the radius of the quantum level. This makes the strength of the charge at any quantum radius proportional to the inverse of the square of that radius.

We don't have a clear understanding yet of how the quantum levels of multiple charges aggregate. Nonetheless we can get an idea how this works by looking at the so-called magnetic lines of force, which seem to follow exactly the same principle as illustrated by the following image from Wikipedia (http://en.wikipedia.org/wiki/File:Magnet0873.png, retrieved 6 November 2016.)

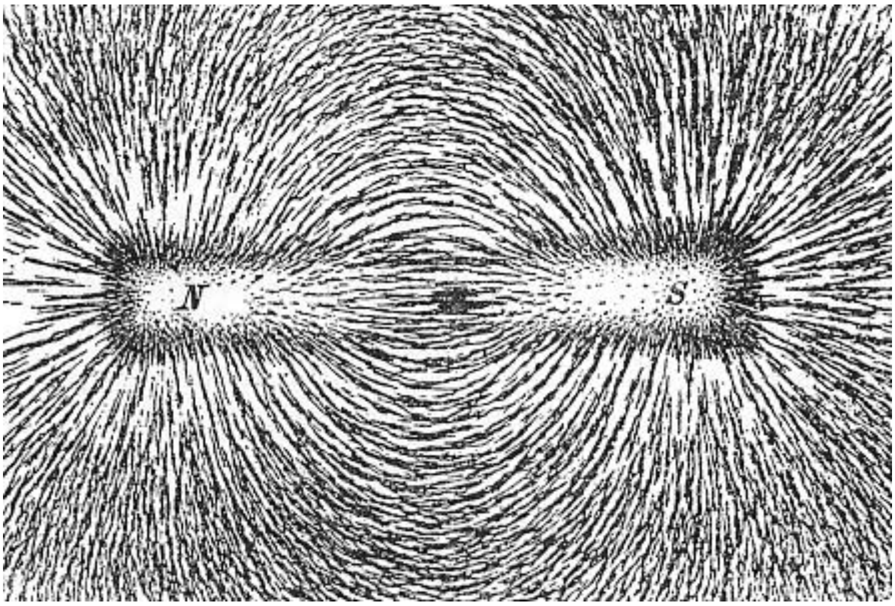



Figure 15. Magnetic lines of force seem to follow aggregated quantum levels.

The question of whether the quantum levels of multiple atoms aggregate and how they might do so is illuminated by the following recent illustration of the earth's Van Allen radiation belts (Johns Hopkins Univ. Applied Physics Laboratory/Univ. of Colorado Boulder Laboratory for Atmospheric and Space Physics , http://www.sciencenews.org/view/access/id/348663/description/RING_AROUND_THE_WORLD,

retrieved 6 November 2016):

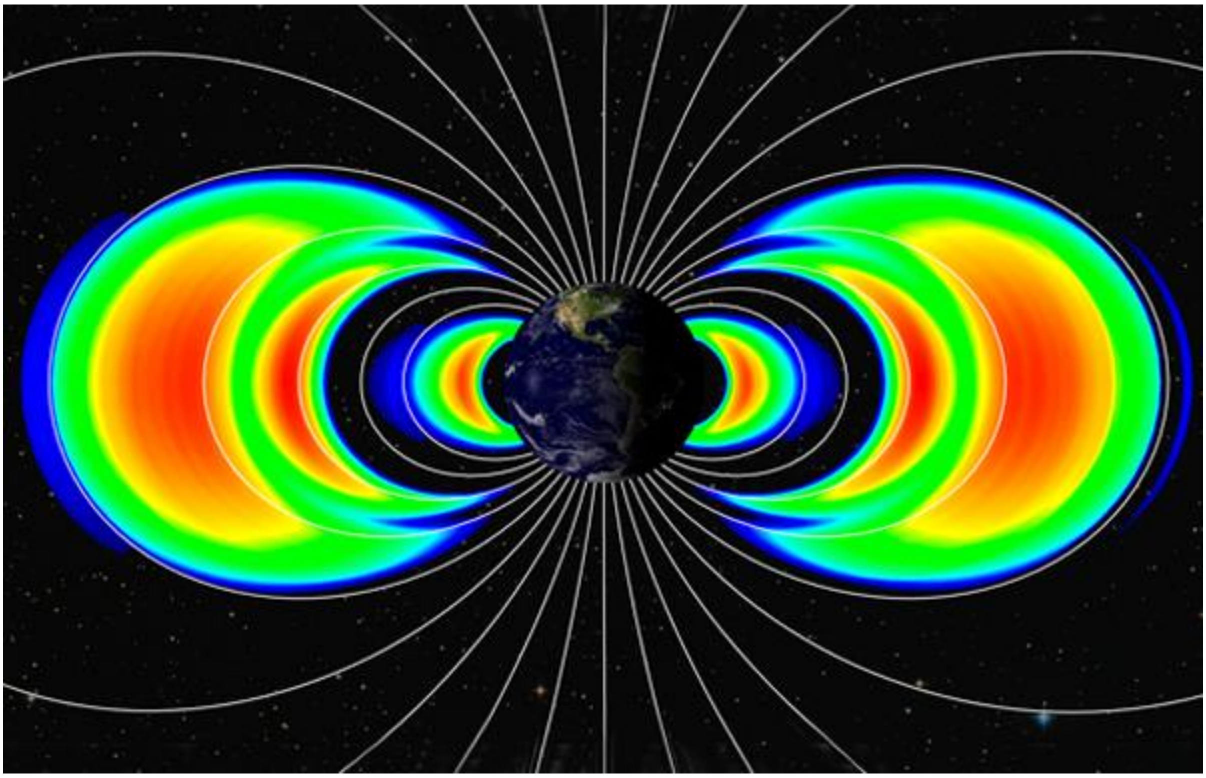


Figure 16. Van Allen radiation belts seem to imply that quantum levels from multiple atoms aggregate.

## What is dark matter

The matter we see about us represents a mere 0.4% of the all the matter + energy in the Universe. Not to alarm you, this number is declining over time! If you stick with it long enough, maybe that weight loss program you were trying will actually work!

Another 3.6% is intergalactic gas so it is much like the matter we are used to seeing, but it is scattered rather widely between the galaxies. The remaining matter is dark matter, some 22% of the matter + energy in the Universe.

As much as there is of dark matter, we do not know exactly what makes it up. This means that unlike the matter we can see, there is 5.5 times more matter of a composition which is simply unknown.

As usual The New Physics model has an intuitive explanation. According to TNP it is possible for neutrons to gather together into super-heavy atoms that have no orbiting electrons, and are therefore much denser than ordinary matter: about 10 trillion times denser.

How could dark matter form? We already know that certain stars become neutron stars when a star around twice the mass of the sun goes supernova, and the core of the star undergoes gravitational collapse. The resulting star made up of mostly neutrons is very dense, with most of the initial mass of the star held by gravitation in a radius of only about 10 km.

During the supernova event or due to some subsequent collisions, chunks of neutron matter might be released into space. According to TNP a large enough chunk would be stable, held together by its own gravitational field.

## What is dark energy

The remaining 73% of the original matter + energy the Universe is now called dark energy, which is another way of saying we think the original matter has been converted into energy, but we can't see it and we don't know where it is.

When two neutron stars orbit each other, their intense gravitation eventually causes them to collapse in on each other and collide, forming a black hole. Thinking about Figure 4, we recall that according to TNP, neutrons are tiny bubbles in space supported internally by a quark structure. What happens when the intense gravitational field of the black hole gathers so much matter that the pressure on the neutrons in the centre crushes their quark structures? We are left with 99% or more of the energy of formation of the neutrons, but their gravitational field is gone. The energy is trapped in the centre of the black hole. It is now dark energy.

## Why neutrinos could go faster than light

Neutrinos are small particles that can travel through matter. The OPERA experiment was started in 2003 to measure the speed of neutrino through matter. In September 2011, the OPERA experiment reported that neutrinos had been observed travelling faster than the speed of light on a 732km path from the CERN laboratory near Geneva to the Gran Sasso laboratory outside of Rome. The neutrinos arrived some 57.8 ± 7.8 nanoseconds earlier than a light photon would have if it could have passed under the Alps. In November, the experiment was repeated and confirmed, with no less than 179 authors cited on the paper.

This set of observations caused absolute havoc in the world of physics. The theory of Special Relativity, often verified, was built on the observation that nothing can travel faster than the speed of light in a vacuum.

In November 2011, TNP model was found to hold a simple explanation. The bubbles in space collected in the nuclei of the atoms on the path through the Alps let the neutrino wave pass through them instantaneously. Devoid of space, the nuclei have no permeability or permittivity, so light speed is infinite across the bubbles. The neutrino wave skips ahead instantly just a tiny bit. If you add up the time saved along the path, assuming the average density of the earth (2.72 $g/cm^2$), then you get a savings of 56.2 nanoseconds, consistent with the observations within experimental error. And we find it is the density, and not the type of material under the Alps that leads to this conclusion, so independent of the actual composition of the earth along the path, if the density is about average the result holds. If the density under the Alps is just a bit greater at 2.98 $g/cm^2$, as it might well be since the Alps are formed by the upthrust of denser material a tectonic plate, then the time gained according to TNP model is precisely the 57.8 nanoseconds observed!

This leaves Special Relativity intact. The speed of light in a vacuum cannot be exceeded. But neutrinos passing through matter is quite another matter, and the excess speed has a simple explanation.

The inability of physics to explain the observation caused enormous pressure on the OPERA team. By May 1012 they had retracted the result, claiming a loose optical connection had led to false readings.

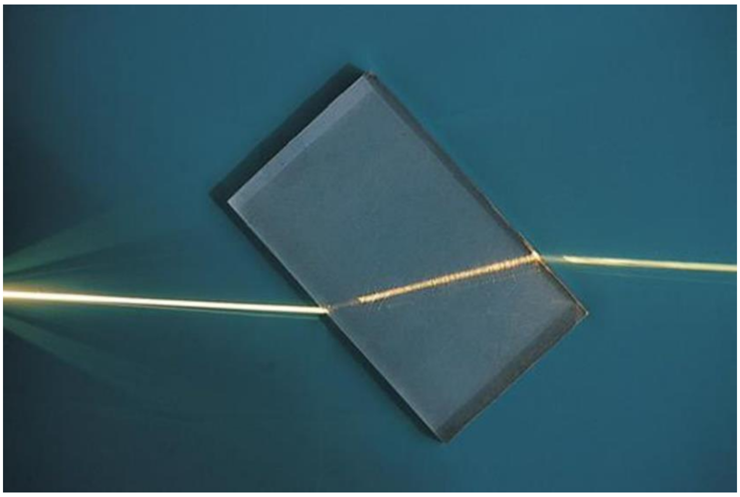
We now have a handy explanation of a phenomenon which may or may not have occurred. If in the fullness of time we all come to believe that the original observations were in error, we have an irrelevant extension to TNP model. If on the other hand we find the original observations to be confirmed in the future, then this branch of TNP model is perhaps the only salvation.

Under these circumstances we might be inclined to keep our powder dry and not include this part of the model until we are certain of the truth. The reason we mention this here despite the current uncertainty is that TNP model makes an important prediction that is easy to observe. If we go twice as far through earth of the same density, the neutrinos will gain twice as much time. This rather unintuitive prediction is precisely the type we need to verify TNP model. So, we include this section, and watch the experiments going forward with considerable interest.

---

## Refraction

This is something we can see with our own eyes. Light rays bend at the surface between two different, transparent materials (air, water, glass or plastic for example). The following photo is from the Wikipedia article on Refraction:

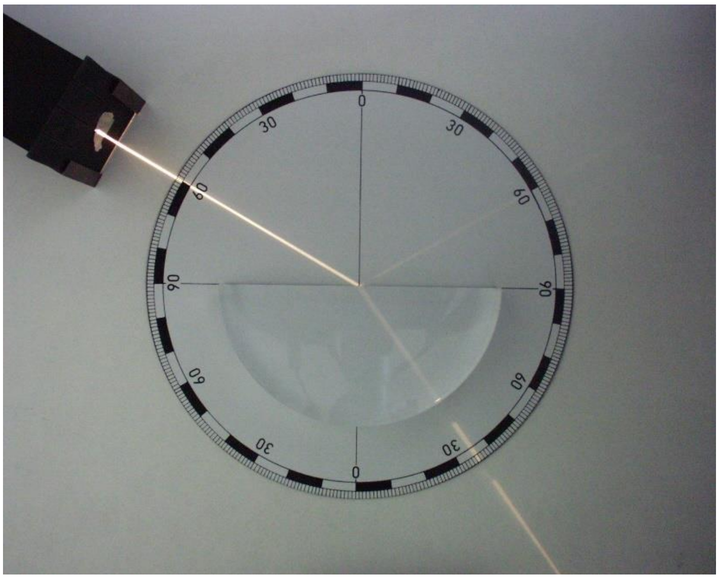


We love the Wikipedia, but it seems the article on Refraction has at least one dubious assertion. It claims that the light changes wavelength at the border. We shall explain the formula they assert:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\lambda_1}{\lambda_2}$$

This says the ratio of the wavelengths in the two materials is the same as the ratio of the sines of the angles the light rays make with the *normal*, an imaginary line perpendicular to the surface at the point of entry. The *sine* (rhymes with wine) of an angle is a number that ranges between 0 for angles near zero degrees to 1 for angles near 90 degrees (right angles.) To put some numbers on this, consider the following measurement:




(By Zátonyi Sándor (ifj.) Fizped (talk) - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2845439)

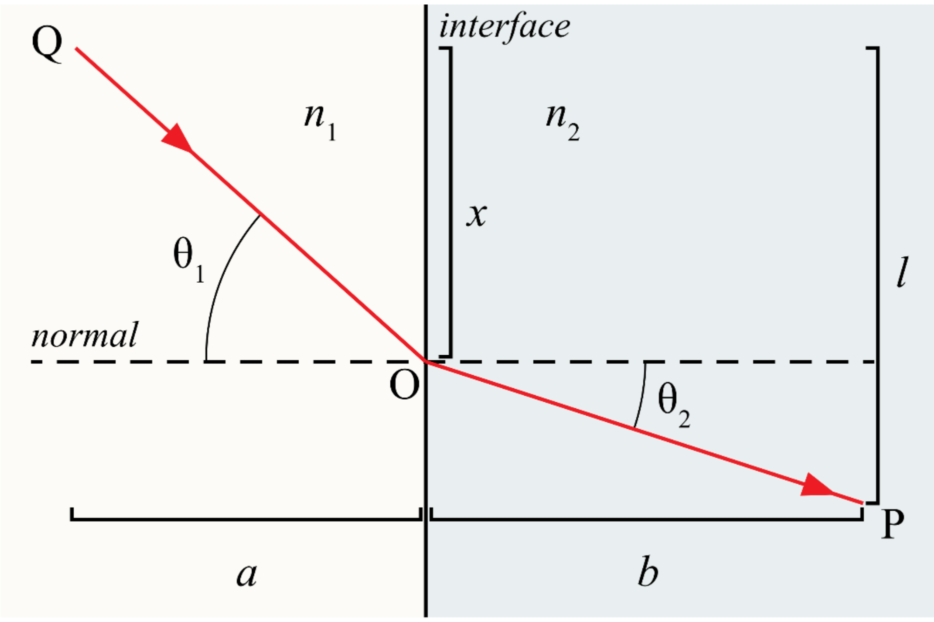
You can see the *normal* to the surface is the vertical line, the light enters at an angle that is 60 degrees to the normal, and inside the material the light ray is 35.5 degrees to the normal. Using the above formula this means a red swimsuit above the surface would appear to be a blue swimsuit under water (glass and water have similar refractive indices.) We simply do not observe this; the assertion that wavelength changes at the surface is not supported by observation.

But we are more concerned about another assertion in the article in the article on Snell's Law: that the velocity of light inside the denser material is slower than that outside:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2}$$

Since $\theta_1$, the angle to the normal in air is larger than $\theta_2$, the angle to the normal in the material, the conclusion is that the velocity of light in air is larger than the velocity of light in water. This is based on the following diagram:

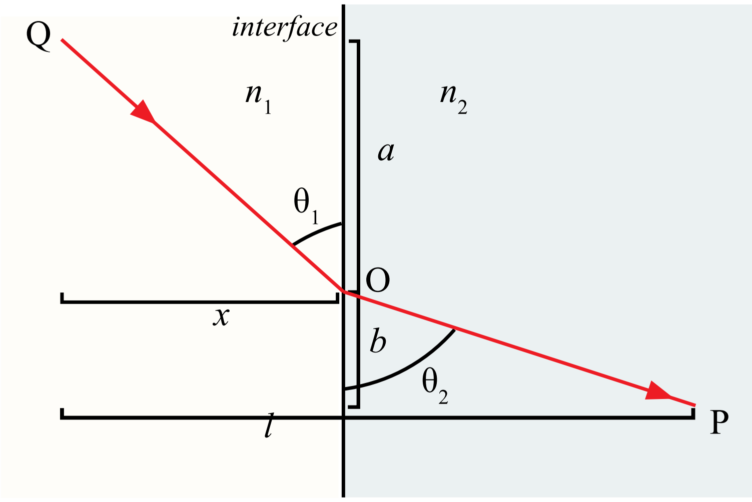
 




https://commons.wikimedia.org/wiki/User:Smedlib

I won't repeat the derivation here. See https://en.wikipedia.org/wiki/Snell%27s_law, Derivation from Fermat's Principle for details.

But suppose you rearrange the picture to derive Snell's Law from the angle of the light ray to the *surface* instead of to the *normal* to the surface. After all, the normal is a human construct: the light ray is unlikely to know much about it, but the surface is a physical phenomenon:




---

The same formula applies, but now $\theta_1$ is smaller than $\theta_2$, so the velocity of light in air is less than that in the material. This is consistent with our earlier finding that neutrinos travel faster through a mountain than through the vacuum of space.

This is also an interesting commentary on the relationship of mathematical models to physical reality, and the role of Confirmation Bias in science. Should we use the angle to the normal to the surface as has been used for centuries, or the angle to the surface?

## Houston, we have a (few) (minor) problem(s)

Before we rush out to market TNP as the best thing since sliced relativity, we should consider its rough edges.

One thing that bothers us is that the remarkably good results on nuclear binding energy are built on the hypothesis that the proton and the neutron have the same diameter. This leads directly to the conclusion that the creation energy of the down quark is twice that of the up quark. This results in a creation energy for the up quark that is 6% below the lowest measured so far. Considering that the range of observations of up quark energy is between -45% and +35% of the average, the 6% discrepancy is not our largest problem: we definitely need better measurements! Nonetheless a theoretical physicist who ignores measurements is on very shaky ground. Think: quicksand.

What happens to TNP if these assumptions are incorrect? The model would become more complex. Our approach has been to construct as simple a model as possible, which is just what gave rise to these assumptions. With more data, we should be able to add only that complexity that is necessitated, keeping the model as simple as possible.

Another thing that bothers us is that as we build up the nucleus, the internal particle structures do not butt up against each other seamlessly in all cases as they do in Figure 5. If this is correct these tiny fissures might be playing a role in nuclear fission, wherein the nuclei of heavy atoms eventually break apart. But if this is not correct it could mean that the internal structure we have chosen for quarks—the truncated icosahedron, or Buckyball—is just not the correct structure (or it could mean that the proton and the neutron are not exactly the same size.) We have not explored all possible structures to see if some other regular or irregular structure or size ratio might deliver an even better result. What we would love to have here is better tools for constructing nuclear models, so we can explore the possibilities more rapidly.

And we can't avoid mentioning the shadow cast on TNP for being able to explain superluminal neutrinos in matter, an observation that has now been retracted. If it turns out the original experiments were in error and this part of the model is irrelevant, that does not mean that TNP in its entirety is an incorrect model of reality. A good model is extended and retracted as experimental observations improve over time. The good parts remain and build a firmer foundation for the future.

Then there is the large set of experimental results to which TNP model has not yet been extended. TNP already covers a wider set of physical phenomena than any other model in physics ever has. But there is still a massive amount of work to do before we are convinced we are on the right track. Then again there was that man who committed suicide by jumping off the roof of a 30-storey building. Passing the 17$^{th}$ floor on the way down, he declared, "So far, so good!"