Glueball and Photonic Molecules

After years of searching, researchers say they've lastlyidentified a glueball - a particle made only of nuclear force. Hypothesized to exist as part of the standard model of particle physics, glueballs have stunned researchers since the 1970s as they can only be spotted indirectly by measuring their procedure of decay. Now, a group of particle scientists in Austria say they've found proof for the existence of glueballs by observing the decay of a particle identified as f0(1710). Protons and neutrons - the particles that everyday matter consist of - are made of tiny elementary particles called quarks, and quarks are seized together by even minor particles called gluons. [11]

The findings build on previous research that several team members contributed to before joining NIST. In 2013, collaborators from Harvard, Caltech and MIT found a way to bind two photons together so that one would sit right atop the other, superimposed as they travel. Their experimental demonstration was considered a breakthrough, because no one had ever constructed anything by combining individual photons—inspiring some to imagine that real-life lightsabers were just around the corner. [10]

The drop of plasma was created in the Large Hadron Collider (LHC). It is made up of two types of subatomic particles: quarks and gluons. Quarks are the building blocks of particles like protons and neutrons, while gluons are in charge of the strong interaction force between quarks. The new quark-gluon plasma is the hottest liquid that has ever been created in a laboratory at 4 trillion C (7 trillion F). Fitting for a plasma like the one at the birth of the universe. [9]

Taking into account the Planck Distribution Law of the electromagnetic oscillators, we can explain the electron/proton mass rate and the Weak and Strong Interactions. Lattice QCD gives the same results as the diffraction patterns of the electromagnetic oscillators, explaining the color confinement and the asymptotic freedom of the Strong Interactions.

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Preface

The diffraction patterns of the electromagnetic oscillators give the explanation of the Electroweak and Electro-Strong interactions. [2] Lattice QCD gives the same results as the diffraction patterns which explain the color confinement and the asymptotic freedom.

The hadronization is the diffraction pattern of the baryons giving the jet of the color – neutral particles!

Scientists Claim That They've Found A Particle Which Is Entirely Made of Nuclear Force

Which are also recognized as 'sticky particles', massless gluons are termed as a complex version of the photon, because just like how photons are accountable for exerting the force of electromagnetism, gluons are come in while exerting a strong nuclear force. One of the scientists who found evidence for the presence of "glueball", Anton Rebhan from the Vienna University of Technology, said "In particle physics, every force is mediated by a special kind of force particle, and the force particle of the strong nuclear force is the gluon," But there is one big variance between the two: while photons aren't affected by the force they apply, gluons are. This vital fact means that while photons can't be present in what's known as a bound state, gluons can be bound together via their own nuclear force to create glueballs.

J.E. Reich wrote for TechTimes as "The existence of glueball particles brings the idea that, not only can particles be forces or force carriers (i.e., photons), but that these massless particles are also contingent upon the force that they are made up of, allowing glueballs to exist in a static state,"

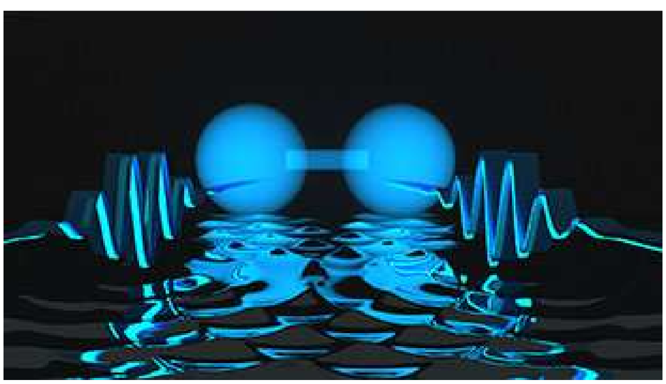
Gluons can be massless on their own, but their contacts with each other give glueballs a mass, which, hypothetically, permits scientists to detect them, if only indirectly through their decay procedure. And although numerous particles have been acknowledged in particle accelerator experiments as being practical candidates for glueballs, until now, no one's been able to make a definite case for any of them comprising of pure atomic force.

The closest researchers have gotten to spotting a glueball is narrowing in on two probable contenders: f0(1500) and f0(1710), which are subatomic particles called mesons that are composed of one quark and one antiquark each.

The scientists are expecting the new data from experimentations at the Large Hadron Collider at CERN (TOTEM and LHCb) in Switzerland and an another accelerator experiment in Beijing (BESIII) will support them strengthen their situation for f0(1710) being a glueball. According to Rebhan "These results will be crucial for our theory. For these multi-particle processes, our theory predicts decay rates which are quite different from the predictions of other, simpler models. If the measurements agree with our calculations, this will be a remarkable success for our approach." [11]

NIST Physicists Show 'Molecules' Made of Light May Be Possible

It's not lightsaber time, not yet. But a team including theoretical physicists from the National Institute of Standards and Technology (NIST) has taken another step toward building objects out of photons, and the findings* hint that weightless particles of light can be joined into a sort of "molecule" with its own peculiar force.



Researchers show that two photons, depicted in this artist's conception as waves (left and right), can be locked together at a short distance. Under certain conditions, the photons can form a state resembling a two-atom molecule, represented as the blue dumbbell shape at center.

The findings build on previous research that several team members contributed to before joining NIST. In 2013, collaborators from Harvard, Caltech and MIT found a way to bind two photons together so that one would sit right atop the other, superimposed as they travel. Their experimental demonstration was considered a breakthrough, because no one had ever constructed anything by combining individual photons—inspiring some to imagine that real-life lightsabers were just around the corner.

Now, in a paper forthcoming in Physical Review Letters, the NIST and University of Maryland-based team (with other collaborators) has showed theoretically that by tweaking a few parameters of the binding process, photons could travel side by side, a specific distance from each other. The arrangement is akin to the way that two hydrogen atoms sit next to each other in a hydrogen molecule.

“It’s not a molecule per se, but you can imagine it as having a similar kind of structure,” says NIST’s Alexey Gorshkov. “We’re learning how to build complex states of light that, in turn, can be built into more complex objects. This is the first time anyone has shown how to bind two photons a finite distance apart."

While the new findings appear to be a step in the right direction—if we can build a molecule of light, why not a sword?—Gorshkov says he is not optimistic that Jedi Knights will be lining up at NIST’s gift shop anytime soon. The main reason is that binding photons requires extreme conditions difficult to produce with a roomful of lab equipment, let alone fit into a sword’s handle. Still, there are plenty of other reasons to make molecular light—humbler than lightsabers, but useful nonetheless.

“Lots of modern technologies are based on light, from communication technology to high-definition imaging,” Gorshkov says. “Many of them would be greatly improved if we could engineer interactions between photons.”

For example, engineers need a way to precisely calibrate light sensors, and Gorshkov says the findings could make it far easier to create a “standard candle” that shines a precise number of photons at a detector. Perhaps more significant to industry, binding and entangling photons could allow computers to use photons as information processors, a job that electronic switches in your computer do today.

Not only would this provide a new basis for creating computer technology, but it also could result in substantial energy savings. Phone messages and other data that currently travel as light beams through fiber optic cables has to be converted into electrons for processing—an inefficient step that wastes a great deal of electricity.

If both the transport and the processing of the data could be done with photons directly, it could reduce these energy losses.

Gorshkov says it will be important to test the new theory in practice for these and other potential benefits.

“It’s a cool new way to study photons,” he says. “They’re massless and fly at the speed of light. Slowing them down and binding them may show us other things we didn’t know about them before.” [10]

Physicists Recreate Substance Similar To The Plasma Believed To Have Existed At The Very Beginning Of The Universe

The first seconds of the universe were filled with a boiling, chaotic inferno. It was packed with a dense plasma: a soup-like fire, made up of some of the tiniest particles in the universe. Unbelievably, physicists have recreated a substance that they think is very similar to this early universe plasma. Albeit, just the tiniest drop.

The drop of plasma was created in the Large Hadron Collider (LHC). It is made up of two types of subatomic particles: quarks and gluons. Quarks are the building blocks of particles like protons and neutrons, while gluons are in charge of the strong interaction force between quarks. The new quark-gluon plasma is the hottest liquid that has ever been created in a laboratory at 4 trillionoC (7 trillionoF). Fitting for a plasma like the one at the birth of the universe.

The plasma was created after a collision between a proton and a lead nucleus. The physicists had always thought that this collision wouldn't produce enough particles (around 1,000) to create a plasma. A collision between two lead nuclei, for comparison, is known to produce plasma but creates twenty times more particles (around 25,000) following collision. However, the results defied their expectations.

“Before the CMS experimental results, it had been thought the medium created in a proton on lead collisions would be too small to create a quark-gluon plasma,” said Quan Wang, a physicist from Kansas University (KU), in a statement. "The analysis presented in this paper indicates, contrary to expectations, a quark-gluon plasma can be created in very asymmetric proton on lead collisions."

“This is the first paper that clearly shows multiple particles are correlated to each other in proton-lead collisions, similar to what is observed in lead-lead collisions where quark-gluon plasma is produced,” added Yen-Jie Lee, from the Michigan Institute of Technology (MIT). “This is probably the first evidence that the smallest droplet of quark-gluon plasma is produced in proton-lead collisions.”

This new research looks at particle physics with a fresh perspective. Instead of counting individual numbers of particles, the plasma forces physicists to look at the behavior of a volume of particles.

There is also speculation that this plasma replicates the conditions of the early universe. “It’s believed to correspond to the state of the universe shortly after the Big Bang,” Wang continued. This plasma is different to other quark-gluon plasma that have been made before now. The interactions in this plasma are extremely strong, which distinguishes it from other plasmas which interact infrequently (like gas particles). This is what makes the researchers think it might be similar to an early universe plasma.

“While we believe the state of the universe about a microsecond after the Big Bang consisted of a quark-gluon plasma, there is still much that we don't fully understand about the properties of quark-gluon plasma.” [9]

Asymmetry in the interference occurrences of oscillators

The asymmetrical configurations are stable objects of the real physical world, because they cannot annihilate. One of the most obvious asymmetry is the proton – electron mass rate $M_p = 1840\ M_e$

while they have equal charge. We explain this fact by the strong interaction of the proton, but how remember it his strong interaction ability for example in the H – atom where are only electromagnetic interactions among proton and electron.

This gives us the idea to origin the mass of proton from the electromagnetic interactions by the way interference occurrences of oscillators. The uncertainty relation of Heisenberg makes sure that the particles are oscillating.

The resultant intensity due to n equally spaced oscillators, all of equal amplitude but different from one another in phase, either because they are driven differently in phase or because we are looking at them an angle such that there is a difference in time delay:

(1) $I = I_0 \sin^2 n\,\phi/2 \,/\, \sin^2 \phi/2$

If ϕ is infinitesimal so that $\sin\phi = \phi$, than

(2) $I = n^2 I_0$

This gives us the idea of

(3) $M_p = n^2 M_e$

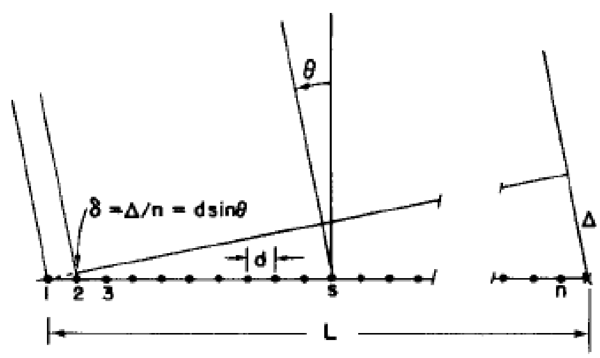


Fig. 30–3. A linear array of n equal oscillators, driven with phases $\alpha_s = s\alpha$.

Figure 1.) A linear array of n equal oscillators

There is an important feature about formula (1) which is that if the angle ϕ is increased by the multiple of 2π, it makes no difference to the formula.

So

(4) $d \sin\theta = m\,\lambda$

and we get m-order beam if λ less than d. [6]

If d less than λ we get only zero-order one centered at $\theta = 0$. Of course, there is also a beam in the opposite direction. The right chooses of d and λ we can ensure the conservation of charge.

For example

(5) $2(m+1) = n$

Where $2(m+1) = N_p$ number of protons and $n = N_e$ number of electrons.

In this way we can see the H_2 molecules so that 2n electrons of n radiate to 4(m+1) protons, because $d_e > \lambda_e$ for electrons, while the two protons of one H_2 molecule radiate to two electrons of them, because of $d_e < \lambda_e$ for this two protons.

To support this idea we can turn to the Planck distribution law, that is equal with the Bose – Einstein statistics.

Spontaneously broken symmetry in the Planck distribution law

The Planck distribution law is temperature dependent and it should be true locally and globally. I think that Einstein's energy-matter equivalence means some kind of existence of electromagnetic oscillations enabled by the temperature, creating the different matter formulas, atoms molecules, crystals, dark matter and energy.

Max Planck found for the black body radiation

As a function of wavelength (λ), Planck's law is written as:

$$B_\lambda(T) = \frac{2hc^2}{\lambda^5}\frac{1}{e^{\frac{hc}{\lambda k_B T}} - 1}.$$

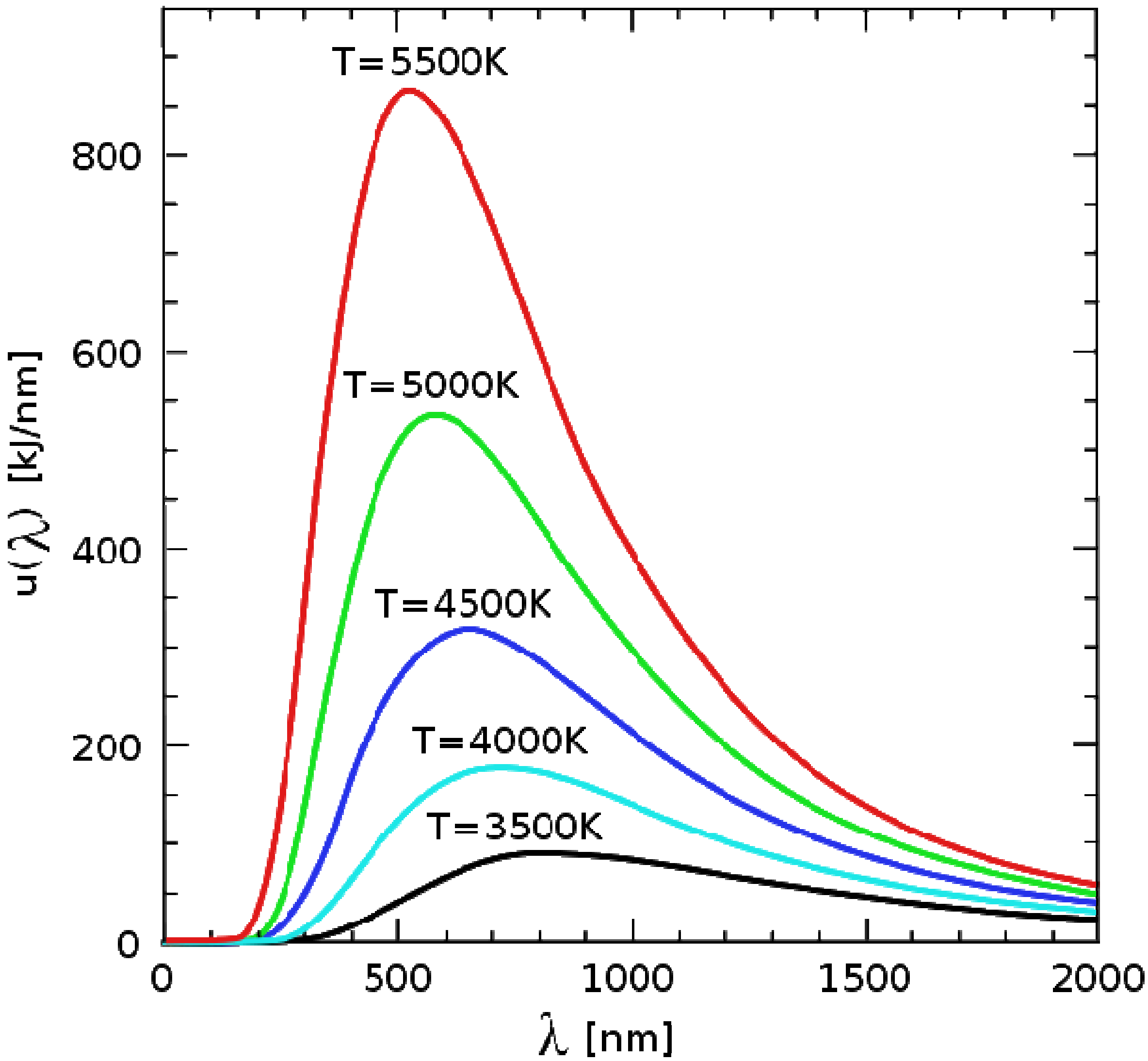


Figure 2. The distribution law for different T temperatures

We see there are two different λ_1 and λ_2 for each T and intensity, so we can find between them a d so that $\lambda_1 < d < \lambda_2$.

We have many possibilities for such asymmetrical reflections, so we have many stable oscillator configurations for any T temperature with equal exchange of intensity by radiation. All of these configurations can exist together. At the λ_{max} is the annihilation point where the configurations are symmetrical. The λ_{max} is changing by the Wien's displacement law in many textbooks.

(7) $$\lambda_{max} = \frac{b}{T}$$

where λ_{max} is the peak wavelength, T is the absolute temperature of the black body, and b is a constant of proportionality called *Wien's displacement constant*, equal to $2.8977685(51) \times 10^{-3}$ m·K (2002 CODATA recommended value).

By the changing of T the asymmetrical configurations are changing too.

The structure of the proton

We must move to the higher T temperature if we want look into the nucleus or nucleon arrive to $d<10^{-13}$ cm. [2] If an electron with $\lambda_e < d$ move across the proton then by (5) $2(m+1) = n$ with $m = 0$ we get $n = 2$ so we need two particles with negative and two particles with positive charges. If the proton can fraction to three parts, two with positive and one with negative charges, then the reflection of oscillators are right. Because this very strange reflection where one part of the proton with the electron together on the same side of the reflection, the all parts of the proton must be quasi lepton so $d > \lambda_q$. One way dividing the proton to three parts is, dividing his oscillation by the three direction of the space. We can order 1/3 e charge to each coordinates and 2/3 e charge to one plane oscillation, because the charge is scalar. In this way the proton has two +2/3 e plane oscillation and one linear oscillation with -1/3 e charge. The colors of quarks are coming from the three directions of coordinates and the proton is colorless. The flavors of quarks are the possible oscillations differently by energy and if they are plane or linear oscillations. We know there is no possible reflecting two oscillations to each other which are completely orthogonal, so the quarks never can be free, however there is asymptotic freedom while their energy are increasing to turn them to orthogonal. If they will be completely orthogonal then they lose this reflection and take new partners from the vacuum. Keeping the symmetry of the vacuum the new oscillations are keeping all the conservation laws, like charge, number of baryons and leptons. The all features of gluons are coming from this model. The mathematics of reflecting oscillators show Fermi statistics.

Important to mention that in the Deuteron there are 3 quarks of +2/3 and -1/3 charge, that is three u and d quarks making the complete symmetry and because this its high stability.

The weak interaction

The weak interaction transforms an electric charge in the diffraction pattern from one side to the other side, causing an electric dipole momentum change, which violates the CP and time reversal symmetry.

Another important issue of the quark model is when one quark changes its flavor such that a linear oscillation transforms into plane oscillation or vice versa, changing the charge value with 1 or -1. This kind of change in the oscillation mode requires not only parity change, but also charge and time changes (CPT symmetry) resulting a right handed anti-neutrino or a left handed neutrino.

The right handed anti-neutrino and the left handed neutrino exist only because changing back the quark flavor could happen only in reverse, because they are different geometrical constructions, the u is 2 dimensional and positively charged and the d is 1 dimensional and negatively charged. It needs also a time reversal, because anti particle (anti neutrino) is involved.

The neutrino is a 1/2spin creator particle to make equal the spins of the weak interaction, for example neutron decay to 2 fermions, every particle is fermions with ½ spin. The weak interaction changes the entropy since more or less particles will give more or less freedom of movement. The entropy change is a result of temperature change and breaks the equality of oscillator diffraction intensity of the Maxwell–Boltzmann statistics. This way it changes the time coordinate measure and makes possible a different time dilation as of the special relativity.

The limit of the velocity of particles as the speed of light appropriate only for electrical charged particles, since the accelerated charges are self maintaining locally the accelerating electric force. The neutrinos are CP symmetry breaking particles compensated by time in the CPT symmetry, that is the time coordinate not works as in the electromagnetic interactions, consequently the speed of neutrinos is not limited by the speed of light.

The weak interaction T-asymmetry is in conjunction with the T-asymmetry of the second law of thermodynamics, meaning that locally lowering entropy (on extremely high temperature) causes the weak interaction, for example the Hydrogen fusion.

Probably because it is a spin creating movement changing linear oscillation to 2 dimensional oscillation by changing d to u quark and creating anti neutrino going back in time relative to the proton and electron created from the neutron, it seems that the anti neutrino fastest then the velocity of the photons created also in this weak interaction?

A quark flavor changing shows that it is a reflection changes movement and the CP- and T- symmetry breaking. This flavor changing oscillation could prove that it could be also on higher level such as atoms, molecules, probably big biological significant molecules and responsible on the aging of the life.

Important to mention that the weak interaction is always contains particles and antiparticles, where the neutrinos (antineutrinos) present the opposite side. It means by Feynman's interpretation that these particles present the backward time and probably because this they seem to move faster than the speed of light in the reference frame of the other side.

Finally since the weak interaction is an electric dipole change with ½ spin creating; it is limited by the velocity of the electromagnetic wave, so the neutrino's velocity cannot exceed the velocity of light.

The Strong Interaction - QCD

Confinement and Asymptotic Freedom

For any theory to provide a successful description of strong interactions it should simultaneously exhibit the phenomena of confinement at large distances and asymptotic freedom at short distances. Lattice calculations support the hypothesis that for non-abelian gauge theories the two domains are analytically connected, and confinement and asymptotic freedom coexist.
Similarly, one way to show that QCD is the correct theory of strong interactions is that the coupling extracted at various scales (using experimental data or lattice simulations) is unique in the sense that its variation with scale is given by the renormalization group. The data for αs is reviewed in Section 19. In this section I will discuss what these statements mean and imply. [4]

Lattice QCD

Lattice QCD is a well-established non-perturbative approach to solving the quantum chromodynamics (QCD) theory of quarks and gluons. It is a lattice gauge theory formulated on a grid or lattice of points in space and time. When the size of the lattice is taken infinitely large and its sites infinitesimally close to each other, the continuum QCD is recovered. [6]

Analytic or perturbative solutions in low-energy QCD are hard or impossible due to the highly nonlinear nature of the strong force. This formulation of QCD in discrete rather than continuous space-time naturally introduces a momentum cut-off at the order $1/a$, where a is the lattice spacing, which regularizes the theory. As a result, lattice QCD is mathematically well-defined. Most importantly, lattice QCD provides a framework for investigation of non-perturbative phenomena such as confinement and quark-gluon plasma formation, which are intractable by means of analytic field theories.

In lattice QCD, fields representing quarks are defined at lattice sites (which leads to fermion doubling), while the gluon fields are defined on the links connecting neighboring sites.

QCD

QCD enjoys two peculiar properties:

- **Confinement**, which means that the force between quarks does not diminish as they are separated. Because of this, it would take an infinite amount of energy to separate two quarks; they are forever bound into hadrons such as the proton and the neutron. Although analytically unproven, confinement is widely believed to be true because it explains the consistent failure of free quark searches, and it is easy to demonstrate in lattice QCD.
- **Asymptotic freedom**, which means that in very high-energy reactions, quarks and gluons interact very weakly. This prediction of QCD was first discovered in the early 1970s by David Politzer and by Frank Wilczek and David Gross. For this work they were awarded the 2004 Nobel Prize in Physics.

There is no known phase-transition line separating these two properties; confinement is dominant in low-energy scales but, as energy increases, asymptotic freedom becomes dominant. [5]

Color Confinement

When two quarks become separated, as happens in particle accelerator collisions, at some point it is more energetically favorable for a new quark-antiquark pair to spontaneously appear, than to allow the tube to extend further. As a result of this, when quarks are produced in particle accelerators, instead of seeing the individual quarks in detectors, scientists see "jets" of many color-neutral particles (mesons and baryons), clustered together. This process is called hadronization, fragmentation, or string breaking, and is one of the least understood processes in particle physics. [3]

Electromagnetic inertia and mass

Electromagnetic Induction

Since the magnetic induction creates a negative electric field as a result of the changing acceleration, it works as an electromagnetic inertia, causing an electromagnetic mass. [1]

The frequency dependence of mass

Since $E = hv$ and $E = mc^2$, $m = hv /c^2$ that is the m depends only on the v frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the m_o inertial mass is the result of the spin, since this is the only accelerating motion of the electric charge. Since the accelerating motion has different frequency for the electron in the atom and the proton, they masses are different, also as the wavelengths on both sides of the diffraction pattern, giving equal intensity of radiation.

Electron – Proton mass rate

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other. [2]

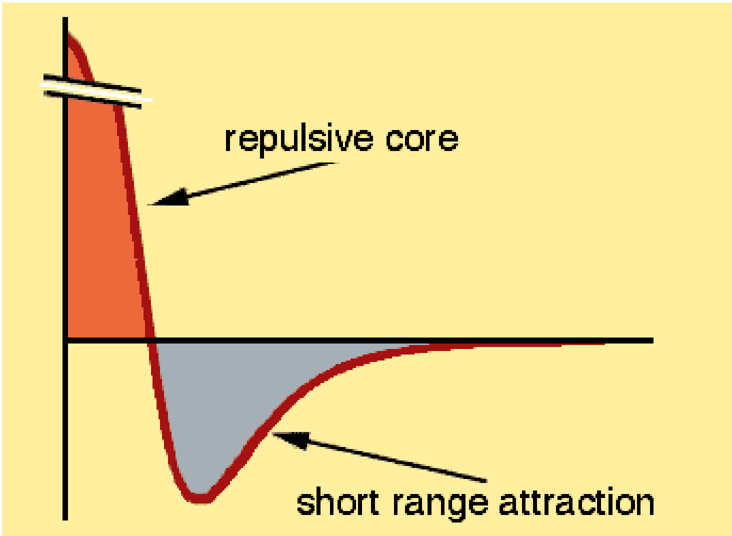
There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

The potential of the diffraction pattern

The force that holds protons and neutrons together is extremely strong. It has to be strong to overcome the electric repulsion between the positively charged protons. It is also of very short range, acting only when two particles are within 1 or 2 fm of each other.

1 fm (femto meter) = 10^{-15} m = 10^{-15} m = 0.000000000000001 meters.

The qualitative features of the nucleon-nucleon force are shown below.



There is an extremely **strong short-range repulsion** that pushes protons and neutrons apart before they can get close enough to touch. (This is shown in orange.) This repulsion can be understood to arise because the quarks in individual nucleons are forbidden to be in the same area by the Pauli Exclusion Principle.

There is a **medium-range attraction** (pulling the neutrons and protons together) that is strongest for separations of about 1 fm. (This is shown in gray.) This attraction can be understood to arise from the exchange of quarks between the nucleons, something that looks a lot like the exchange of a pion when the separation is large.

The density of nuclei is limited by the short range repulsion. The maximum size of nuclei is limited by the fact that the attractive force dies away extremely quickly (exponentially) when nucleons are more than a few fm apart.

Elements beyond uranium (which has 92 protons), particularly the trans-fermium elements (with more than 100 protons), tend to be unstable to fission or alpha decay because the Coulomb repulsion between protons falls off much more slowly than the nuclear attraction. This means that each proton sees repulsion from every other proton but only feels an attractive force from the few neutrons and protons that are nearby -- even if there is a large excess of neutrons.

Some "super heavy nuclei" (new elements with about 114 protons) might turn out to be stable as a result of the same kind of quantum mechanical shell-closure that makes noble gases very stable chemically. [7]

Conclusions

Lattice QCD gives the same results as the diffraction theory of the electromagnetic oscillators, which is the explanation of the strong force and the quark confinement. [8]

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