Leptoquarks by LHeC

Leptoquark's Tracks? The ZEUS detector began showing results that hinted at the leptoquark last fall. More intriguing results emerged from Fermilab a year ago. A preliminary analysis of a few anomalous collisions between protons suggested that their constituent quarks might be made of smaller, more fundamental entities--a direct violation of the Standard Model. After subsequent analysis, however, the "subquarks" vanished; theorists showed that with minor tweaking, the Standard Model could easily account for the data. [11]

An intriguing signal from the Large Hadron Collider (LHC) might prove to be the crack that prises apart the standard model — physicists' current best description of how matter and forces interact. [10]

Named Ds3(2860), the particle, a new type of meson, was discovered by analyzing data collected with the LHCb detector at CERN's Large Hadron Collider (LHC). The new particle is bound together in a similar way to protons. Due to this similarity, the Warwick researchers argue that scientists will now be able to study the particle to further understand strong interactions. [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 discovery of a new particle will "transform our understanding" of the fundamental force of nature that binds the nuclei of atoms, researchers argue. Led by scientists from the University of Warwick, the discovery of the new particle will help provide greater understanding of the strong interaction, the fundamental force of nature found within the protons of an atom's nucleus.

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!

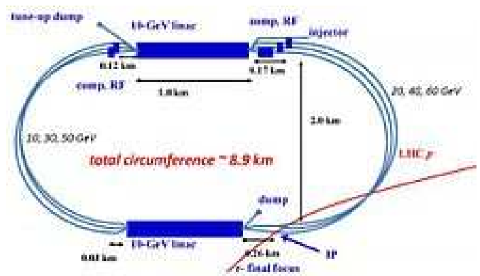
Leaping Leptoquarks!

Leptoquarks are predicted by certain grand unified theories; called GUTs, they postulate an underlying unity between the electroweak force, which accounts for electromagnetism and nuclear decay, and the strong force, which binds quarks together. But all the protons in the universe would have decayed by now if the leptoquarks actually existed at the energy levels attained in HERA, points out David Miller of University College London.

Leptoquarks also appear in certain versions of supersymmetry; this much loved but still unverified theory posits an underlying unity between particles that transmit forces and particles that bear mass. Unfortunately, the HERA results would support a rather ungainly and thus unpopular version of supersymmetry. Theorists have also proposed that the HERA observations might derive from subquarks or from a new force that couples quarks and positrons at high energies.

HERA researchers expect to have enough additional data to rule out or confirm some of these hypotheses by the end of this year. There is a 1 percent chance that the "leptoquarks" will turn out to be statistical fluctuations that the standard model can accommodate, according to Allen Caldwell, a spokesperson for the ZEUS team. Although that probability seems small, he notes, it must still be considered the most likely outcome, given the history of similar observations.

Frank Wilczek of the Institute for Advanced Study in Princeton, N.J., took the HERA reports seriously enough to co-author a paper on their theoretical implications.
But he says those implications, given all the other constraints imposed by previous experiments, evoke explanations that even particle physicists might find too odd to believe. "Whatever is true is good for physics," Wilczek says. "But it's not what anyone wanted." Caldwell, who at the age of 37 has been "living with the Standard Model" for his entire career, demurs. He notes that members of his generation have never experienced the thrill of a totally new and unexpected finding. "Let's hope that this one doesn't go away," he says. [11]



Current default layout of the LHeC recirculating linear electron accelerator complex. Collisions with the proton beam happen at the interaction point (IP).

Leptoquarks are hypothetical particles that carry information between quarks and leptons of a given generation that allow quarks and leptons to interact. They are color-triplet bosons that carry both lepton and baryon numbers. They are encountered in various extensions of the Standard Model, such as technicolor theories or GUTs based on Pati–Salam model, SU(5) or E6, etc. Their quantum numbers like spin, (fractional) electric charge and weak isospin vary among theories.

Leptoquarks, predicted to be nearly as heavy as an atom of lead, could only be created at high energies, and would decay rapidly. A third generation leptoquark, for example, might decay into a bottom quark and a tau lepton. Some theorists propose that the 'leptoquark' observed by HERA and DESY could be a new force that bonds positrons and quarks or be examples of preons found at high energies. Leptoquarks could explain the reason for the three generations of matter.
Furthermore, leptoquarks could explain why the same number of quarks and leptons exist and many other similarities between the quark and the lepton sectors. At high energies, when leptons that do not feel the strong force and quarks that cannot be separately observed because of the strong force become one, it could form a more fundamental particle and describe a higher symmetry. There would be three kinds of leptoquarks made of the leptons and quarks of each generation.

The LHeC project to add an electron ring to collide bunches with the existing LHC proton ring is proposed as a project to look for higher-generation leptoquarks. [12]

The Large Hadron Electron Collider (LHeC) is an accelerator study for a possible upgrade of the existing LHC storage ring - the currently highest energy proton accelerator operating at CERN in Geneva. By adding to the proton accelerator ring a new electron accelerator, the LHeC would enable the investigation of electron-proton and electron-ion collisions at unprecedented high energies and rate, much higher than had been possible at the electron-proton collider HERA at DESY at Hamburg, which terminated its operation in 2007. The LHeC has therefore a unique program of research, as on the substructure of the proton and nuclei or the physics of the newly discovered Higgs boson. The basic concept of the LHeC consists in two linear superconducting accelerators of about 1 km length each, which arranged in a racetrack configuration tangential to the LHC are passed three times before the e-p collision. With the acceleration in each linac of the electrons to about 10 GeV energy, the final beam has about 60 GeV energy in collision with then 7 TeV protons or 2.7 TeV lead ions. A unique feature of the design is the optimization for a particularly low power consumption. That is achieved by decelerating the electron beam after the collision and gaining back nearly all its energy into the cavity system of the linacs, a principle termed energy recovery. Currently, preparations of an international collaboration with CERN are ongoing for developing superconducting accelerator cavities, at the appropriate frequency of 802 MHz. In parallel a design study for an energy recovery linac test platform is being pursued at CERN. Related to the proton and heavy ion physics of the LHC, the physics program and a detector for the LHeC are under study also. For maximum use of the operation time and resources of the LHC complex at CERN it is envisaged that electron-proton and proton-proton data are taken simultaneously. The LHeC electron beam may be combined with a multi-10-TeV proton beam in the far future, which is under consideration in a worldwide study at CERN since 2013. [13]

LHC signal hints at cracks in physics' standard model

Analysis of data gathered during 2011–12 at the collider at CERN, Europe’s particle-physics laboratory near Geneva, Switzerland, suggests that in particular decays, short-lived particles called B-mesons create taus more frequently than they create muons. (Taus and muons are heavier cousins of electrons.) But the standard model says that once the particles’ mass differences are taken into account, the decays should occur at exactly the same rate. The finding will be published in Physical Review Letters this month (and has been on the arXiv1 pre-print server since June).

The discrepancy in decay rates, spotted at the collider’s LHCb experiment, is small and cannot be claimed as a discovery, because the anomaly may be merely a statistical fluctuation that could fade as more data are collected on B-meson decays. Particle physicists’ usual threshold for announcing a discovery is, in statistical parlance, 5 sigma; the LHCb signal has reached only 2.1 sigma.

But physicists are excited because the same anomaly has also been seen in results from two previous experiments: the ‘BaBar’ experiment at the SLAC National Accelerator Laboratory in Menlo Park, California, which reported it in 20122, and the ‘Belle’ experiment at Japan’s High Energy Accelerator Research Organization (KEK) in Tsukuba, which reported its latest results at a conference in May. LHCb's result is “bang on" the previous two, says Mitesh Patel, a physicist at Imperial College London who works on the experiment.

“A 2-sigma difference in a single measurement isn’t interesting by itself,” says Tara Shears, a particle physicist at the University of Liverpool, UK, and a member of the LHCb collaboration. “But a series of

2-sigma differences, found in different types of decay and independently by different people in a different experiment, become very intriguing indeed."

New physics?

Last year, LHCb found a similar bias, with a significance of 2.6 sigma, in decays of another type of B meson, this time a preference to decay into electrons rather than muons. What makes both measurements so exciting is that if the results prove real, they could point to the same underlying new physics, says Shears.

Both biases could potentially be explained, for example, by positing another kind of Higgs boson, which possesses charge and interacts differently with the various particles involved in the decays. Supersymmetry, a popular theory that seeks to extend the standard model, predicts such multiple Higgs bosons, although Patel says that, should the signal prove real, this is just one of many potential explanations.

Don Lincoln, a physicist at another LHC experiment called CMS, cautions that the findings are still most probably a statistical fluctuation or an improperly estimated uncertainty in the experiment. But seeing the discrepancy in multiple places should make people pay attention. "This is clearly something that must be studied in more detail," he says.

The finding is based on data from the LHC's first run, and physicists will have to wait for as long as a year to gather a similar amount of data from the collider's second run, which began on 3 June. In the meantime, the LHCb team will examine other similar decays in existing data to see if further biases emerge, says Patel.

Physicists at CMS and the LHC experiment ATLAS are chasing their own intriguing results. They search for new particles directly (unlike LHCb, which tries to spot such particles by their indirect influence on known decays). Both CMS and ATLAS have seen low-significance 'bumps' within roughly the same mass region of their data — around 2 teraelectronvolts (TeV) — which could be caused by decays of a new particle, although it is not clear whether the findings are entirely compatible.

The latest ATLAS paper, available on the arXiv, puts the signal's statistical significance at 3.4 sigma. [10]

New subatomic particle sheds light on fundamental force of nature

Named Ds3*(2860), the particle, a new type of meson, was discovered by analyzing data collected with the LHCb detector at CERN's Large Hadron Collider (LHC). The new particle is bound together in a similar way to protons. Due to this similarity, the Warwick researchers argue that scientists will now be able to study the particle to further understand strong interactions.

"Calculations of strong interactions are done with a computationally intensive technique called Lattice QCD," says Professor Gershon. "In order to validate these calculations it is essential to be able to compare predictions to experiments. The new particle is ideal for this purpose because it is the first known that both contains a charm quark and has spin 3."

There are six quarks known to physicists; Up, Down, Strange, Charm, Beauty and Top. Protons and neutrons are composed of up and down quarks, but particles produced in accelerators such as the LHC can contain the unstable heavier quarks. In addition, some of these particles have higher spin values than the naturally occurring stable particles.

"Because the Ds3*(2860) particle contains a heavy charm quark it is easier for theorists to calculate its properties. And because it has spin 3, there can be no ambiguity about what the particle is," adds Professor Gershon.

"Therefore it provides a benchmark for future theoretical calculations. Improvements in these calculations will transform our understanding of how nuclei are bound together."

Spin is one of the labels used by physicists to distinguish between particles. It is a concept that arises in quantum mechanics that can be thought of as being similar to angular momentum: in this sense higher spin corresponds to the quarks orbiting each other faster than those with a lower spin.

Warwick Ph.D. student Daniel Craik, who worked on the study, adds "Perhaps the most exciting part of this new result is that it could be the first of many similar discoveries with LHC data. Whether we can use the same technique, as employed with our research into Ds3*(2860), to also improve our understanding of the weak interaction is a key question raised by this discovery. If so, this could help to answer one of the biggest mysteries in physics: why there is more matter than antimatter in the Universe." [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) $M_p = n^2 M_e$

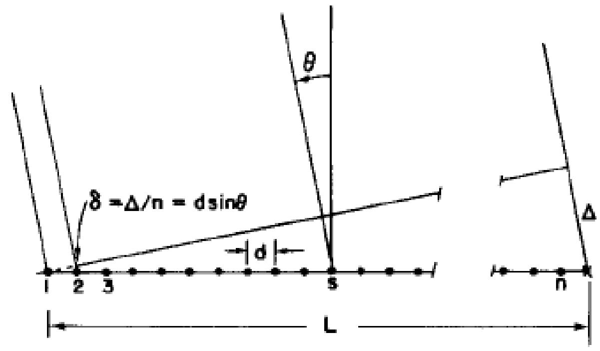


Fig. 30–3. A linear array of n equal oscillators, driven with phases $\alpha_s = s\alpha$.

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:

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

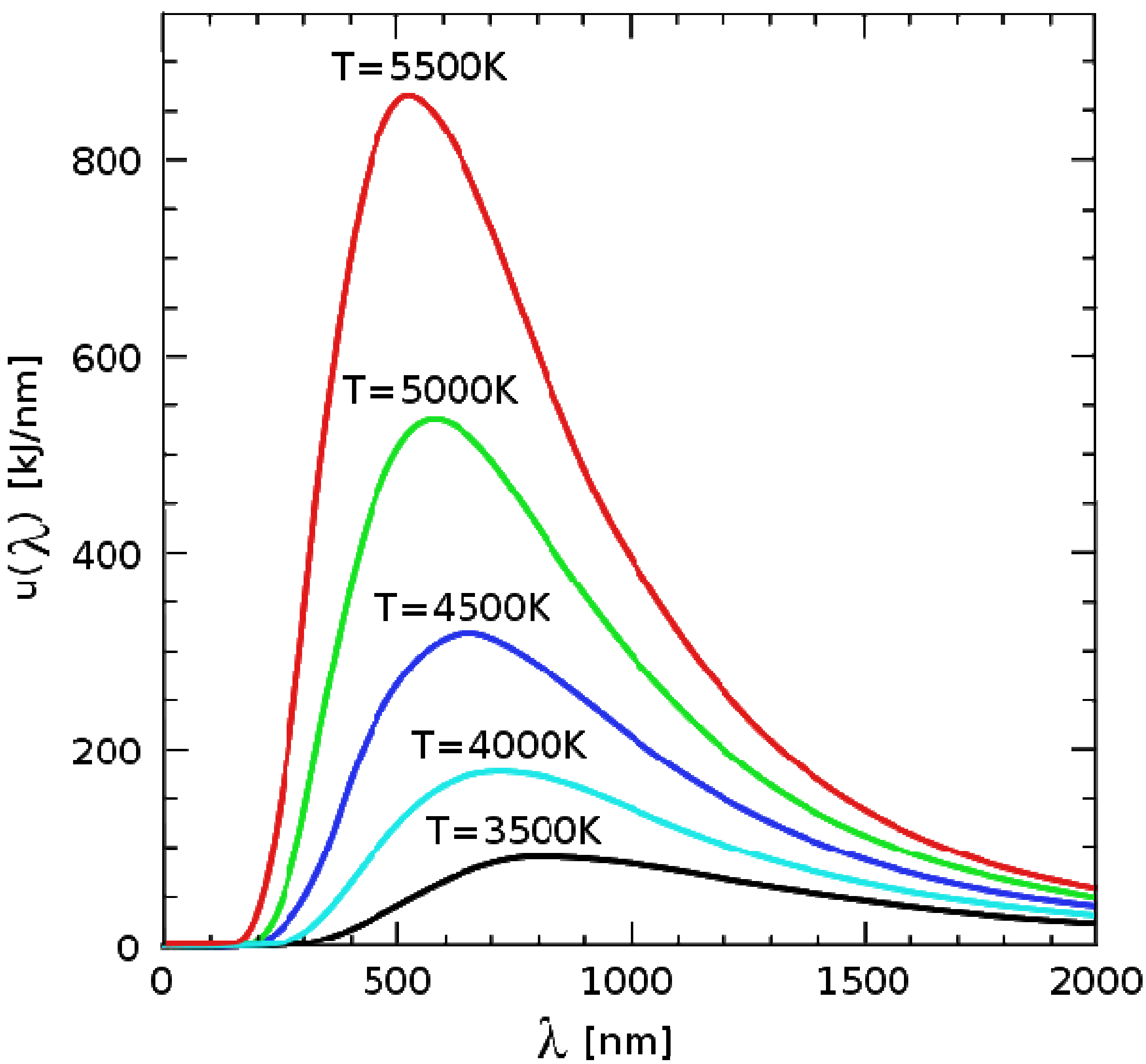


Figure 2. The distribution law for different T temperatures

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) $$\lambda_{\mathrm{max}} = \frac{b}{T}$$

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 $2.8977685(51)\times10^{-3}$ 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]

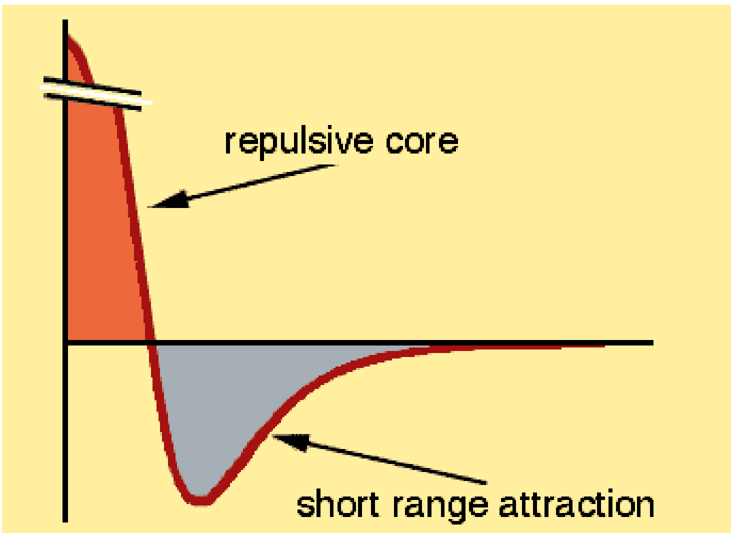
There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a 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

Since the 1970s, experiments have time and again proved the accuracy of the standard model. Yet its failure to account for phenomena such as gravity and dark matter leads many physicists to think that it is merely an approximation of another description beneath. Patel says that he finds LHCb's tantalizing results more convincing than those seen by its rival experiments, but would be happy to see either emerge as real as more data and analysis come in. "The standard model has stood for too long, and we'll take its fall in any way it comes." [10]

Warwick Ph.D. student Daniel Craik, who worked on the study, adds "Perhaps the most exciting part of this new result is that it could be the first of many similar discoveries with LHC data. Whether we can use the same technique, as employed with our research into Ds3*(2860), to also improve our understanding of the weak interaction is a key question raised by this discovery. If so, this could help to answer one of the biggest mysteries in physics: why there is more matter than antimatter in the Universe." [9]

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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