Coronal Heating Problem

It is known that the sun's corona—the outermost layer of the sun's atmosphere—is roughly 100 times hotter than its photosphere—the sun's visible layer. [16]

A team led by scientists from the University of California, Los Angeles and the Department of Energy's SLAC National Accelerator Laboratory has reached another milestone in developing a promising technology for accelerating particles to high energies in short distances: They created a tiny tube of hot, ionized gas, or plasma, in which the particles remain tightly focused as they fly through it. [15]

Using the Continuous Electron Beam Accelerator Facility (CEBAF) at the Department of Energy's Jefferson Lab, a team of researchers has, for the first time, demonstrated a new technique for producing polarized positrons. The method could enable new research in advanced materials and offers a new avenue for producing polarized positron beams for a proposed International Linear Collider and an envisioned Electron-Ion Collider. [14]

A study led by researchers from the U.S. Department of Energy's (DOE) SLAC National Accelerator Laboratory and the University of California, Los Angeles has demonstrated a new, efficient way to accelerate positrons, the antimatter opposites of electrons. The method may help boost the energy and shrink the size of future linear particle colliders - powerful accelerators that could be used to unravel the properties of nature's fundamental building blocks. [13]

More realistic versions of lattice QCD may lead to a better understanding of how quarks formed hadrons in the early Universe.

The resolution of the Proton Radius Puzzle is the diffraction pattern, giving another wavelength in case of muonic hydrogen oscillation for the proton than it is in case of normal hydrogen because of the different mass rate.

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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Author: George Rajna

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More realistic versions of lattice QCD may lead to a better understanding of how quarks formed hadrons in the early Universe.

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!

Chaotic magnetic field lines may answer the coronal heating problem

It is known that the sun's corona—the outermost layer of the sun's atmosphere—is roughly 100 times hotter than its photosphere—the sun's visible layer. The reason for this mysterious heating of the solar coronal plasma, however, is not yet entirely understood. A research team in India has developed a set of numerical computations to shed light on this phenomenon, and present this week in Physics of Plasmas, analysis examining the role of chaotic magnetic fields in potential heating mechanisms.

Operating under the idea that chaotically tangled magnetic field lines exist throughout astrophysical plasmas, the team used high-performance computer simulation to gain an understanding of these chaotic field lines. Specifically, they investigated conditions that create ribbons of intense electric current, known as current sheets.

The current sheets, believed to be produced in the coronal plasma, are potential sites for magnetic reconnections, which provide a mechanism for extreme heating of the corona. Moreover, within the current sheets, the electric field peaks up and accelerates charged particles.

"We want to go one step forward to explain the spontaneous generation of these current sheets," said Sanjay Kumar, a member of the research team.

The research method focused on allowing an incompressible, thermally homogeneous magnetofluid with infinite electrical conductivity to relax via viscous dissipation, toward a characterized final state. The computations were made consistent with well-accepted magnetostatic theory and resulted in spontaneous current sheet development, making them relevant for the study of particle acceleration in astrophysical plasmas.

Using Vikram-100, the 100TF High Performance Computing facility at the Physical Research Laboratory, the researchers simulated the viscous relaxation and verified accurate flux-freezing, a conservative behavior a reliable simulation must demonstrate. The team plotted the maximal intensities of volume current densities for specific trends of increasing magnetic field chaos, which provided a measure of the production of current sheets. Additionally, the maximal magnitudes of volume current density were found to scale with the numerical resolution used in the computer simulation, which showed the expected scaling of current sheet development.

The simple fact that the maximum value of volume current density was increased with increasing magnetic field line chaos, called "chaoticity," suggests a direct proportionality between the intensity of the current sheet and chaoticity.

In the three cases studied, the researchers found the formation of two different sets of current sheets. One set was arranged along the y-axis, while the second formed in a different location and at a time later than the first. From their analysis of this occurrence, the team determined that a favorable evolution bring non-parallel magnetic field lines into close proximity and intensify current sheets.

These simulations provide new and novel insight regarding the influence of chaotic magnetic field lines on the spontaneous development of current sheets, and hence potential places of particle acceleration.

"This is the first time we have explained the role of chaotic field line in generating these spontaneous current sheets," Kumar said, referring to the scientific community as a whole. [16]

A plasma tube to bring particles up to speed at SLAC

A team led by scientists from the University of California, Los Angeles and the Department of Energy's SLAC National Accelerator Laboratory has reached another milestone in developing a promising technology for accelerating particles to high energies in short distances: They created a tiny tube of hot, ionized gas, or plasma, in which the particles remain tightly focused as they fly through it.

The technique is especially important for positrons, the antimatter siblings of electrons, which tend to lose focus as they travel through plasma during a process known as plasma wakefield acceleration. In tests at SLAC's Facility for Advanced Accelerator Experimental Tests (FACET), a DOE Office of Science User Facility, beams of positrons stayed tightly bundled as they traveled through the plasma tube.

"Being able to efficiently create particle beams that are both highly energetic and focused is a prerequisite for many state-of-the-art accelerator applications," says SLAC's Marc Hogan, co-principal investigator of a study published today in Nature Communications. "Our results bring us a step closer to making plasma-driven particle accelerators a reality."

Such devices could potentially power future particle colliders that reveal nature's fundamental components, as well as bright X-ray light sources that take ultrafast snapshots of materials with atomic resolution.

A Plasma Tube to Keep Speedy Particles on Track

In plasma wakefield acceleration, energetic bundles of electrons or positrons traverse a plasma and generate plasma "wakes" for trailing bunches of particles to ride. Since the method can boost the energy of the surfing particles up to 1,000 times more over a given distance than conventional technology, it could pave the way for next-generation accelerators that are more powerful, smaller and less expensive.

However, the technique has yet to overcome a major challenge: Strong forces pointing toward the center of the plasma can degrade the quality of the particle beam, which consists of bunches of electrons or positrons. In the positron case, the particles are defocused and lost in the plasma.

Now, says SLAC's Spencer Gessner, the lead author of the new study, "We've engineered a hollow plasma channel – a tube of plasma with neutral gas on the inside. Due to the particular geometry of the plasma, particles flying through the channel don't experience any of the unwanted forces."

Proof-of-Principle Experiment at FACET

The idea of creating plasma tubes has been around for about 20 years, but Gessner and his fellow researchers are the first to demonstrate that they can actually make these channels large enough for particle acceleration experiments.

To create plasma for their experiments, the researchers send a high-power laser through a hot gas of the chemical element lithium. Normally, the laser beam's intensity is rather uniform and therefore generates a uniform plasma.

But in this case, they first sent the beam through a special spiral-shaped grating, which shaped the laser beam in such a way that if you looked at it in cross-section, it would consist of concentric rings. The innermost ring was the only one intense enough to create plasma, and as the laser beam traveled through a cloud of lithium gas, this ring formed a plasma tube about 3 inches long and two-hundredths of an inch wide. The tube persisted for just a few trillionths of a second – long enough for the scientists to send one of FACET's powerful positron beams through it.

"Our results indeed show that the positron bunch doesn't get defocused as it travels through the tube," Gessner says. "But we found even more: The plasma responds by producing a wake that takes a lot of energy out of the bunch. This energy could be used to accelerate a trailing bunch of positrons."

Next Steps Toward Future Applications

The team will soon follow up with experiments aimed at demonstrating that the technique can in fact boost the energy of positrons that surf the plasma wave inside the hollow channel. The researchers also intend to improve the method's efficiency by increasing the amount of energy stored in the wake, which already corresponds to 10 times the acceleration power of conventional radiofrequency acceleration technology.

"With its unique combination of powerful positron beams and high-power lasers, FACET is the only place in the world where we can do this type of research," Hogan says. "We're looking forward to further exploring this exciting approach to plasma wakefield acceleration."

In addition to UCLA and SLAC, the following institutions contributed to this work: University of Oslo, Norway; University of Paris-Saclay, France; and Tsinghua University, China. The project received funding from the DOE, the Research Council of Norway, the National Science Foundation, the European Research Council and the National Basic Research Program of China. [15]

Spinning electrons yield positrons for research

Researchers use accelerators to coax the electron into performing a wide range of tricks to enable medical tests and treatments, improve product manufacturing, and power breakthrough scientific research. Now, they're learning how to coax the same tricks out of the electron's antimatter twin - the positron - to open up a whole new vista of research and applications.

Using the Continuous Electron Beam Accelerator Facility (CEBAF) at the Department of Energy's Jefferson Lab, a team of researchers has, for the first time, demonstrated a new technique for producing polarized positrons. The method could enable new research in advanced materials and offers a new avenue for producing polarized positron beams for a proposed International Linear Collider and an envisioned Electron-Ion Collider.

Jefferson Lab Injector Scientist Joe Grames says the idea for the method grew out of the many advances that have been made in understanding and controlling the electron beams used for research in CEBAF.

"We have a lot of experience here at Jefferson Lab in operating a world-leading electron accelerator," Grames said. "We are constantly improving the electron beam for the experiments, pushing the limits of what we can get the electrons to do."

The CEBAF accelerator gathers up free electrons, sets the electrons to spinning like tops, packs them full of additional energy ("accelerating" the particles to up to 12 billion electron-volts), and directs them along a tightly controlled path into experimental targets. Grames and his colleagues would like to take that finesse a step further and transform CEBAF's well-controlled polarized electron beams into well-controlled beams of polarized positrons to offer researchers at Jefferson Lab an additional probe of nuclear matter. They named the endeavor the Polarized Electrons for Polarized Positrons experiment, or PEPPo.

Positrons are the anti-particles of electrons. Where the electron has a negative charge, the positron has a positive one. Producing positrons that are spinning in the same direction, like the electrons in CEBAF, is very challenging. Before PEPPo, researchers had successfully managed to coax polarized positrons into existence using very high-energy electron beams and sophisticated technologies. The PEPPo method, however, puts a new twist on things.

"From the beginning, our aim was to show that we could use the polarized electron beam we produce every day at CEBAF to create the positrons. But we wanted to do that using a low-energy and small-footprint electron beam, so that a university or company may also benefit from our proof of principle," Grames explained.

The PEPPo system was placed inside the CEBAF accelerator's injector, which is the part of the accelerator that generates electrons. The system consists mainly of small magnets for managing the particle beams, targets for transforming them, and detectors for measuring the particles.

In it, a new beam of electrons from CEBAF is directed into a slice of tungsten. The electrons rapidly decelerate as they pass through the tungsten atoms, giving off gamma rays. These gamma rays then interact with other atoms in the tungsten target to produce lower-energy pairs of positrons and electrons. Throughout the process, the polarization of the original electron beam is passed along.

The researchers use a magnet to siphon the positrons away from the other particles and direct them into a detector system that measures their energy and polarization.

"We showed that there's a very efficient transfer of polarization from electrons to the positrons," said Grames.

Further, the researchers found that it is also possible to dial up the degree of polarization that they are interested in by selecting positrons of the right energy. While the more abundant lower-energy positrons are less polarized, the positrons with highest-energy retain nearly all of the polarization of the original electron beam. In PEPPo, the electron beam was 85 percent polarized and accelerated to 8 million electron-volts (MeV).

"Nuclear physicists typically want the highest polarization possible for their experiments," he explained. "Positrons collected at half the original electron energy were about 50 percent polarized, which is still quite high. But, as we approached the maximum energy, we measured 82 percent, showing that a very large portion of the original electron polarization is transferred."

The PEPPo experiment ran for four weeks in the spring of 2012. The result has just been published in Physical Review Letters, and it is featured as an Editors' Suggestion.

Grames and his colleagues say now that they have their proof of principle, they want to design a source that is capable of producing a beam of polarized positrons for research.

"With this result in hand, we are now asking ourselves what's the best way to collect these positrons into a beam that may be used by nuclear physicists in experiments at Jefferson Lab and that may be useful for other facilities. That's the next step." [14]

Antimatter catches a wave: Accelerating positrons with plasma is a step toward smaller, cheaper particle colliders

The scientists had previously shown that boosting the energy of charged particles by having them "surf" a wave of ionized gas, or plasma, works well for electrons. While this method by itself could lead to smaller accelerators, electrons are only half the equation for future colliders. Now the researchers have hit another milestone by applying the technique to positrons at SLAC's Facility for Advanced Accelerator Experimental Tests (FACET), a DOE Office of Science User Facility.

"Together with our previous achievement, the new study is a very important step toward making smaller, less expensive next-generation electron-positron colliders," said SLAC's Mark Hogan, co-author of the study published today in Nature. "FACET is the only place in the world where we can accelerate positrons and electrons with this method."

SLAC Director Chi-Chang Kao said, "Our researchers have played an instrumental role in advancing the field of plasma-based accelerators since the 1990s. The recent results are a major accomplishment for the lab, which continues to take accelerator science and technology to the next level."

Shrinking Particle Colliders

Researchers study matter's fundamental components and the forces between them by smashing highly energetic particle beams into one another. Collisions between electrons and positrons are especially appealing, because unlike the protons being collided at CERN's Large Hadron Collider - where the Higgs boson was discovered in 2012 - these particles aren't made of smaller constituent parts.

"These collisions are simpler and easier to study," said SLAC's Michael Peskin, a theoretical physicist not involved in the study. "Also, new, exotic particles would be produced at roughly the same rate as known particles; at the LHC they are a billion times more rare."

Antimatter catches a wave at SLAC

Future particle colliders will require highly efficient acceleration methods for both electrons and positrons. Plasma wakefield acceleration of both particle types, as shown in this simulation, could lead to smaller and more powerful …more

However, current technology to build electron-positron colliders for next-generation experiments would require accelerators that are tens of kilometers long. Plasma wakefield acceleration is one way researchers hope to build shorter, more economical accelerators.

Previous work showed that the method works efficiently for electrons: When one of FACET's tightly focused bundles of electrons enters an ionized gas, it creates a plasma "wake" that researchers use to accelerate a trailing second electron bunch.

Creating a Plasma Wake for Antimatter

For positrons - the other required particle ingredient for electron-positron colliders - plasma wakefield acceleration is much more challenging. In fact, many scientists believed that no matter where a trailing positron bunch was placed in a wake, it would lose its compact, focused shape or even slow down.

"Our key breakthrough was to find a new regime that lets us accelerate positrons in plasmas efficiently," said study co-author Chandrashekhar Joshi from UCLA.

Instead of using two separate particle bunches - one to create a wake and the other to surf it - the team discovered that a single positron bunch can interact with the plasma in such a way that the front of it generates a wake that both accelerates and focuses its trailing end. This occurs after the positrons have traveled about four inches through the plasma.

Antimatter catches a wave at SLAC

Computer simulations of the interaction of electrons (left, red areas) and positrons (right, red areas) with a plasma. The approximate locations of tightly packed bundles of particles, or bunches, are within the dashed lines. Left: For …more

"In this stable state, about 1 billion positrons gained 5 billion electronvolts of energy over a short distance of only 1.3 meters," said former SLAC researcher Sébastien Corde, the study's first author, who is now at the Ecole Polytechnique in France. "They also did so very efficiently and uniformly, resulting in an accelerated bunch with a well-defined energy."

Looking into the Future

All of these properties are important qualities for particle beams in accelerators. In the next step, the team will look to further improve their experiment.

"We performed simulations to understand how the stable state was created," said co-author Warren Mori of UCLA. "Based on this understanding, we can now use simulations to look for ways of exciting suitable wakes in an improved, more controlled way. This will lead to ideas for future experiments."

Although plasma-based particle colliders will not be built in the near future, the method could be used to upgrade existing accelerators much sooner.

"It's conceivable to boost the performance of linear accelerators by adding a very short plasma accelerator at the end," Corde said. "This would multiply the accelerator's energy without making the entire structure significantly longer." [13]

More realistic versions of lattice QCD

Under normal conditions, quarks and gluons are confined in the protons and neutrons that make up everyday matter. But at high energy densities—the range accessible at today's particle accelerators—quarks and gluons form a plasma reminiscent of the primordial Universe after the big bang. Understanding how the transition (Fig. 1) from the confined state to this quark-gluon plasma (and vice versa) occurs is a fundamental goal of experiments at the Relativistic Heavy Ion Collider and the Large Hadron Collider, which recreate the plasma by colliding nuclei at ultrarelativistic speeds. Theorists are therefore looking for new ways to study the transition with quantum chromodynamics (QCD), the mathematically challenging theory that describes the strong interaction between quarks. In Physical Review Letters, researchers in the HotQCD Collaboration report an analysis of this phase transition using a formulation of QCD that lends itself to numerical solutions on a computer, called lattice QCD [6]. Their simulations of deconfinement—the first to be performed with a version of lattice QCD that accurately describes the masses and, in particular, the symmetries of the quarks—yield the critical temperature for the transition to occur, and show that it is a smooth crossover, rather than an abrupt change.

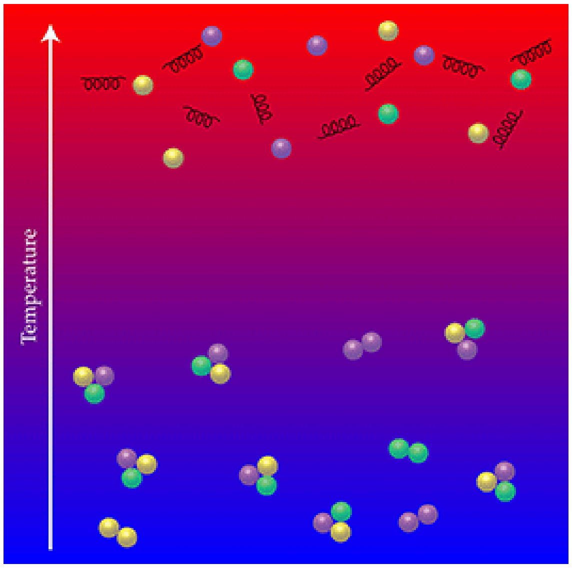


Figure 1. At everyday temperatures, quarks are confined in hadrons (such as protons, neutrons and pions). But at the energy densities accessible at particle accelerators, quarks can become deconfined, forming a quark-gluon plasma—a phase reminiscent of the primordial Universe. Numerical simulations based on lattice quantum chromodynamics are helping physicists understand how the transition from the confined to the deconfined state occurs. [12]

The Proton Radius Puzzle

Officially, the radius of a proton is 0.88 ± 0.01 femtometers (fm, or 10^{-15} m). Researchers attained that value using two methods: first, by measuring the proton's energy levels using hydrogen spectroscopy, and second, by using electron scattering experiments, where an electron beam is shot at a proton and the way the electrons scatter is used to calculate the proton's size.

But when trying to further improve the precision of the proton radius value in 2010 with a third experimental technique, physicists got a value of 0.842 ± 0.001 fm—a difference of 7 deviations from the official value. These experiments used muonic hydrogen, in which a negatively charged muon orbits around the proton, instead of atomic hydrogen, in which an electron orbits around the proton. Because a muon is 200 times heavier than an electron, a muon orbits closer to a proton than an electron does, and can determine the proton size more precisely.

This inconsistency between proton radius values, called the "proton radius puzzle," has gained a lot of attention lately and has led to several proposed explanations. Some of these explanations include new degrees of freedom beyond the Standard Model, as well as extra dimensions. [9]

Taking into account the Electro-Strong Interaction we have a simple explanation of this puzzle.

In the muonic hydrogen the muon/proton mass rate different from the electron/proton mass rate of the normal hydrogen, giving exactly the measured difference for the proton's radius, using the diffraction pattern of the Electro-Strong Interaction.

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:

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

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

$$(2)\quad I = n^2 I_0$$

This gives us the idea of

$$(3)\quad M_p = n^2 M_e$$

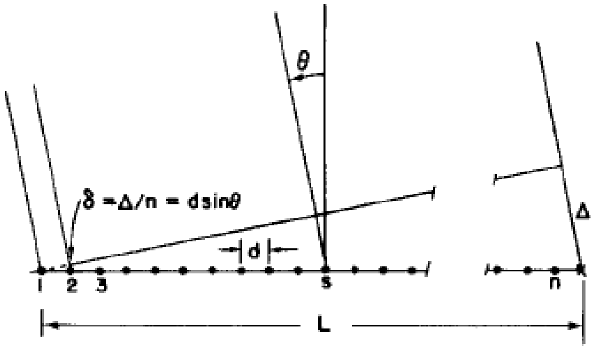


Fig. 30–3. A linear array of n equal oscillators, driven with phases $\alpha_s = s\alpha$.

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 θ = m λ

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.

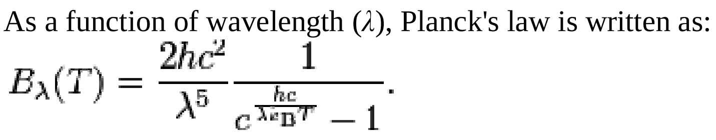
In this way we can see the H_2 molecules so that 2n electrons of n radiate to 4(m+1) protons, because $d_e > \lambda_e$ for electrons, while the two protons of one H_2 molecule radiate to two electrons of them, because of $d_e < \lambda_e$ for this two protons.

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:

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

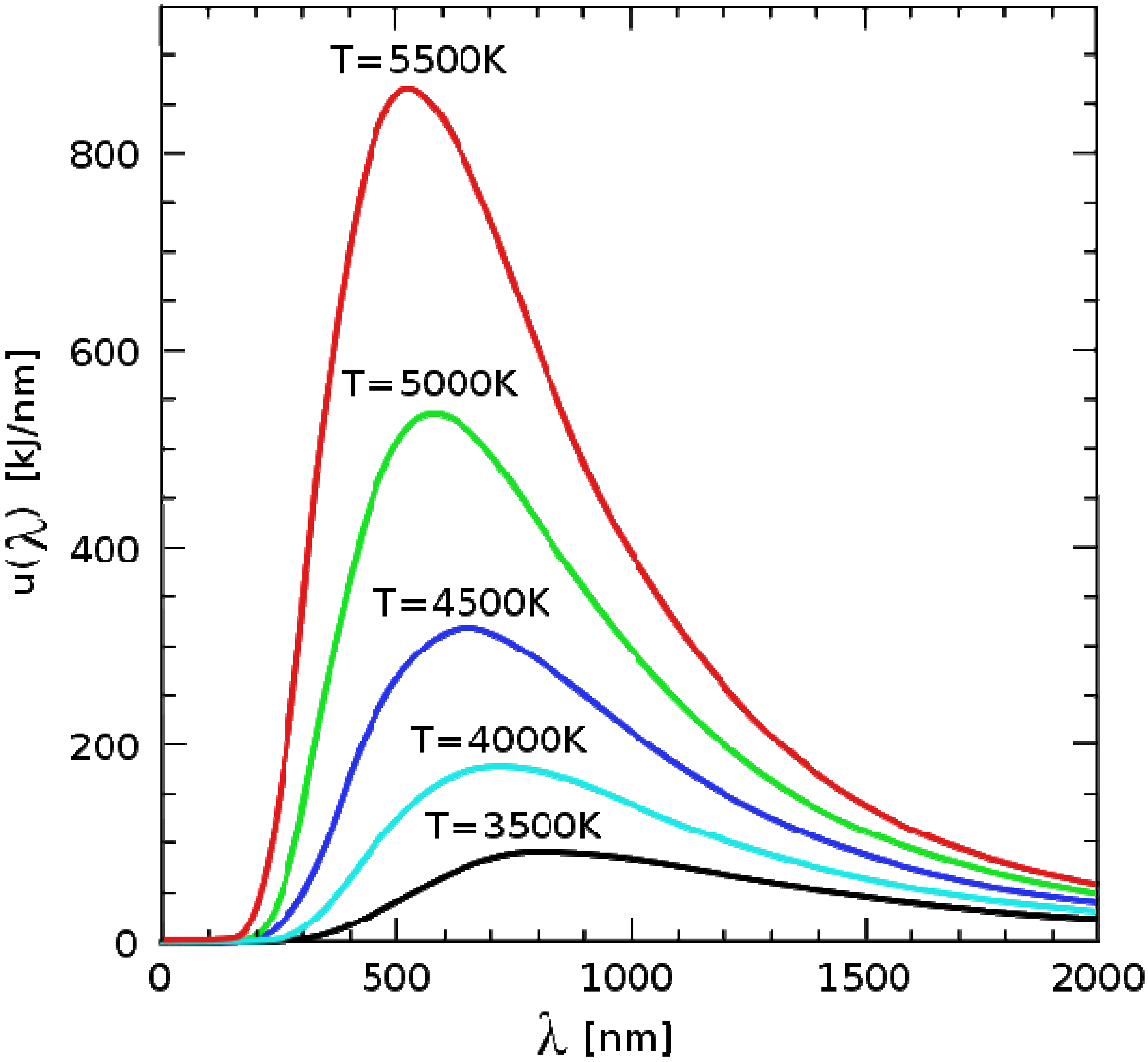


Figure 2. The distribution law for different T temperatures

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 $\lambda_{\max}$ 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 an asymptotic freedom while their energy are increasing to turn them to the orthogonally. 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]

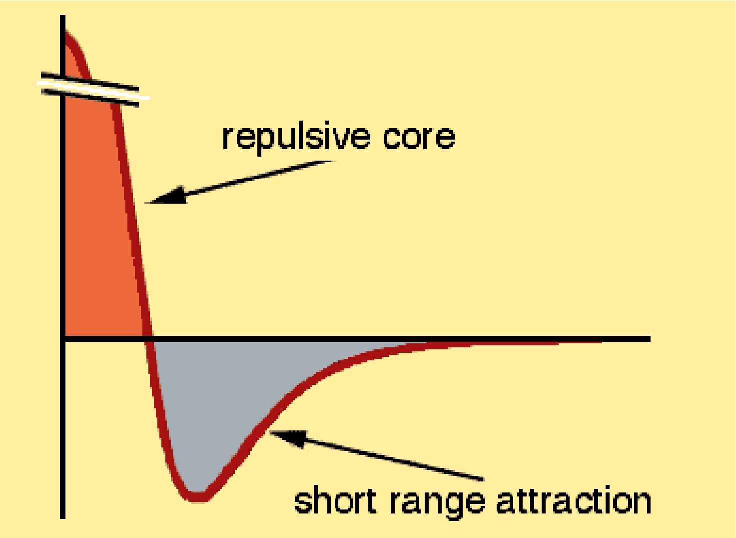
There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a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

Experiments with explanation

We present the results of experimental and theoretical study of the scattering of low energy pμ atoms in solid hydrogen cooled to 3 K. The resulting emission of low energy pμ atoms from the hydrogen layer into the adjacent vacuum was much higher than that predicted by calculations which ignored the solid nature of the hydrogen. [11]

Conclusions

More realistic versions of lattice QCD may lead to a better understanding of how quarks formed hadrons in the early Universe.

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]

The resolution of the Proton Radius Puzzle is the diffraction pattern of the electromagnetic oscillations, giving different proton radius for muon-proton diffraction.

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