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Chapter 1 : electroweak and strong interactions | Download eBook PDF/EPUB

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Expected proof or rejection of this prediction may come from 1 precise calculations that are based on improved astronomical data on the dynamics and thermodynamics inside the intergalactic voids, 2 a predicted, non-accelerating expansion era that can be detected in probing the universe until most shining entities ignite and radiate, plus the time for that radiation to dissipate in the depth of the voids and form the gradients. In these volumes we claim: It is also a major issue in general philosophy and the philosophy of science and comparative religions. Time and Symmetry -- The Most Complicated Issues of Science Time is the ruler of all human concepts; it comprises the deepest foundation of all knowledge, including world history, science, philosophy and religions. But contrary to most writers we claim that it is the most complicated of all human concepts, and we prove it in these three volumes. The expanding universe is not a theory. It is a well verified and established fact. And it is the only clock! But if you are awake, just go outside and watch the dark night sky and ask yourself, whereto all the star radiation energy has gone? Why the dark night sky is not as bright as the sun? Physical Time is the decrease in temperature in the Radiation Era [Fig. It is also the most universal and durable clock known. S ymmetry underlines the most important concepts and facts in our life and in Nature. It takes center stage in our aspirations, aesthetics, facts, science, theology and the arts. Lectures 2 to 4 illustrate some current conflicts in science that are fundamentally rooted in the correct understanding, or misunderstanding, of concepts and facts associated with symmetry-asymmetry concepts. These issues lead us to reassess disputes in physics between Einsteinian philosophy of science and that of quantum mechanics. So let us next make a short stop at the largest workshop of science. It is run by armies of quantum proponents of reality. I n Sheldon Glashow, Abdus Salam and Steven Weinberg [right, in that order] won the Nobel Prize in physics for developing the electroweak theory that unifies the electromagnetic and week interactions [Lecture 3]. According to their theory both interactions have about the same strength at very high energies. The origin of the masses of W and Z has been treated by postulating the existence of the hypothetical Higgs Boson, which, however, has not yet been unequivocally verified experimentally. But following increasing confidence levels as of Dec. Theorists still face the option that the Higgs boson will not be verified [Lecture 3]. Many physicists have since repeatedly warned that one cannot achieve the symmetry breaking condition and that concepts like topological symmetries are never broken spontaneously. Once you start to work with symmetric mathematics you cannot end up with asymmetric results, unless you fool yourself in the way that Feynman states. To by-pass this problem, Prigogine smuggled asymmetry in without declaring the contraband, simply by resorting to two misleading words: In a nutshell, what are the fundamental issues involved? This conclusion is widely accepted and well proven. Hence, our claim is deeply rooted in General Relativity [Footnote 1. Starting from symmetric EFE energy-momentum tensor and symmetric conservation equations, we introduce the standard symmetric cosmological metric of curved space-time and have ended up with a mathematical proof of how fundamental dynamics and thermodynamics are deduced from EFE [Vol. The new thermodynamics is thus entropy-free. While entropy can remain a useful model-variable in steam maps and air conditioning, it is not required in theoretical physics and in the philosophy of science. The failures of probabilistic quantum physics and Prigogine-type macro-dynamics and thermodynamics are linked. Secondly, we claim that all asymmetries observed in Nature have been caused by a single observed cosmological fact detailed in Ref. Four years later, during qualifying oral examination to become a doctorate student, an engineering-professors-panel passed these claims as possibly valid, after consulting with professor Nathan Rosen of the Technion Physics Department. Nathan Rosen The claims were tolerated as a mere curiosity at the

Johns Hopkins University in Baltimore, MD, where I served as an assistant professor of chemical engineering from to This has generated a confrontation with leading scientists like Ilia Prigogine [Lecture 3]. Full professorship followed the prize, and reaching a saturation level in published worldwide acclaims [Reviews], a total switch to work on poststall supermaneuverability of tailless-stealth, manned and unmanned, military and civil thrust-vectored aircraft took place next. This aerospace work is on jet-steering of tailless-stealth air and modified land and sea vehicles. National Security were reviewd by U. We are less than a visible dot somewhere here. In our studies we focus on the expanding dark voids that wrap around the superclusters of galaxies. The expansion of these voids makes them not only the largest, unsaturable sink of all radiation energy pouring out of the superclusters shown, but the primary cause of the second law of thermodynamics and the cosmological arrow of time. Due to the limited speed of light, which causes the Event Horizon, humans can never see the entire universe. In fact, part of what we see now in Fig. There is no need to speculate on mysterious dark matter and dark energy. Radiation pressure in the large void structures of the universe is not negligible. Its value on a test-surface facing the lowest radiation-energy density value depicted in Fig. Variations of this pressure are added on the uniform remnant glow left from the 1st Genesis. Like a gas, it acts on all superclusters of galaxies, pushing them apart against gravity and slightly accelerating the expansion of the universe. The theoretical crisis involved is debated in Lecture 3. Spaces 3 and 2 may also slightly expand. These surfaces are located between any neighboring pair of superclusters of galaxies, represented here by two clusters of galaxies. The radiation is pouring out of all galactic and stellar active emitters and is irreversibly absorbed forever in the depths of expanding SPACE It is the left over radiation from the end of the 1st genesis, the radiation dominated era. And the radiation pressure gradients push the filaments away from each other. But even in this zoomed-in image the solar system is less than a visible dot somewhere here. Our Solar System and our entire galaxy are less than a visible point in Fig. The cosmic voids that are the furthest from us absorb energy from parts of the universe that we cannot see. We return to this issue later and in Footnote 7. Most shining galaxies contain a super massive black hole at their center 1. Voids-Space-1 expansion is not only the cause of the 2nd law of thermodynamics; its expansion is the Master Arrow of Time and the origin of asymmetries in Nature [13]. Unlike most scientists, who claim that the entropy and disorder of the universe increases with time, we claim the opposite: Gravity everlasting transformation of chaos into structures in the entire universe. Their visible differentiation from the material energy emitters the yellow-green-red hot sources is the earliest recorded by science [Lecture 5]. The small size of these voids is to be increased during the next 17 billion years of the world expansion to end up with the gigantic voids recorded in Fig. These voids irreversibly absorb all the radiation poured into them from the gravitationally-condensing, and, therefore, heated material emitters. Most important, this differentiation-aggregation is isotropic and homogeneous. The recorded early dark cosmological voids are not only the first-ever macro-differentiation in the world, they constitute the central tools of Cosmological Gravitism. T o start with, we resort to additional, verified evidence that relates to this legitimate question. It was discovered in and is the remnant of radiation in early SPACE-1, which has since expanded and cooled by the expansion of the voids during about It is undisputed today that the cosmic dark voids not only expand, but their expansion is accelerated. There is however, a debate on the cause of that acceleration. Hubble Cosmic Expansion Law is marked in Fig. Employing next Figures 1 to 5, we assert: SPACE -1 wraps all superclusters of galaxies. But it does not include the non expanding superclusters. SPACE 2 wraps around, but does not include the non-expanding clusters of galaxies. SPACE-3 wraps around but does not include the non-expanding galaxies, stars, planets, moons, etc. Our Milky-Way Galaxy [images and Footnote 8] contains billions of gravitycompacted stars, planets and other entities. Our galaxy is almost , lightyears in diameter at its disk-like longest spiral arms. It is in the form of an almost flat spiral disk [image below] with an average thickness of about 1, light-years. These are discussed by references 74 to We are linked here-now to what is going on far out there by resorting to a thought experiment: Since we do not see, and cannot study the entire universe explanation below , the dynamics of a single adiabatic envelope that wraps around a typical emitter - as defined and analyzed in Footnote 1. This conclusion is important because less and less of the observed universe [Fig. The maximum speed of light is not violated by Hubble expansion. When sectors of the universe expand away from us at speeds higher than the speed of light, that law is not violated. The expansion of the universe generates a large-scale event horizon â€" an observational and theoretical limit for us to see the entire universe; namely, the light from such far away receding emitters is gradually being redshifted until the most remote sources totally disappear from our sights, forever. Consequently, there is no option but to study adiabatic cosmological cells of the universe, like the one defined in Fig. The portion of the universe recorded in Fig. Thus, much of what we observe in Fig. Without the so-called cosmological constant [] EGR accepts no plausible static cosmological solutions. From this point of view our new astrophysical school of systems dynamics and thermodynamics it is the agreement with EGR and said Einsteinian outlook, that our outlook is deeply rooted in EGR. From Large to Small-Scale Systems-Dynamics, and Back C lustering differences begin on the largest and earliest scales of the visible universe, as demonstrated by Figs. Since Space-1 is expanding -- and its expansion rate has been observationally proved as being accelerated -- the universe is unidirectionally cooling down forever. The corollary is that, eventually, all energy density gradients depicted in Fig, 1. Said expansion generates the observed large-scale energydensity gradients [Fig. Einsteinian gravity is well-approximated by Newtonian Physics as one goes down the scales of size-masses.

Chapter 2 : [] The Structure of the Proton in the LHC Precision Era

Selected Topics on Electroweak Interactions, Neutrinos and Qcd: A Review of High Energy Colliders: 26th International Meeting on Fundamental Physics, Isla De LA Toja, Galicia, Spain, June Hardcover - October 1,

Current research in particle physics Experiments Testing the Standard Model Electroweak theory , which describes the electromagnetic and weak forces, and quantum chromodynamics , the gauge theory of the strong force , together form what particle physicists call the Standard Model. The Standard Model , which provides an organizing framework for the classification of all known subatomic particles, works well as far as can be measured by means of present technology, but several points still await experimental verification or clarification. Furthermore, the model is still incomplete. Prior to one of the main missing ingredients of the Standard Model was the top quark , which was required to complete the set of three pairs of quarks. Searches for this sixth and heaviest quark failed repeatedly until in April a team working on the Collider Detector Facility CDF at Fermi National Accelerator Laboratory Fermilab in Batavia, Illinois, announced tentative evidence for the top quark. This was confirmed the following year, when not only the CDF team but also an independent team working on a second experiment at Fermilab, code-named DZero, or D0, published more convincing evidence. The results indicated that the top quark has a mass between and gigaelectron volts GeV; eV. This is almost as heavy as a nucleus of lead , so it was not surprising that previous experiments had failed to find the top quark. The discovery of the top quark in a sense completed another chapter in the history of particle physics ; it also focused the attention of experimenters on other questions unanswered by the Standard Model. For instance, why are there six quarks and not more or less? This asymmetry between particle and antiparticle could in turn be related to the domination of matter over antimatter in the universe. Experiments studying neutral B mesons, which contain a b quark or its antiquark, may eventually reveal similar effects and so cast light on this fundamental problem that links particle physics with cosmology and the study of the origin of matter in the universe. Testing supersymmetry Much of current research, meanwhile, is centred on important precision tests that may reveal effects that lie outside the Standard Modelâ€"in particular, those that are due to supersymmetry. The precision of these measurements is such that comparisons with the predictions of the Standard Model constrain the allowed range of values for quantities that are otherwise unknown. The predictions depend, for example, on the mass of the top quark, and in this case comparison with the precision measurements indicates a value in good agreement with the mass measured at Fermilab. This agreement makes another comparison all the more interesting, for the precision data also provided hints as to the mass of the Higgs boson. The Higgs boson is the particle associated with the mechanism that allows the symmetry of the electroweak force to be broken, or hidden, at low energies and that gives the W and Z particles, the carriers of the weak force , their mass. The particle is necessary to electroweak theory because the Higgs mechanism requires a new field to break the symmetry, and, according to quantum field theory , all fields have particles associated with them. Researchers knew that the Higgs boson must have spin 0, but that was virtually all that could be definitely predicted. However, after years of experiments, the Higgs boson was found in at the Large Hadron Collider. Its mass was quite light, about GeV. In this event there were a pair of Z bosons, one of which decayed into a pair of electrons green lines and green towers while the other decayed into a pair of muons red lines. The combined mass of the two electrons and the two muons was close to gigaelectron volts GeV. Numerous other events of this same type with the same net mass have been observed. This implies that a particle of mass GeV is being produced and subsequently decaying to two Z bosons, exactly as expected if the observed particle were the Higgs boson. This symmetry appeals to theorists in particular because it allows them to bring together all the particlesâ€"quarks, leptons, and gauge bosonsâ€"in theories that unite the various forces see below Theory. The price to pay is a doubling of the number of fundamental particles, as the new symmetry implies that the known particles all have supersymmetric counterparts with different spin. If they indeed exist, all these new supersymmetric particles must be heavy to have escaped detection so far. Investigating neutrinos Other hints of physics beyond the present Standard Model concern the neutrinos. In the Standard Model these particles have zero mass, so any measurement of a nonzero mass, however small, would indicate the existence of processes that are outside the Standard Model. Experiments to measure directly the masses of the three neutrinos have yielded only limits; that is, they give no sign of a mass for the particular neutrino type but do rule out any values above the smallest mass the experiments can measure. Other experiments have measured neutrino mass indirectly by investigating whether neutrinos can change from one type to another. The first indications that neutrinos might oscillate came from experiments to detect solar neutrinos. By the mids several different types of experiments, such as those conducted by the American physical chemist Raymond Davis, Jr. A popular explanation was that the electron-neutrinos had changed to another type on their way through the Sunâ€”for example, to muon-neutrinos. Muon-neutrinos would not have been detected by the original experiments, which were designed to capture electron-neutrinos. Then in the Sudbury Neutrino Observatory SNO in Ontario, Canada, announced the first direct evidence for neutrino oscillations in solar neutrinos. The experiment, which is based on 1, tons of heavy water , detects electron-neutrinos through one reaction, but it can also detect all types of neutrinos through another reaction. Taking all available solar neutrino data together as of and fitting them to a theoretical model based on oscillations between the electron- and muon-neutrinos indicate a difference in the mass-squared of 7. Earlier evidence for neutrino oscillations came in from the Super-Kamiokande detector in the Kamioka Mine, Gifu prefecture, Japan, which was studying neutrinos created in cosmic ray interactions on the opposite side of Earth. The detector found fewer muon-neutrinos relative to electron-neutrinos coming up through Earth than coming down through the atmosphere. This suggested the possibility that, as they travel through Earth, muon-neutrinos change to tau-neutrinos, which could not be detected in Super-Kamiokande. Davis was awarded a share of the prize for his earlier efforts in South Dakota. SNO director Arthur B. McDonald shared the prize with Kajita. Experiments at particle accelerators and nuclear reactors have found no conclusive evidence for oscillations over much-shorter distance scales, from tens to hundreds of metres. The aim is to build up a self-consistent picture that indicates clearly the values of neutrino masses. This dark matter must exist if the motions of stars and galaxies are to be understood, but it has not been observed through radiation of any kind. It is possible that some, if not all, of the dark matter may be due to normal matter that has failed to ignite as stars, but most theories favour more-exotic explanations, in particular those involving new kinds of particles. Such particles would have to be both massive and very weakly interacting; otherwise, they would already be known. Other current research involves the search for a new state of matter called the quark-gluon plasma. This should have existed for only 10 microseconds or so after the birth of the universe in the big bang , when the universe was too hot and energetic for quarks to coalesce into particles such as neutrons and protons. The quarks, and the gluons through which they interact, should have existed freely as a plasma, akin to the more-familiar plasma of ions and electrons that forms when conditions are too energetic for electrons to remain attached to atomic nuclei, as, for example, in the Sun. In experiments at CERN and at the Brookhaven National Laboratory in Upton, New York, physicists collide heavy nuclei at high energies in order to achieve temperatures and densities that may be high enough for the matter in the nuclei to change phase from the normal state, with quarks confined within protons and neutrons , to a plasma of free quarks and gluons. One way that this new state of matter should reveal itself is through the creation of more strange quarks, and hence more strange particles, than in normal collisions. These experiments, together with those that search for particles of dark matter and those that investigate the differences between matter and antimatter, illustrate the growing interdependence between particle physics and cosmology â€”the sciences of the very small and the very large. Theory Limits of quantum chromodynamics and the Standard Model While electroweak theory allows extremely precise calculations to be made, problems arise with the theory of the strong force , quantum chromodynamics QCD , despite its similar structure as a gauge theory. As mentioned in the section Asymptotic freedom , at short distances or equivalently high energies, the effects of the strong force become weaker. This means that complex interactions between quarks, involving many gluon exchanges, become highly improbable, and the basic interactions can be calculated from relatively few exchanges, just as in electroweak theory. As the distance between quarks increases, however, the increasing effect of the strong force means that the multiple interactions must be taken into account, and the calculations quickly become intractable. The outcome is that it is difficult to calculate the properties of hadrons , in particular their masses, which depend on the energy tied up in the interactions between the quarks they contain. Since the s, however, the advent of supercomputers with increased processing power has enabled theorists to make some progress in calculations that are based on a lattice of points in space-time. This is clearly an approximation to the continuously varying space-time of the real gauge theory , but it reduces the amount of calculation required. The greater the number of points in the lattice, the better the approximation. The computation times involved are still long, even for the most powerful computers available, but theorists are beginning to have some success in calculating the masses of hadrons from the underlying interactions between the quarks. Meanwhile, the Standard Model combining electroweak theory and quantum chromodynamics provides a satisfactory way of understanding most experimental results in particle physics, yet it is far from satisfying as a theory. Many problems and gaps in the model have been explained in a rather ad hoc manner. Toward a grand unified theory Many theorists working in particle physics are therefore looking beyond the Standard Model in an attempt to find a more-comprehensive theory. One important approach has been the development of grand unified theories, or GUTs, which seek to unify the strong, weak, and electromagnetic forces in the way that electroweak theory does for two of these forces. Such theories were initially inspired by evidence that the strong force is weaker at shorter distances or, equivalently, at higher energies. This suggests that at a sufficiently high energy the strengths of the weak, electromagnetic, and strong interactions may become the same, revealing an underlying symmetry between the forces that is hidden at lower energies. This symmetry must incorporate the symmetries of both QCD and electroweak theory, which are manifest at lower energies. There are various possibilities, but the simplest and most-studied GUTs are based on the mathematical symmetry group SU 5. As all GUTs link the strong interactions of quarks with the electroweak interactions between quarks and leptons , they generally bring the quarks and leptons together into the overall symmetry group. This implies that a quark can convert into a lepton and vice versa , which in turn leads to the conclusion that protons, the lightest stable particles built from quarks, are not in fact stable but can decay to lighter leptons. These interactions between quarks and leptons occur through new gauge bosons , generally called X, which must have masses comparable to the energy scale of grand unification. The mean life for the proton, according to the GUTs, depends on this mass; in the simplest GUTs based on SU 5 , the mean life varies as the fourth power of the mass of the X boson. Experimental results, principally from the LEP collider at CERN, suggest that the strengths of the strong, weak, and electromagnetic interactions should converge at energies of about GeV. This tremendous mass means that proton decay should occur only rarely, with a mean life of about years. This result is fortunate, as protons must be stable on timescales of at least years; otherwise, all matter would be measurably radioactive. It might seem that verifying such a lifetime experimentally would be impossible; however, particle lifetimes are only averages. Given a large-enough collection of protons, there is a chance that a few may decay within an observable time. This encouraged physicists in the s to set up a number of proton-decay experiments in which large quantities of inexpensive materialâ€"usually water, iron, or concreteâ€"were surrounded by detectors that could spot the particles produced should a proton decay. Such experiments confirmed that the proton lifetime must be greater than years, but detectors capable of measuring a lifetime of years have yet to be established. It turns out that, for the strengths of the strong, weak, and electromagnetic interactions to converge properly, the GUT must include supersymmetry â€”the symmetry between fermions quarks and leptons and the gauge bosons that mediate their interactions. Supersymmetry, which predicts that every known particle should have a partner with different spin, also has the attraction of relieving difficulties that arise with the masses of particles, particularly in GUTs. The problem in a GUT is that all particles, including the quarks and leptons, tend to acquire masses of about GeV, the unification energy. The introduction of the additional particles required by supersymmetry helps by canceling out other contributions that lead to the high masses and thus leaves the quarks and leptons with the masses measured in experiment. This important effect has led to the strong conviction among theorists that supersymmetry should be found in nature, although evidence for the supersymmetric particles has yet to be found. A theory of everything While GUTs resolve some of the problems with the Standard Model, they remain inadequate in a number of respects. They give no explanation, for example, for the number of pairs of quarks and leptons; they even raise the question of why such an enormous gap exists between the masses of the W and Z bosons of the electroweak force and the X bosons of lepton-quark interactions. Most important, they do not include the fourth force, gravity. The dream of theorists is to find a totally unified theoryâ€”a theory of everything, or TOE. Attempts to derive a quantum field theory containing gravity always ran aground, however, until a remarkable development in first hinted that a quantum theory that includes gravity might be possible. The new development brought together two ideas that originated in the s. All potential problems cancel out, despite the fact that the theory requires a massless particle of spin 2â€”in other words, the gauge boson of gravity, the graviton â€—and thus automatically contains a quantum description of gravity. It soon seemed, however, that there were many superstring theories that included gravity, and this appeared to undermine the claim that superstrings would yield a single theory of everything. Among the many efforts to resolve these seemingly disparate treatments of superstring space in a coherent and consistent manner was that of Edward Witten of the Institute for Advanced Study in Princeton, New Jersey.

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Chapter 3 : Download Plasma Modeling Methods And Applications Iop Expanding Physics PDF â€“ PDF S

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This is an open access article distributed under the Creative Commons Attribution License , which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. We calculate the production cross sections of the processes in this model. We further study the observability of the process through and find that it is still challenging for the 14 TeV LHC with high luminosity to detect this signal. So far, all the measurements of the discovered new particle [3 â€” 10] are well compatible with the scalar boson predicted by the Standard Model SM [11 â€” 15]. It is well known that the SM cannot be the final theory of nature. Theoretically, successful explanation of some problems, such as the hierarchy problem, requires new physics beyond the SM near the TeV scale. Experimentally, the solid evidence for neutrino oscillation is one of the firm hints for new physics. The minimal extension of the SM that we consider in this paper is that the SM gauge groups are augmented by a symmetry, where and represent the baryon number and lepton number, respectively. The gauge symmetry can explain the presence of three right-handed neutrinos and provide a natural framework for the seesaw mechanism [16 , 17]. In addition, it is worth noting that symmetry breaking can take place at the TeV scale, hence giving rise to new and interesting TeV scale phenomenology. The Yukawa couplings play an important role in probing the new physics since they are sensitive to new flavor dynamics. The top quark is the heaviest particle discovered and owns the strongest Yukawa coupling. The top quark Yukawa coupling is speculated to be sensitive to the electroweak symmetry breaking EWSB mechanism and new physics. The production process is a golden channel for directly probing the top Yukawa coupling; however, this process cannot provide the information on the relative sign between the coupling of the Higgs to fermions and to vector bosons. As a beneficial supplement, the production process can bring a unique possibility [18 â€” 21] and many relevant works have been carried out [22 â€” 34]. The model predicts heavy neutrinos, a TeV scale extra neutral gauge boson, and an additional heavy neutral Higgs, which makes the model phenomenologically rich. The heavy Higgs state mixes with the SM Higgs boson so that some Higgs couplings are modified and this effect can also influence the process of single top and Higgs associated production. Besides, the process of single top and heavy Higgs associated production deserves attention, which is equally important for understanding the EWSB and probing new physics. Performing the detailed analysis on this process may provide a good opportunity to probe the model signal. The paper is structured as follows. In Section 2 we review the model related to our work. In Section 3 we first calculate the production cross sections of the single top and associated production at the LHC and then explore the observability of -channel process by performing a parton-level simulation. Finally, we make a summary in Section 4. A Brief Review of the Model The minimal extension of the SM [35 â€” 42] is based on the gauge group with the classical conformal symmetry. Under this gauge symmetry, the invariance of the Lagrangian implies the existence of a new gauge boson. In order to make the model free from all the gauge and gravitational anomalies, three generations of right-handed neutrinos are necessarily introduced. The Lagrangian for Yang-Mills and fermionic sectors is given by where.

Chapter 4 : International Winter Meeting on Nuclear Physics (January)

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Such remnants of at least one supernova in our galaxy were captured into orbit around the sun. Gravity then guided and compressed some to form the observed spherical planets and moons in the Solar system. The sole sin of such innocent stars is being too fat and big, thereby converting their huge mass, initially only hydrogen and helium , by nuclear the well-known fusion metabolism, to heavier chemical elements [oxygen, carbon, nitrogen, phosphor, etc. It is always gravitation that plays the central role in the "selection" of the structures to be produced: First in controlling the structures galaxies and clusters in SPACE-1, then in forcing chemical evolution through a succession of specific reactions in which evolution means the development of complex elements from simple ones. Supernova unusual bright glow has been studied since , starting from the Crab Nebula. The reason for this selection is explained below. Certain types of supernovas serve in astronomy as the max-cosmic temperature standard for calibrating distances to far-away galaxies via the absolute luminosity brightness method discussed in Volume I. That end [see below] is reached when a threshold amount of iron is formed in the interior of a massive star [Volume I]. At this stage all net energy generation inside the star stops and the process reverses into an endothermic one during which energy is consumed. This leads to a gigantic collapse-implosion of the entire star structure. If the mass of the star is about 1. If its mass is larger, the formation of an extremely packed neutron star [image] or a black hole [Footnote 1. A gigantic supernova explosion follows the collapse-implosion by bouncing back from a central dense body [neutron star]. Type Ia supernovas harbor consistent brightness absolute luminosity because their progenitor is accreting mass from a nearby star, always imploding into the central neutron star at exactly the same mass -- the Chandrasekhar Mass Limit. From there the energy reaches the outer layers of the star and eventually leaves the star and spreads out in non-expanding Spaces 3, 2 and, eventually, being dissipated forever inside expanding VOIDSSPACE Black holes are astronomical local objects that are spread throughout galaxies and superclusters of galaxies that are wrapped around by non-expanding SPACE-3, or may exist within Spaces 2 and 1. Astrophysicists indirectly detect the presence of black holes, which may range from roughly the mass of a few suns to ten billion times greater. Black holes are general relativistic cosmological sinks for all matter-energy arriving and falling into them from nearby stars and any radiation. They are postulated to be highly concentrated, local gravity-sinks where the gravity field is so strong that nothing, not even light, can escape from them. Whether or not this is verified by future science, the outcome would not change the foundations of Gravitism. General relativistic cosmology predicts that black holes are one-way sinks in spacetime. Some are assumed to be in the center of some galaxies. They may be associated with what is observed and termed quasars. Within a black hole all atomic and sub-atomic structures had already been crushed to become only geometricallycurved space-time. This is due to the extremely strong gravitational field within the 45 black hole. Quasars are assumed to be super massive forms of black holes. These quasars are in young faraway galaxies that are surrounded by relatively high-density gas that emits X-rays as it is being sucked into and accelerated towards a one-way sink of a massive black hole. Dust-gas cloud being destroyed by black hole near our galactic center: Thus, during the next 10 years, the cloud will be gradually falling into our galactic black hole. The black hole would start destroying the cloud in , heating it first by viscosity friction and gravity to millions of degrees C resulting in visible energy outputs. Our galactic black hole is about 4 million times more massive than the sun and is 27, light-years away. These surfaces wrap around superclusters of galaxies in 3 dimensions. No net energy flow means that radiation [and matter particles] somewhat similar to the ones detected within our solar wind â€” do not cross such adiabatic surfaces. The maximum temperature attainable in each galaxy is about the same. It is roughly the same as that generated initially by a supernova and is attributed to: The sun, like all active stars, is a selfgravitating massive sphere of sub-atomic particles in a state of hot plasma that is pressed-heated by the attractive force of gravity. Its diameter is about 1. During more than half of its present age, the universe did not harbor our solar system. It is located inside non-expanding Space 3 that wraps our entire galaxy and is spatially interconnected with Spaces 2 and 1. Hemispheres from sea level to 80km Troposphere up to about 13km; Ozone layer about km; Stratosphere km; Mesosphere km ; Thermosphere km dilute Nitrogen km, Oxygen km, Helium km, Hydrogen km]. Climate scientists claim that global temperatures will raise a few degrees Fahrenheit in the next hundred years. Samples from ice cores from Greenland show that 11, years ago the average temperatures in Greenland increased by about 15 degrees Fahrenheit, over the course of 10 years, a change partially attributed to melting polar ice, which altered ocean circulation and weather patterns. From about 3,, years ago until the last one, which gradually ended from about 12, to years ago. These ages have strongly affected ecological systems on earth, and each lasted 49 about 50, to , years and each had lowered the surface of the oceans, resulting in climate-induced changes in life and all ecological systems. No equivalent amount of this incoming radiation energy remains with earth and the other planets, as many wrongly assume. Part of it is reflected immediately by our upper atmosphere to outer, cold-dark spaces 3, 2 and, eventually, to Space Nearby Systems, somewhat similar to our solar system, are created by supernovas. Nearest stars include Alpha Centauri, Sirius and Procyon. There are about 50 solar-system-likes there. They are further treated in Volume I. At this point we only refer to a claim favored by the main media [Cf. Upcoming tests at CERN [Lecture 3], the Planck Satellite and the ground-based 51 LIGO and VIRGO observatories, may reveal slight variations in gravitational radiation that is claimed to be associated with such postulated effects, say, on the polarization of the cosmic black body radiation. The rate of galactic collisions was much higher in the past, mainly because the galaxies were closer to each other. Our galaxy is predicted by some models to collide with the Andromeda galaxy in about 5 billion years; One candidate orbits a star like the sun. It shows a dark ring of dust and gas circling a star dark bands, center in a star-forming region in our galaxy, about light-years away from us. Scientific theories and academic studies always advance, stagnate or decline under the domination of a philosophy, whether declared or undeclared. Western academia has since withdrawn from the game. Indeed, contemporary professors today vie with one another in presenting fragmented lectures devoid of interconnected content, for they can no longer hope to achieve popularity by injecting updated core knowledge into what has gradually become an ever narrower, disciplinary professionalism. This turn of events has resulted in overvaluation of technical professionalism, empty academicism, absolutation of ever-narrower disciplines, and the common inclination to reject bona fide core knowledge from the class. For these trends only push the young into cynicism, nihilism and feelings of emptiness in education and society at large. The Current Crisis in Education is not subsiding. More than ever before it demands answers, re-assessments, a revised philosophy and acts: How to administer mutual interactions instead of linear causality; structured complexity instead of summation of events; structured historical buildup of facts, instead of summation of isolated events and narrow academic Departments. Entering the temples of knowledge they settle for that of an eagle, but what they find is that of a specialist gopher. The selection of interconnected kernels of updated knowledge to be included in CCCC is based on what I consider a much needed CCCC education at all levels, starting from high schools. It must be delivered to all students, each semester, not only by top faculty, but also by university officialdom and cultural leadership. Otherwise a university president, or a provost, is at best acting more like a CEO of a cooperation aimed at maximizing profit and less at best education and research. Modern skepticism is usually the negation of a core, interconnected, educational methodology. Not so with Einsteinian skepticism. Einstein advocated the removal of imposed borders between traditional disciplines and university departments and faculty; stating that knowledge is one; its division is human weakness. T Such a methodology leads to C. The Temples of

Knowledge Today Assertion 2. They are likely to resort to a priori or superficial answers to complex problems whose detailed implications are beyond them. Yet, the facts are that deep divisions keep deepening and deserts of narrow specialism keep spreading more than ever before. Sources of studies are millions of online blogs with uneven quality and little or no reliable references. They must be re- confirmed by fresh verified information from any sub-field of science, hence, are subject to constant revision and even replacement; -- in this, each succeeding generation takes a measurable step beyond the position of its predecessors. Closely related to the unrestricted content of modern science is its unrestricted questioning of all earlier convictions in light of verifiable evidence that refutes extant axioms, definitions, assertions, outlooks and theories. Thus, every item of carefully recorded experimental or observational information is a proper object for analysis. A drive towards novelty and discovery impels inquiry to explore all corners of the universe. These tenets are the central pillars of Gravitism. But there is more to it. The outlook includes constant re-assessments of the theory -- of any theory -- and analysis of the errors involved as one updates and improves it. Anything outside that fence is, a priori, rejected and lost forever. Indeed, without paying much attention to fundamental consequences, we often resort to such definitions as we find them in dictionaries, textbooks and everyday life. For instance, any arithmetical truth cannot be defined by arithmetics. Even in computer science one cannot create a complete and consistent finite list of axioms, or an infinite list. Each time one adds a statement as an axiom; there are other correct statements that cannot be proved, even with the new axiom. Moreover, if the system can prove that it is consistent, it is not. As might have been expected, this idea has been much debated by mathematical philosophers: How can a theory be both correct and unprovable? Is mathematics a loop of our mind? Is the mind a self referential loop? Not all axiom systems satisfy these hypotheses, even when these systems have models that include natural numbers as a subset. Another limitation applies only to systems that are used as their own proof systems. Theorems are computably enumerable: One can then ask if it has the stronger property of being recursive: Can one write a computer program to definitively determine if a statement is true or false?

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Chapter 5 : Frontiers of Fundamental Physics (FFP14)

speakerc2ca34 Alain Blondel (DPNC University of Geneva) Precision Electroweak Measurements at Future High Energy Colliders abstract The prospects for precision measurements of the properties of the Z, W, Higgs and top particles will be reviewed.

Typically one dedicated series of lectures around one theme per year. The student is obliged to follow these series of lectures, and supplements this with 5 additional seminars on particle physics topics. Of the special series of lectures the student will write a short report. For the second part of the course the student can select, with the approval of the professor, two topics in particle physics. The primers are written with the aim to introduce a regular master student into the topic and bring the reader to the level to understand the main research questions in the specific domain. The student will read and study the relevant literatures on the topic. The primers are to be written in English. Below the series of lectures organized over the last years for this course. Silicon Tracking detectors at colliders Dr. Frank Hartmann KIT April 7 and 8, announcement General-purpose particle detectors at colliders consist of several systems that operate synchronously to measure the properties of particles created in high-energy collisions. The tracking device is a center part of each detector and requires a high resolution to track charged particles. Over the last decades silicon detectors emerged as the main tracking detectors technology. The performance of silicon detectors however is influenced by the high radiation present around the particle collision point. Detectors are designed to mitigate this degradation. Typically several layers of silicon sensors are grouped according to an optimal geometry to measure the collision events. The origin of cosmic rays Prof. Stijn Buitink Vrije Universiteit Brussel April 9 and 10, announcement Cosmic rays are the most energetic particles in the Universe. Their origin is yet unknown despite a century of intensive research with observatories all around the world. Possible sources include the remnants of supernova explosions, the jets of active black holes and gamma-ray bursts. This lecture series will give an overview of the physics of cosmic accelerators and the state-of-the-art of cosmic-ray detection. Link to the slides will be made available. Muon detection and reconstruction at colliders Dr. At colliders they are produced in the decay of W, Z, H bosons as well as in the hadronization of b-quarks. They appear in the most prominent collider signatures of predicted new physics phenomena like supersymmetry. At the same time muons are crucial for the study of B and D mesons, touching concepts as CP violation. Therefore the continuous development of novel muon detection and reconstruction techniques is an active research field.

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Chapter 6 : Howard E. Haber

26th International Meeting on fundamental Physics: selected topics on electroweak interactions, neutrinos and QCD: a review of high energy colliders, Isla de La Toja, Galicia, Spain, June

Thursday Morning Many neutron stars are in binaries and accrete matter transferred from their companion. Often, this accretion is intermittent: In this talk, I will discuss recent efforts to constrain the core heat capacity and neutrino emissivity of matter at densities above saturation from observations of the surface temperature More Presented by Prof. More Presented by Ms. Tuesday Afternoon This work constitutes one part of an investigation of the low-temperature changes of the properties of the eta-prime meson. In turn these properties are strongly tied to the U 1 axial anomaly of Quantum Chromodynamics. The final aim is to explore the interplay of the chiral anomaly and in-medium effects. We determine the lifetime of an eta-prime meson being at rest in a strongly interacting mediu More Presented by Mrs. Tuesday Afternoon In the Standard Model, electrons, muons, and tau leptons have identical electroweak gauge interactions, a hypothesis known as lepton universality. PIENU is a high precision measurement of the ratio of the rate of the pion decay to electron plus neutrino compared to pion decay to muon plus neutrino, including radiative processes. The SM theoretical prediction of this ratio is one of the most accu More Presented by Dr. Friday Morning The in-medium modi cations of hadron properties have been identi ed as one of the key problems in understanding the non-perturbative sector of QCD. Several theoretical papers discuss the possibility of a partial restora- tion of chiral symmetry in a strongly interacting environment. However, is it possible to nd experimental evidence for partial symmetry restoration by studying the in-medium Short Contribution One of the main uncertainties in the Equation of State of neutron-rich nuclear matter concerns the density and momentum dependence of the nuclear symmetry energy. Some constraints on the density dependence of the symmetry energy at sub-saturation densities have been recently obtained. However questions remain, especially concerning the momentum dependence of the symmetry mean-field potential that To the best of our knowledge no nuclear physics related description of such deviation can be made. The deviation between the experimental and theoretical angular correlations is significant an This resulted in a volume of data much larger than originally anticipated. Based on the status of current data production levels and the structure of the LHC experiment computing models, the estimates of the data production rates and reso

Chapter 7 : Vrije Universiteit Brussel

The first part gives a short introduction to the theory of electroweak interactions, with specific emphasize on neutrinos. In the second part we apply this framework to selected topics in astrophysics and cosmology, namely neutrino oscillations, neutrino hot dark dark matter, and big bang nucleosynthesis.

The nuclear binding force As early as , when Ernest Rutherford named the proton and accepted it as a fundamental particle, it was clear that the electromagnetic force was not the only force at work within the atom. Something stronger had to be responsible for binding the positively charged protons together and thereby overcoming their natural electrical repulsion. The discovery in of the neutron showed that there are at least two kinds of particles subject to the same force. Later in the same year, Werner Heisenberg in Germany made one of the first attempts to develop a quantum field theory that was analogous to QED but appropriate to the nuclear binding force. Heisenberg proposed that a proton, for example, could emit a positively charged particle that was then absorbed by a neutron; the proton thus became a neutron, and vice versa. The nucleus was no longer viewed as a collection of two kinds of immutable billiard balls but rather as a continuously changing collection of protons and neutrons that were bound together by the exchange particles flitting between them. Heisenberg believed that the exchange particle involved was an electron he did not have many particles from which to choose. Quantum field theory did not seem applicable to the nuclear binding force. Then in a Japanese theorist, Yukawa Hideki , took a bold step: Yukawa argued that, to give this limited range, the force must involve the exchange of particles with mass, unlike the massless photons of QED. According to the uncertainty principle , exchanging a particle with mass sets a limit on the time allowed for the exchange and therefore restricts the range of the resulting force. Because the predicted mass of the new particle was between those of the electron and the proton, the particle was named the mesotron, later shortened to meson. In particular, as a group of Italian physicists succeeded in demonstrating while hiding from the occupying German forces during World War II , the cosmic ray particles penetrate matter far too easily to be related to the nuclear binding force. To resolve this apparent paradox , theorists both in Japan and in the United States had begun to think that there might be two mesons. In scientists at Bristol University in England found the first experimental evidence of two mesons in cosmic rays high on the Pic du Midi in France. Using detectors equipped with special photographic emulsion that can record the tracks of charged particles, the physicists at Bristol found the decay of a heavier meson into a lighter one. According to the modern definition of a meson as a particle consisting of a quark bound with an antiquark, the muon is not actually a meson. It is classified as a lepton â€"a relation of the electron. Moreover, experiments confirmed that positive, negative, and neutral varieties of pions exist, as predicted by Nicholas Kemmer in England in Kemmer regarded the nuclear binding force as symmetrical with respect to the charge of the particles involved. He proposed that the nuclear force between protons and protons or between neutrons and neutrons is the same as the one between protons and neutrons. Close similarities between nuclei containing the same total number of protons and neutrons, but in different combinations, suggest that protons can be exchanged for neutrons and vice versa without altering the net effect of the nuclear binding force. To introduce this symmetry into the theory of the nuclear force, it proved useful to adopt the mathematics describing the spin of particles. In this respect the proton and neutron are seen as different states of a single basic nucleon. This new property is called isotopic spin, or isospin for short, and the nuclear binding force is said to exhibit isospin symmetry. Symmetries are important in physics because they simplify the theories needed to describe a range of observations. For example, as far as physicists can tell, all physical laws exhibit translational symmetry. This means that the results of an experiment performed at one location in space and time can be used to predict correctly the outcome of the same experiment in another part of space and time. This symmetry is reflected in the conservation of momentum â€”the fact that the total momentum of a system remains constant unless it is acted upon by an external force. Isospin symmetry is an important symmetry in particle physics , although it occurs only in the action of the nuclear binding forceâ€"or, in modern terminology, the strong force. The symmetry leads to the conservation of isospin in nuclear interactions that occur via the strong force and thereby determines which reactions can occur. Later in the year Clifford Butler and George Rochester, two British physicists studying cosmic rays, discovered the first examples of yet another type of new particle. Within the next few years, researchers found copious examples of these particles, as well as other new particles that were heavier even than the proton. The evidence seemed to indicate that these particles were created in strong interactions in nuclear matter, yet the particles lived for a relatively long time without themselves interacting strongly with matter. By at least four different kinds of strange particles had been observed. In an attempt to bring order into this increasing number of subatomic particles, Murray Gell-Mann in the United States and Nishijima Kazuhiko in Japan independently suggested a new conservation law. In the decay of the particles, however, a different, weaker force is at work, and this weak force does not conserve strangenessâ€"as with isospin symmetry, which is respected only by the strong force. According to this proposal, particles are assigned a strangeness quantum number , S, which can have only integer values. Because the strong force conserves strangeness, it can produce strange particles only in pairs, in which the net value of strangeness is zero. This phenomenon, the importance of which was recognized by both Nishijima and the American physicist Abraham Pais in , is known as associated production. SU 3 symmetry With the introduction of strangeness, physicists had several properties with which they could label the various subatomic particles. In particular, values of mass, electric charge, spin, isospin, and strangeness gave physicists a means of classifying the strongly interacting particlesâ€"or hadrons â€"and of establishing a hierarchy of relationships between them. The classification of the hadron class of subatomic particles into groups on the basis of their symmetry properties is also referred to as the Eightfold Way. Combinations of the quarks u, d, and s and their corresponding antiquarks to form hadrons. The octets hexagons and the decuplet arise when particles are grouped according to strangeness, S, and charge, Q. The development of quark theory The beauty of the SU 3 symmetry does not, however, explain why it holds true. Gell-Mann and another American physicist, George Zweig , independently decided in that the answer to that question lies in the fundamental nature of the hadrons. The most basic subgroup of SU 3 contains only three objects, from which the octets and decuplets can be built. The two theorists made the bold suggestion that the hadrons observed at the time were not simple structures but were instead built from three basic particles. Gell-Mann called these particles quarks â€"the name that remains in use today. By the time Gell-Mann and Zweig put forward their ideas, the list of known subatomic particles had grown from the three of â€"electron, proton, and neutronâ€"to include most of the stable hadrons and a growing number of short-lived resonances , as well as the muon and two types of neutrino. That the seemingly ever-increasing number of hadrons could be understood in terms of only three basic building blocks was remarkable indeed. For this to be possible, however, those building blocksâ€"the quarksâ€"had to have some unusual properties. These properties were so odd that for a number of years it was not clear whether quarks actually existed or were simply a useful mathematical fiction. By the mids, however, 10 years after quarks were first proposed, scientists had compiled a mass of evidence that showed that quarks do exist but are locked within the individual hadrons in such a way that they can never escape as single entities. This evidence resulted from experiments in which beams of electrons , muons , or neutrinos were fired at the protons and neutrons in such target materials as hydrogen protons only , deuterium , carbon , and aluminum. The incident particles used were all leptons , particles that do not feel the strong binding force and that were known, even then, to be much smaller than the nuclei they were probing. The scattering of the beam particles caused by interactions within the target clearly demonstrated that protons and neutrons are complex structures that contain structureless, pointlike objects, which were named partons because they are parts of the larger particles.

Gell-Mann and Zweig required only three quarks to build the particles known in These quarks are the ones known as up u , down d , and strange s. Since then, experiments have revealed a number of heavy hadrons â€”both mesons and baryons â€”which show that there are more than three quarks. In addition to the up, down, and strange quarks, there are quarks known as charm c , bottom or beauty, b , and top or truth, t. These quark flavours are all conserved during reactions that occur through the strong force ; in other words, charm must be created in association with anticharm, bottom with antibottom, and so on. This implies that the quarks can change from one flavour to another only by way of the weak force , which is responsible for the decay of particles. The up and down quarks are distinguished mainly by their differing electric charges, while the heavier quarks each carry a unique quantum number related to their flavour. Using this system, the lambda can be viewed as a neutron with one down quark changed to a strange quark; charge and spin remain the same, but the strange quark makes the lambda heavier than the neutron. Thus, the quark model reveals that nature is not arbitrary when it produces particles but is in some sense repeating itself on a more-massive scale. The answer to questions like these seems to lie in the property called colour. Colour was originally introduced to solve a problem raised by the exclusion principle that was formulated by the Austrian physicist Wolfgang Pauli in The omega-minus particle, according to the Pauli exclusion principle, should not exist. To resolve this paradox, in â€”65 Oscar Greenberg in the United States and Yoichiro Nambu and colleagues in Japan proposed the existence of a new property with three possible states. In analogy to the three primary colours of light , the new property became known as colour and the three varieties as red, green, and blue. The three colour states and the three anticolour states ascribed to antiquarks are comparable to the two states of electric charge and anticharge positive and negative , and hadrons are analogous to atoms. Just as atoms contain constituents whose electric charges balance overall to give a neutral atom, hadrons consist of coloured quarks that balance to give a particle with no net colour. Moreover, nuclei can be built from colourless protons and neutrons, rather as molecules form from electrically neutral atoms. This analogy between electric charge and colour led to the idea that colour could be the source of the force between quarks, just as electric charge is the source of the electromagnetic force between charged particles. In the late s and early s, theorists turned their attention to developing a quantum field theory based on coloured quarks. In such a theory colour would take the role of electric charge in QED. It was obvious that the field theory for coloured quarks had to be fundamentally different from QED because there are three kinds of colour as opposed to two states of electric charge. To give neutral objects, electric charges combine with an equal number of anticharges, as in atoms where the number of negative electrons equals the number of positive protons. With colour, however, three different charges must add together to give zero. This implies that a quark can emit somethingâ€”the quantum of the field due to colourâ€”that itself carries colour. And if the field quanta are coloured, then they can interact between themselves, unlike the photons of QED , which are electrically neutral. Despite these differences, the basic framework for a field theory based on colour already existed by the late s, owing in large part to the work of theorists, particularly Chen Ning Yang and Robert Mills in the United States, who had studied similar theories in the s. The new theory of the strong force was called quantum chromodynamics , or QCD, in analogy to quantum electrodynamics , or QED. In QCD the source of the field is the property of colour, and the field quanta are called gluons. Eight gluons are necessary in all to make the changes between the coloured quarks according to the rules of SU 3. Asymptotic freedom In the early s the American physicists David J. Gross and Frank Wilczek working together and H. David Politzer working independently discovered that the strong force between quarks becomes weaker at smaller distances and that it becomes stronger as the quarks move apart, thus preventing the separation of an individual quark. This is completely unlike the behaviour of the electromagnetic force. The quarks have been compared to prisoners on a chain gang. When they are close together, they can move freely and do not notice the chains binding them. This behaviour has been attributed to the fact that the virtual gluons that flit between the quarks within a hadron are not neutral but carry mixtures of colour and anticolour. The farther away a quark moves, the more gluons appear, each contributing to the net force. When the quarks are close together, they exchange fewer gluons, and the force is weaker. Only at infinitely close distances are quarks free, an effect known as asymptotic freedom. The strong coupling between the quarks and gluons makes QCD a difficult theory to study. The theory has nevertheless had a number of successes in describing the observed behaviour of particles in experiments, and theorists are confident that it is the correct theory to use for describing the strong force.

Chapter 8 : Ã§Â”ÂµÃ¥Â•Â†Ã¤Â»Â·Ã¦ Â¼Ã§Â›Â‘Ã¦ÂŽÂ§

Similarly, high-energy neutrino astrophysics, such as using neutrinos to probe active galactic nuclei, are omitted. Neutrino physics and astrophysics are rapidly developing areas.

Chapter 9 : PDF for astro-ph/v1

We conclude this report by discussing some selected topics relevant for the future of PDF determinations, including the treatment of theoretical uncertainties, the connection with lattice QCD calculations, and the role of PDFs at future high-energy colliders beyond the LHC.