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Chapter 1 : Quarks, Leptons and Gauge Fields | Kerson Huang |

The main content is an introduction to Yang-Mills fields, and the Standard Model of Particle Physics. A concise introduction to quarks is provided, with a discussion of the representations of SU(3). The Standard Model is presented in detail, including such topics as the Kobayashi-Maskawa matrix, chiral symmetry breaking, and the Î¸-vacuum.

List of mesons Ordinary mesons are made up of a valence quark and a valence antiquark. Because mesons have spin of 0 or 1 and are not themselves elementary particles, they are "composite" bosons. In quantum hydrodynamic models, mesons mediate the residual strong force between nucleons. At one time or another, positive signatures have been reported for all of the following exotic mesons but their existences have yet to be confirmed. A tetraquark consists of two valence quarks and two valence antiquarks; A glueball is a bound state of gluons with no valence quarks; Hybrid mesons consist of one or more valence quark-antiquark pairs and one or more real gluons. Atomic nuclei[edit] A semi-accurate depiction of the helium atom. In the nucleus, the protons are in red and neutrons are in purple. In reality, the nucleus is also spherically symmetrical. Atomic nuclei consist of protons and neutrons. Each type of nucleus contains a specific number of protons and a specific number of neutrons, and is called a " nuclide " or " isotope ". Nuclear reactions can change one nuclide into another. See table of nuclides for a complete list of isotopes. Atoms[edit] Atoms are the smallest neutral particles into which matter can be divided by chemical reactions. An atom consists of a small, heavy nucleus surrounded by a relatively large, light cloud of electrons. Each type of atom corresponds to a specific chemical element. To date, elements have been discovered or created. The atomic nucleus consists of protons and neutrons. Protons and neutrons are, in turn, made of quarks. Molecules[edit] Molecules are the smallest particles into which a non-elemental substance can be divided while maintaining the physical properties of the substance. Each type of molecule corresponds to a specific chemical compound. Molecules are a composite of two or more atoms. See list of compounds for a list of molecules. A molecule is generally combined in a fixed proportion. It is the most basic unit of matter and is homogenous. Quasiparticles[edit] Quasiparticles are effective particles that exist in many particle systems. The field equations of condensed matter physics are remarkably similar to those of high energy particle physics. As a result, much of the theory of particle physics applies to condensed matter physics as well; in particular, there are a selection of field excitations, called quasi-particles , that can be created and explored. Phonons are vibrational modes in a crystal lattice. Excitons are bound states of an electron and a hole. Plasmons are coherent excitations of a plasma. Polaritons are mixtures of photons with other quasi-particles. Polarons are moving, charged quasi- particles that are surrounded by ions in a material. Magnons are coherent excitations of electron spins in a material. Other[edit] Accelerons are hypothetical particles postulated to relate neutrino mass to dark energy, and are named for the role they play in the accelerating expansion of the universe An anyon is a generalization of fermion and boson in two-dimensional systems like sheets of graphene that obeys braid statistics. A WIMP weakly interacting massive particle is any one of a number of particles that might explain dark matter such as the neutralino or the axion. A GIMP gravitationally interacting massive particle is a particle which provides an alternative explanation of dark matter, instead of the aforementioned WIMP. The pomeron , used to explain the elastic scattering of hadrons and the location of Regge poles in Regge theory. The skyrmion , a topological solution of the pion field, used to model the low-energy properties of the nucleon , such as the axial vector current coupling and the mass. A genon is a particle existing in a closed timelike world line where spacetime is curled as in a Frank Tipler or Ronald Mallett time machine. The pions are quasi-goldstone bosons quasi- because they are not exactly massless of the broken chiral isospin symmetry of quantum chromodynamics. A goldstino is a goldstone fermion produced by the spontaneous breaking of supersymmetry. An instanton is a field configuration which is a local minimum of the Euclidean action. Instantons are used in nonperturbative calculations of tunneling rates. A dyon is a hypothetical particle with both electric and magnetic charges. A geon is an electromagnetic or gravitational wave which is held together in a confined region by the gravitational attraction of its own field of energy. An inflaton is the generic name for an unidentified scalar particle responsible for the cosmic inflation. A spurion is the name given to a "particle" inserted mathematically into an isospin-violating decay in order to analyze it as though it conserved isospin. What is called "true muonium" , a bound state of a muon and an antimuon, is a theoretical exotic atom which has never been observed. An ion a charged atom or molecule is either an anion or a cation. A dislon is a localized collective excitation of a crystal dislocation around the static displacement. Classification by speed[edit] A tardyon or bradyon travels slower than light and has a non-zero rest mass. A luxon travels at the speed of light and has no rest mass. A tachyon mentioned above is a hypothetical particle that travels faster than the speed of light and has an imaginary rest mass.

Chapter 2 : The Standard Model Shows How Elementary Particles Interact - Fact or Myth?

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Total number of known elementary particles: A look at the standard model in simple terms. Types of Fermions The types of fermions are: Quarks make up the nucleus of atoms and protons. The nucleus contains most of the mass of an atom. We find electrons in the shells of atoms and they are responsible for the electronic fields of atoms as well as passing electricity between systems. Neutrinos meanwhile act on weak force and can decay the bonds of strong force. Fermions repel and attract each other by exchanging bosons. Fermions are changed by this interaction more on that below. Types of Bosons Bosons are particles that carry forces between fermions. Each boson carries one of the four forces. The types of bosons are: Mediates the weak force to decay strong force. A theoretical for now particle that mediates gravitational force. The electromagnetic repulsion or attraction between two charges can be thought of as due to the exchange of many virtual photons between the charges. So a up-quark has a anti-up-quark. An electron has a positron not a proton. Particle-antiparticle pairs can annihilate each other, producing photons; since the charges of the particle and antiparticle are opposite, the total charge is conserved. Only the photon boson is produced in annihilation. A photon is its own anti-particle. Motion like spin can be explained with energy. Particles also have properties like direction and frequency the electromagnetic spectrum depends on frequency for instance, as does the gravitational wave spectrum. We can also break down quarks into flavors and colors which describe different layouts of these elements and leptons into different types as well. The properties of a particle determine which forces can act on it and which forces it can carry or mediate. This affects how particles interact and how they form systems. Once quarks are glued, charged electrons combine with quark-based nuclei, protons, and neutrons to form atoms. Then atoms, in turn, attract like magnets based on charge. Weak force decays they bonds back into elementary particles. The systems of quarks, atoms, and even bigger molecules are generally analogous. Two massless particles can come together to form a system with mass. This angular momentum determines how particles will interact and what forces they can carry. A general rule of the universe is that two identical fermions can never occupy the same quantum state, but two bosons can. Angular momentum is conserved, mass is conserved, a charge is conserved, color charge is conserved, energy is conserved, etc. We can overly simplify this by just knowing mass-energy is conserved not created or destroyed in interactions. This does things like make quarks flip their spin from positive to negative when they interact via gauge bosons. The speed of its fluctuation relates back to its place on the electromagnetic spectrum. Thus visible light is just a specific type of field fluctuation from photons. Remember photons being a gauge boson can be held by fermions as a charge. Learn more about the nature of light here. Conclusion The standard model of particle physics presents a fairly straightforward jigsaw puzzle.

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Chapter 3 : quarks and leptons | Download eBook PDF/EPUB

A Field Guide to the Culture Wars: The Battle over Values from the Campaign Trail to the Classroom (Religion, Politics, and Public Life Under the auspices of the Leonard E. Greenb).

Tauonic antineutrino Tau antineutrino The first lepton identified was the electron, discovered by J. Thomson and his team of British physicists in The electron neutrino was simply called the neutrino, as it was not yet known that neutrinos came in different flavours or different "generations". Nearly 40 years after the discovery of the electron, the muon was discovered by Carl D. Due to its mass, it was initially categorized as a meson rather than a lepton. In , Leon M. Lederman , Melvin Schwartz , and Jack Steinberger showed that more than one type of neutrino exists by first detecting interactions of the muon neutrino, which earned them the Nobel Prize , although by then the different flavours of neutrino had already been theorized. The first evidence for tau neutrinos came from the observation of "missing" energy and momentum in tau decay, analogous to the "missing" energy and momentum in beta decay leading to the discovery of the electron neutrino. The first detection of tau neutrino interactions was announced in by the DONUT collaboration at Fermilab , making it the latest particle of the Standard Model to have been directly observed, [28] apart from the Higgs boson , which has been discovered in Although all present data is consistent with three generations of leptons, some particle physicists are searching for a fourth generation. The spin-statistics theorem thus implies that they are fermions and thus that they are subject to the Pauli exclusion principle: No two leptons of the same species can be in exactly the same state at the same time. Furthermore, it means that a lepton can have only two possible spin states, namely up or down. A closely related property is chirality , which in turn is closely related to a more easily visualized property called helicity. The helicity of a particle is the direction of its spin relative to its momentum ; particles with spin in the same direction as their momentum are called right-handed and otherwise they are called left-handed. In many quantum field theories , such as quantum electrodynamics and quantum chromodynamics , left- and right-handed fermions are identical. Only left-handed fermions and right-handed anti-fermions participate in the weak interaction. This is an example of parity violation explicitly written into the model. In the literature, left-handed fields are often denoted by a capital L subscript e. Right-handed neutrinos and left-handed anti-neutrinos have no possible interaction with other particles see sterile neutrinos and so are not a functional part of the Standard Model, although their exclusion is not a strict requirement; they are sometimes listed in particle tables to emphasize that they would have no active role if included in the model. Even though electrically charged particles electron, muon, or tau do not engage in the weak interaction specifically, they can still interact electrically, and hence still participate in the combined electro-weak force , although with a different strengths Y.

Chapter 4 : standard model - What are quarks and leptons in Quantum Field Theory? - Physics Stack Exch

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Chapter 5 : Quarks, leptons & gauge fields | Kerson Huang |

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Chapter 7 : quarks leptons gauge fields | Download eBook pdf, epub, tuebl, mobi

Gauge fields are the messengers carrying signals between elementary particles, enabling them to interact with each other. Originating at the level of quarks, these basic interactions percolate upwards, through nuclear and atomic physics, through chemical and solid state physics, to.

Chapter 8 : Quarks, Leptons and Gauge Fields - Ebook Library Download

This chapter illustrates the theory of Lie algebras and their representations. Two topics, which go beyond Lie algebra theory, are super symmetry and quantum groups.

Chapter 9 : Quarks, Leptons & Gauge Fields by Kerson Huang

Quantum field theory in general doesn't know about quarks and leptons. It knows about bosonic and fermionic fields (e.g., scalar fields, vector fields, spinor fields) and their interactions. So think of quantum field theory as a framework.