Chapter 1 : Superfluid vacuum theory - Wikipedia

â€¢ "The non-localized gauge potential properties view": the quantities that make up the ontology can be derived from the gauge potential, but are not necessarily associated to arbitrarily small neighbourhoods in space-time.

Comparable sales are a useful tool for evaluating the potential value of an investment property. There are a number of free online resources through which comparable home sales can be pulled. Rather, successful investors spend a considerable amount of time performing market and property research before making a decision, while using any and all decision-making tools available to them. As a beginner investor, one will find that learning how to identify comparable sales is one such important tool. A commonly-used abbreviation, real estate comps refer to comparable sales in real estate that allow buyers, sellers and investors to compare the relative value of properties within a same area. Because the value of a property is relative, and often subjective, individuals can look at recent sales of similar properties in the same market to gauge whether or not a particular property has been priced fairly. For buyers, comparable home sales signal whether or not a property of interest is listed at a fair price, and can also justify offers that are made. On the other hand, sellers can use comparable house sales to justify their asking prices , while also getting a sense of how quickly their properties might sell. For investors, however, comparable home values are arguable one of the most important metrics to understand. There are several variables to keep in mind when learning how to properly run neighborhood comps. In the previous scenario, the investor used recent sale prices to evaluate the potential profitability of an investment property. Ask your real estate agent to obtain information on the sale price for these types of deals. Location is also extremely important when running neighborhood comps, as home values are relative to specific markets. By finding comparable sales as close in proximity to your listing as possible, the more accurate of an indicator you will have. Property features should also come into consideration, such as square footage, lot size, age, condition, number of bedrooms and bathrooms, and additional features. Although it can be difficult to find a property sporting features identical to the property of interest, it is important to find comps that are as similar as possible. Ultimately, the goal when searching for comparable sales is to be able to compare apples to apples, rather than apples to oranges. To learn more about using comparable home sales to determine the value of your property, go here. Using Real Estate Comps To Find The Best Deals When searching through potential investment properties, an investor will typically research recent comparable sales to get an idea of what a property might sell for if they were to invest in a particular neighborhood. For example, let us say that the investor finds an older, outdated three bedroom property for sale at a great price. They might then look at the recent sale prices of a similar three bedroom properties in that same area. This helps the investor calculate the After-Repair-Value on the property, gauge their potential profit margin, and decide whether a property is worth the investment or not. Investors will quickly find that real estate comps can be used to find great deals, and not just to analyze the potential of a property they already have in mind. For example, comps can help someone analyze a particular market, decide on the right timing, and examine desirable property features. For starters, investors can pull hypothetical comps in any given neighborhood in order to conduct a market analysis. This process can help them identify promising neighborhoods to target. Second, hypothetical real estate comps can be used to monitor selling prices, as well as how long properties sit on a market. By doing so, investors can keep a pulse on whether or not the timing will be right. Finally, by comparing recently-sold properties within a target market, investors can analyze what features seem to be the most profitable. This can help investors opt for properties that have desired features, or know what upgrades will prove most profitable. Not only can they help investors calculate the profit potential of a particular property, they can use comps to get to know certain markets and keep a pulse on ever-changing trends. Knowing how to pull MLS comps is also valuable for investors when they are ready to sell their properties as well. Click here to read more on how to pull MLS comps for the seller side. Resources For Finding Comparable Home Values There are a variety of ways to find comparable home values, and many investors will make use of more than one method when running their numbers to ensure as accurate of a value estimate as possible. These methods include searching for the prices of recently sold properties online, or driving around a target neighborhood and attending open houses. In addition, real estate agents who specialize in certain markets are often a great resource on recent sale prices, identifying comparable properties, as well as speculating future sale prices. Investors can also spend time keeping a pulse on property list prices, versus what they actually sell for. Running these comparisons can be a great indicator on whether the market is showing an upward or downward trend. The following are websites through which property values can be researched for free: This free and user-friendly site allows visitors to search for sold listings, which can be used as neighborhood comparable sales. Redfin is an online brokerage, allowing site visitors to connect with full-service agents and listings online. Redfin offers a home value estimate tool using market data. Contact a local real estate agent to find out recent selling prices. This site provides site visitors access to recent sales and comparables via public data. Summary Comparable sales in real estate is an important tool for real estate investors to employ any time that they are considering an investment property. Comparable home sales, which are properties sold recently in the same neighborhood that have similar features as the target property, help investors to evaluate the potential after-repair value and thus measure their potential profit margin. Investors who are able to hone their skills in the research phase of investment property acquisition are those who are most likely able to maximize their profit potential. Because the real estate market fluctuates so frequently, and because home values are subjective based on desirability, knowing how to pull neighborhood comps is an essential skill to add to the investing arsenal. Because no two properties are identical, do you have any tips and tricks to identifying the best possible comparable sales? Share in the section below: By subscribing, you agree to receive blog updates and relevant offers by email. You can unsubscribe at any time.

Chapter 2 : Is the world made of loops? | Alexander Afriat - racedaydvl.com

view that gauge theories motivate a novel metaphysics involving a shift away from localised properties. I have argued against some of the details of this view elsewhere (Rickles, , pp.); but overall I agree with Healey that a view involving so-called holono-mies (or rather Wilson loops) is superior to the other available options.

Alexander Afriat Is the world made of loops? The individuals of [A] can moreover be transcendedâ€"punctually, without integration around loopsâ€"by an appropriate version of the electromagnetic connection. The re- lationship is puzzling, but one can try to make sense of it in various ways. Then there would be no trouble in interpreting these results, but, as is well known, there are severe difficulties in the way of doing this. In the literature one finds enumerations of three or even four interpretations, which we can call: I1 electromagnetic field interpretation I2 electromagnetic potential interpretation I3 holonomy4 interpretation I4 topology interpretation. The topology interpretation I4 , dealt with in Afriat , will not be considered here. I1 nothing at all I2 electromagnetic potential I3 loops. Interpretations I1 and I3 are so embarrassed by the embarras de richesses 1 that they altogether renounce the riches. In I1 an empty annulus is simply accepted, what- ever the consequences again, a non-local influence between the electromagnetic field in the solenoid and the wavefunction beyond the annulus ; in I3 the void is filled with other embarrassing riches which are confidently passed off as altogether unembarrass- ing. In any case it is better to overfill an awkward void, somehow or other, than to leave it empty; so I2 and I3 are both preferable to I1. This paper is about I3 , as opposed to I2 in particular. Again, I see no reason to prefer I3 to I2 ; the reason embarras de richesses given for looking beyond I2 to I3 pertains to both, and is if anything more problematic in I3 than in I2. But it may already be helpful to imagine not one but two concentric cylindrical shields: To bring out the nonlocal effect the distance, the annulus between the two shields can be made arbitrarily large. Can the presence of options really be so harmful as to justify their rejection or even annihilation? Everyone agrees that the attractive transformation properties of quantities like C or F can be interesting, important, physically relevant. Does it really contain too much? Must too much really amount to nothing at all? Does one really have to dismiss the electromagnetic potential A because many potentials [A] correspond to F and C? One can appreciate or even prefer quantities with attractive transformation properties; but is that a reason to proscribe equivalence classes altogether? To try to do physics without them? But this concerns I1 more than I3 â€"which has its own embarrassing riches. I cannot claim to have dealt with them all, and leave any outstanding subtleties to more able exegetes. My concerns are chiefly interpretational, philosophical, foundational, in any case not philological; which admittedly raises the secondary issue of exactly how the interpretations considered here relate to those in the literature. They will not, I hope, be altogether unrelated, even if I sometimes idealise and simplify. Whatever doubts or ambiguities there may be about the holonomy interpretation s , I think one can at least say this: The holonomist, grudging to pick an individual out of the equivalence class [A],9 first dismisses the electromagnetic potential as a physi- cally meaningless mathematical fiction;10 and then wants to transcend the individuals with a loop integral which, being common to them all, is awarded an appropriateâ€" presumably ontologicalâ€"primacy. Against the holonomist it can be argued that appropriate electromagnetic properties 7 Healey , , , 8 Lyre , , a,b. Gordon Belot attaches ontological importance to holonomiesâ€" without, however, preferring them to potentials. A central notion here will be measurability: F and C can be measured, but not Aâ€" for the time being at any rate. Indeed measurability is a complicated matter: Different contexts require different notions of measurability; no notion will be given an absolute primacy, which transcends context. Is it meant that A can be transformed? Of course it canâ€"but so can C and F , and in many different ways: If that were to happen, then his observations would discriminate in favor of an interpretation of the gauge theory that commits it to such a privileged gauge, and against a holonomy interpretation. This has not yet happened. But since we cannot be sure that it never will, it seems that we are in no position to answer the question as to whether a holonomy interpretation is correct. But it remains true that the gauge dependence of A has above all to be understood in terms of the observability of F and C, and their indifference to 2. Healey devotes much attention to quantized non-Abelian Yang-Mills theory. I only14 consider electrodynamicsâ€”and hence U 1 , rather than the non-Abelian structure groups of general Yang-Mills theoryâ€”without quantization beyond the in- troduction of a wavefunction. Varying the current through the solenoid changes the arbitrarily distant interference pattern, which is perhaps surprising. Indeed they cancel by addition, but one can wonder about the physical meaning of the sum. But the holonomist seems toâ€—indeed has toâ€—go beyond all three. One can hardly contest i or ii , which are purely mathematical; and ideas18 along the lines of iii go back to Cassirer or perhaps Einstein , 19 or even Klein ; nor can the point be anything like the world is made of abstract structures or abstract structures should be taken seriously,20 which may be right but not new, either; nor can it be a mere extension of old ideas about invariance or structures to yet another theory. So exactly what is the issue? Something along the lines of a world made of loops? S, Lyre b p. Let us try to understand what exactly the holonomist may have in mind. The holonomist could argue as follows: But what electromagnetic entities are available there? Again, the holonomist24 dismisses A, or even all of [A], by combining i with an appropriate version of iii. What else could the electromagnetic property C belong to? A clue is provided by the following trivial example: Could the integral C also belong to its domain of integration,27 in much the same way? In our electromagnetic case, what is the domain of integration? A circle, as in the trivial example? So one holonomy interpretation could amount to this: The integral C is a property of its domain of integration just as the circumference was a property of the perimeter. But can the assignment of an integral to its domain of integration really help us understand the Aharonov-Bohm effect? So the holonomist may have to go beyond that assign- ment of an integral to its domain of integration, and make physical or metaphysical or ontological claims about the loops in the domain of integrationâ€—maybe along the lines of loops are real or loops really exist or since loops do the work, they must really be there or even the world is made of loops. This is a position that, whatever its origin, is at least worth mentioning. Rather than dwell on the philological issue of exactly how 24 Unlike Healey, who denies any physical reality to the class [A] and all its individuals , Lyre seems to have no objection to the equivalence class; p. The most direct way to implement this idea would be to require that the gauge potential properties are just those that are represented by gauge-invariant H magnitudes. Here a set would work, but something weaker is enough: This second holonomy interpretation is more straightforward than the first. Briefly, it emphasises the ontological primacy of loops without bothering to point out that an integral belongs to its domain of integration: This second interpretation can be attributed to Lyre ,29 Lyre a ,30 Lyre b ,31 or again to Healey ,32 Healey This is the interpretation of classical electromagnetism I shall defend. This belief may be encouraged by the predictive successes consequent upon in- troducing classical electromagnetism into the quantum mechanics of particles. If it is accepted that these theories describe reality, does not it follow that the quan- tities in question are as real as any others? But surely the Aharonov-Bohm effect has to be conveyed by something. The solenoid, and the electromagnetic field it contains, are arbitrarily far from the wavefunction and the screen on which the effect is seen. The circulation C, which determines the interference pattern, has a promising indifference to 2 ; but C is just a number, not enough on its own to convey or account for the effectâ€—something more is presumably sought. As a compressed statement we can adopt S: A does not as- sign a property Ax to the physical point x because there are so many other potentials in [A]. Can something similar be attempted here? But even if the local dependence on the structure group can thus be overcome somewhere or other by means of appropriate compensation, G remains undeniably present on the principal bundle. So we have to find a way of descending from the principal bundle to M , to whose points we want to assign the electromagnetic property. There will be no attempt to do away with gauge freedom altogether; rather, it will be shown that such freedom by no means prevents the assignment of an appropriate electromagnetic property to each point of the annulus. Properties in modern physics, when unpacked, can have plenty of internal structure: Again, gauge freedom is still there, but at least we have a single electromag- netic property at xâ€—single by the standards of internal structure typical to physics, to modern physics at any rate. Cardinality or perhaps the grammatical category of numberâ€”singular, plural is not invariant under mathematical reformulation: Again, the holonomist argument amounts to this: So the crucial move to loops and inte- gration is only justified by the supposed impossibility of getting rid of the individu- als of [A] at a point x; if they could already be punctually transcended, why bother with integration? We can take the principal bundle to be trivial, in other words a Cartesian product, with no relevant loss of generality. It is only when this bundle representation is trivial that the older vector representation of the potential is even possible. That is always the case for Maxwellian electromagnetism defined over Minkowski spacetime, but it is not true if one allows for the possibility of magnetic monopoles. It is undeniably true that the individuals can always be introduced or referred to; indeed one has to be able to introduce them; vertical automor- phisms or equivalent operations are always available, however abstract or geometrical the formulation. But the individuals can nonetheless be transcended, packed away out of sight, by means of appropriate constructions or reformulations. Picking individuals gauge fixing and transcending them may look like incompat- ible solutions. Perhaps; but at worst a choice would be forcedâ€”pending which, both remain available. A gauge transformation 2 would then deform the level rays, bending them without making them cross. To emphasize that loops are no better than A, we can even arrange for a gauge transformation to induce a loop deformation thus strengthening the duality: If a potential subject to 2 is too flimsy to exist, why should loops also subject to 2 be any better? Are vectors any more real than the covectors dual 36 p. Crossings in opposite directions cancel, and add nothing to the integral. Is a Lagrangian ontologically inferior to the Hamiltonian dual to it?

Chapter 3 : Top 4 Things That Determine A Home's Value

The non-localized gauge potential properties view is motivated by the idea that the structure of gauge potential properties is given by the gauge- invariant content of a gauge theory.

Reviewed by Ward Struyve, K. Leuven Our current day most successful theories are gauge theories. On the one hand there are the quantized Yang-Mills theories that describe non-gravitational interactions. On the other hand there is general relativity whose quantum version is still under construction which describes gravitational interaction. These theories are called gauge theories because their standard formulation contains unobservable and hence apparently redundant elements. In the philosophical community, the gauge aspects of Yang-Mills theories have received far less attention then those of general relativity. Most of this book concerns a careful and detailed study of the ontological implications of both classical and quantized Yang-Mills theories. In particular, a non-localized ontology is defended in which the basic ontological variables are the holonomies associated with loops in space-time. In the first half of the book the first four chapters , Healey considers classical gauge fields. In classical electromagnetism, the gauge field interacts with point-particles and a natural ontology is given by the point-particles and the electric and magnetic field. When the classical gauge field is instead coupled to a quantum particle described by a wave function , a new effect arises, namely the Aharonov-Bohm effect, which seems to call for a revision of the classical ontology. Of course, by introducing a quantum particle one actually also needs to deal with the interpretational problems of standard quantum theory. Healey circumvents these problems by considering possible ontologies only for gauge fields, without much consideration for the ontology of the quantum particle. These interpretational issues are reconsidered in some detail in Chapter 8, in the context of quantized Yang-Mills theories, where they are unavoidable. While it is definitely a good idea to disentangle gauge issues from interpretational issues, I believe that abstaining from fully incorporating the matter degrees of freedom in the ontology leads to other complications as I will indicate below. I believe a better approach would have been to consider also a completely classical theory of interacting gauge fields with matter fields. As with the classical non-Abelian Yang-Mills theories, one could assume that the hypothetical empirical content lies in the gauge invariant quantities. Healey considers three possible types of ontology for classical gauge fields first for electromagnetism in Chapter 2, and then for general Yang-Mills theories in Chapter 4: Healey presents two arguments against the first view. First, this view implies action at a distance. This follows from the Aharonov-Bohm effect, where a magnetic field confined to a localized spatial region still has an effect on the interference pattern of a quantum particle that passes outside that region. Second, in the case of non-Abelian Yang-Mills theories, there exist gauge inequivalent gauge potentials that give rise to the same field strength in a simply connected region. So the field strength at that region would not completely capture the gauge invariant content associated to that region. The second view is considered in more detail, with distinction of various approaches including those of Leeds, Maudlin and Mattingly , but is finally rejected, basically on the ground of underdetermination: After having rejected the first two possible views, Healey argues in favor of the third one. In particular, Healey defends a holonomy interpretation, whereby the ontology is given by the holonomies associated to loops images of oriented closed curves in space-time these can be constructed from line integrals of the gauge potential along closed curves. While these quantities relate to extended regions of space-time, they do not imply non-local action. In the case of electromagnetism, which is an Abelian Yang-Mills theory, these holonomies are gauge independent. In the case of non-Abelian Yang-Mills theories, the holonomies are actually not entirely gauge invariant. Moreover, they also depend on the choice of base point on the loop. Healey seems to argue these issues away by noting that the quantities transform "covariantly" when also the wave function of the quantum system is taken into account. Healey actually describes just such an extension in Section 7. These are constructed from the holonomy along the path and fermion fields at the end points, and seem adequately to take into account the fermionic degrees of freedom. Healey spends some time on the complications in constructing such quantities, but such constructions seem to arise naturally in the Weyl representation of the Dirac matrices; see for example [1] and references therein. Maybe including the matter degrees of freedom in this way leads to some complications for some interpretations of quantum theory, but they seem completely adequate in the context of a completely classical field theory. But that being said, the Wilson loop approach would have the same metaphysical implications as the holonomy approach. It would also yield a non-localized ontology that evolves in a local way. By considering an ontology also for the quantum particle or a classical matter field , it would also be clear how the holonomies act on the particle. As for now, Healey states that the holonomies do not act on hypothetical localized phase properties of the wave function, but rather on some yet to be determined non-localized phase properties along a loop see for example p. This account is not only a bit vague, it might also change for an ontology that properly takes into account the matter degrees of freedom as seems to be the case for the generalized Wilson loop approach. As Healey indicates in Section 3. This is an important kinematical result. If the hololomies are taken to be the basic quantities, one should also express their dynamics without reference to gauge potentials. Unfortunately this problem is not discussed by Healey. It is also notable that in rejecting the second view, Healey does not appeal to the indeterminism that generally arises when taking the potential to represent physical reality. For example, the equations of motion for the gauge potential do not yield a unique solution given initial data, but rather a class of solutions that are all related by a gauge transformation. Since these solutions are observationally indistinguishable, there seems to be an unnecessary surplus structure. However, Healey does not appeal to this indeterminism of the equations of motion to reject the second view although he mentions it in passing on p. This field can be expressed as a gauge invariant function of the charge current which is itself gauge invariant. Since the current field is gauge invariant, there is deterministic evolution. These other fields could be obtained from the current field by what merely looks formally like a gauge transformation. After having considered classical gauge fields, Healey devotes the second half of the book to their quantized counterparts. In Chapter 5, Healey first considers different routes to obtain a quantum theory from classical Yang-Mills theories. In this approach, which is briefly mentioned in Section 6. See, for example, [2] for some discussion of this approach. In chapter 6, Healey considers the empirical import of gauge symmetry. In particular, some interesting features of quantized Yang-Mills theories are discussed, such as the Higgs mechanism, theta-vacua and anomalies, some of which still involve challenging conceptual questions. Then, in Chapter 7, loop representations are considered, within the context of canonical quantization. In those representations the quantum states are functionals of loop variables which are constructed in an overcomplete basis of Wilson loops. The virtue of these representations is that the gauge freedom is completely eliminated just as in reduced phase space quantization. Healey considers the question of whether such representations might yield other quantum theories than the one that arises in the standard Fock representation. Different representations of the operator algebras might yield inequivalent quantum theories. This might allow the resulting quantum theories to be experimentally distinguished. And an experimental bias towards a theory that is obtained from a loop representation could support a loop based ontology within certain interpretations of quantum theory. The various interpretations of quantum theory and their ontological implications for Yang-Mills theories are considered in Chapter 8. As Healey rightly notes, this is only an initial survey. Even though one can broadly distinguish the interpretations, such as Everettian or de Broglie-Bohm type intepretations, the ontological implications may still depend heavily on the details of the approach. For example, Everettian interpretations take the quantum state to represent the ontology, but there are various ways in which this quantum state can be understood: Also in interpretations that have more ontology than just the quantum state, like de Broglie-Bohm theory or certain versions of collapse theories, there seem to be a variety of options. Some of these will incorporate an ontology that is similar to a possible ontology for classical Yang-Mills theories. For example, some might admit a holonomy interpretation. But one also has approaches where there is nothing like that. Healey intended the book to be self-contained, with extended appendices serving this goal. Nevertheless, some parts may be hard to follow without some background knowledge or without consultation of the original literature. References [

1] T. Earman, "Tracking down gauge: Castellani, Cambridge UP, Cambridge Timpson, "Quantum Mechanics on Spacetime I: David Peat, Routledge, London, p. Bell on The Foundations of Quantum Mechanics, eds. Veltman, World Scientific, Singapore,

Chapter 4 : Ideal Property Inspections |

gauge properties), and (3) new non-localized electromagnetic properties view (non- localized gauge potential properties view). For the AB effect, and for classical YM.

July 18, There are varieties of scientific realism, but let me begin with the strongest sort. This would be the view that scientific theories, principles, and theoretical entities are factually true or false, that they are the way the physical world is constituted or not, that they are instantiated, as conceived, in the world or not. On this view also, science can come ever closer even all the way to ascertaining the truth or falsity of a theory, and so, ever closer to ascertaining a way the world is; by further observations and experiments and their analyses. Even facets of the theory not observable, directly nor indirectly, may be so ascertained of the world, under full-strength realism Van Fraassen , 7â€"9; Newton-Smith , 28â€"29, 37â€"39; Boyd , , ; Brown , 10â€"16, 20â€"22; Miller , â€"67; Suppe , chp. So far as I know, every realist and every other philosopher of science recognizes a distinction between mathematical existence and physical existence e. If it can be established within bounds that a mathematical structure obtains in the physical world, that a structure is instantiated in or is applicable to the physical world, then mathematical existence can lead us to new physical existents: Milder sorts of realists and the antirealists, of course, are not going to concede that all of these items should be ascribed physical reality, even though each item has received substantial empirical corroboration. But antirealists and realists alike will agree that the fullness with which a mathematical structure applies to the world, in the specific domain under investigation, has to be established empirically. Any scientific realist must allow that at a given time in the development of science there will be theoretical items about which one should be agnostic concerning their physical reality. For the full-strength scientific realist, however, there is no facet of theory about which one should be agnostic on principle, agnostic always, at any stage of scientific development. Constructive empiricism is the antirealist position of Bas van Fraassen. The constructive empiricist is, on principle, agnostic about what is physically real when it comes to unobservable elements in a scientific theory. The content of a theory over and above its empirical content should never become accepted as true of the world agnosticism , though it may rightly become accepted as empirically adequate, as true with respect to observable phenomena Van Fraassen , 11â€"13; , â€"93, â€"14, â€"28; , 3â€"4, , â€" No more than potential empirical adequacy is required to motivate theoretical research programmes; scientific realism is not required ibid. Immediately, I find the constructive empiricist stance attractive. We can sense directly, within ranges, that heat is flowing into or out of our bodies. But identification of the object of our sensing as rate of heat flow is a theoretical identification of physics and physiology. The thermodynamic concepts of heat and energy are theoretical and are confrontable empirically, by touch or instrument, only in limited ways, not in their whole cloth, through and through. To the mind of the constructive empiricist, the things that we can know to be physically real are i things that we have actually observed, without sense-extending aids nor commonsense-extending inferences, and ii things thusly observable but to now less directly observed ibid. In category i would be falling, firmness, coldness, snow, trees, tables, and moon rocks and not "sense data" [ibid. From my earlier list of physical existents that are commonly claimed to have been reached in contemporary physics, only Neptuneâ€"because it is category ii â€"counts as physically real in the book of constructive empiricism. The divide between constructive empiricism and realism pertains to claims that science has established or can establish the existence of the remaining, more subtle items on my list; and we should add to those contentious items, electrons, molecules, DNA strands, viruses, organelles, and even cells ibid. None of these fall into categories i or ii. I should take three steps into realism. In learning to observe with optical microscopes, one needs to acquire some elementary understanding of the instruments, some skill in scope operation, and skill in manipulating specimens while they are under the scope. Presented to the unaided eye, the dust-or-gland in question is, at best, simply a speck. Under the observability criteria i and ii , we cannot get beyond that speck when it comes to affirming physical existence on account of observation. We put a visible fly on the slide and manipulate it with visible tools. Using the scope, visual observation, though it becomes surely indirect, extends down to organs of fruit fly, even down to particular parts of cells. We see the tiny glass needleâ€”a tool that we have ourselves hand crafted under the microscopeâ€”jerk through the cell wall" ibid. Surely realism about cells, actively observed using various scopes and stains, is justified. Realism concerning cells is justified by specifics of their observation and manipulation and how these overlap with and directly connect to our normal observations and manipulations further, Hacking , I do not think that this modest step is a step down a slippery slope to realism concerning all items indirectly but reliably detected and manipulated in physical science contra Hacking In a general way, the further we extend the sensitivities and spatial reach of our senses with instruments consider thermometry and X-ray crystallography , the more high-level theoretical inferences and interpretations are required for ascertaining what we have detected or manipulated. The we just used should include not only the users of instruments, but the designers and manufacturers of those instruments. Science, like industry, is a collective enterprise. Having taken step one into more realism, I should say that I think Van Fraassen is nonetheless correct in trying to maintain a distinction between detection and observation further, Brown , chp. He would say that tracks in a cloud chamber allow us to detect charged particles. The detection is based on observations, but we do not observe the particles themselves in the chamber Van Fraassen , With such instruments, we have detected, though we have not observed, charged elementary particles such as the electron. A Scanning Tunneling Microscope STM image of the surface of the semiconductor gallium arsenide reveals something looking like aligned beads Wickramasinghe , We are very sure those arrays of beads are maps of arrays of atoms and molecules. We are not observing those atoms in the STM image. We are inferring them from our understanding of the character of our sensor electrons and piezoelectrics , sensor motion control system, theory of electron tunneling probability, and signal processing and display. Still, the consilience of observations and manipulations with the STM and our many other current instruments, and consilience of all the observations and manipulations over the last century and more that made those instruments possible is overwhelming: Molecules, atoms, electrons, photons, and radio waves, the existence of all these are now inferred with complete assurance cf. It is no longer plausible that atoms are not concrete particulars, as concrete as the lasers they have made possible, as concrete as the rotation of the earth on its axis. Atoms are themselves unobservable, yet we know for sure they exist. This is my second step into realism. Under step two, by at least , inference to the physical existence of atoms and molecules was warranted, indeed required Nye , â€” Hacking, because of his stress upon the effectiveness of experimental manipulation for the getting of real entities, has eschewed realism concerning extragalactic objects No getting to the physically real, beyond the phenomena, for intergalactic astrophysics. Taking my step two into realism allows that astrophysicists might come to know truths of extragalactic physical reality Shapere Richard Miller has pointed out that constructive empiricism, limiting right scientific inference of physical existence to such a tight compass of observabilityâ€”what I have cast as category i or ii observabilityâ€”is placed in a predicament over Pluto. That planet is observable with the unaided eyesight of astronauts, they could eventually go there, "Pluto exists" we may rightly assert. Yet "the coldness of Pluto is not observable, since humans cannot detect it without instruments. They would die instantly if they tried" Miller , My first two steps into realism are together sufficient to allow us to assert a physical temperature for a physical planet. Steps one and two are enough to sanction realism, physical truth or falsity, physical existence or only mathematical existence, for everything on my original list of controversial, unobservable items: Now that two-step realism has allowed molecules, atoms, electrons, photons, and radio waves as for sure physical existents, rather than as only empirically adequate theoretical items, Van Fraassen would want to ask: Whose electron got the physical reality? Or is it the electron of Einstein-Planck â€”8 , a point particle possessing a fixed nonzero inertial mass in its own rest frame, that mass being encountered as variable with relative velocity by outside frames in motion relative to the electron, "electromagnetic mass" being voided, totally identified with inertial mass? A number of these models of the electron have been eliminated by empirical test. At times the competing models can appear empirically equivalent; that would be the case for Lorentz v.

Einstein in Zahar , But in time, empirically different implications are teased out of these theories; that is the way of most empirically equivalent theories; the empirical equivalence is temporary Miller , â€” By the Lorentz v. The existent, electron, is evidently more like the Einstein-Planck model than the Lorentz model. Even if electrons, taken as existents, as concrete particulars, are here to stay, which of their properties are here to stay? It does not seem reasonable to say we know that electrons are physically real, but that we are agnostic about the physical reality of all properties of the electron. The properties leaving aside QFT of the electron we count as essential, for some decades now, are mass, charge, intrinsic spin, and de Broglie wavelength and less essential, but very important, the electron being a perfect point. Our deepest theory of micromatter is quantum mechanics with special relativity. Physicists have in fact been long anticipating and seeking a deeper theory to fully fuse quantum theory with special and general relativity theory. When that is achieved, will the deepest physical concepts in our ontologyâ€”mass-energy, angular momentum, and electric charge and spacetime? These theoretical entities, which we take for concretely physical, have been won through very long hard digging. Insofar as they may become voided, it plausibly would be only as with "electromagnetic mass": Existence of the old-concept tokens continue under new-concept tokens. The most interesting empirical equivalences, to my mind, are those in which the equivalence has been proven mathematically. As Apollonius knew, the apparent motions of moon, sun, or planet about the earth can be modeled equivalently by either of two geometric models, eccenter or epicycle. Their equivalence is geometrically demonstrable. Which of these two models is physically real? I should say, as do many others, that what is invariant between the models is potentially "the undraped figure of nature itself," whereas, the remainder in the models is surely only "the gay-coloured vesture with which we clothe it. Again we are drawn to the invariant between the formulations as being closer to the unadorned figure of nature. Consider also Newtonian mechanics. Within the domain of Newtonian mechanics, Lagrangian and Hamiltonian formulations are demonstrably equivalent to the Newtonian. However, the Lagrangian formulation applies to a wider domain including the Newtonian, and the Hamiltonian formulation applies to a wider domain including the Lagrangian Arnold , 2, 53, Within the Newtonian domain, we might look for what is invariant among the three equivalent formulations for taking as closer to the undraped figure of nature. Then, too, we might rather take the Hamiltonian formulation as closer because it has the widest range of applicability, indicating depth cf. Stein ; Nozick Well, there is my third step into realism, the invariants-depth step. It is a shy step, for it only allows one to say one has gotten closer to a physical reality, never that one has reached the final, deepest invariants. Because of the shyness of step three, I believe my three steps together land me shy of full-strength scientific realism. Mathematical Methods of Classical Mechanics. On the Current Status of Scientific Realism. In The Philosophy of Science. Foundations of Space-Time Theories. Experimentation and Scientific Realism. In Philosophy of Science: Do We See through a Microscope?

Chapter 5 : Comparable Home Sales: A Real Estate Investors Guide | FortuneBuilders

The No Gauge-Potential Properties View. The Localized Gauge-Potential Properties View. The Non-Localized Gauge-Potential Properties View. A Holonomy Interpretation. Epistemological Considerations. Objections Considered. Semantic Considerations. Metaphysical Implications: Non-Separability and Holism. 5. Quantized Yang-Mills Gauge Theories. 6.

It is the land underneath the structure that appreciates in value. This is a significant distinction, considering that the purchase of a home is the single greatest investment that most retail investors will make in their lifetimes. Land as an Appreciating Asset Making the distinction between the improved portion of a property and the land on which it sits may seem trivial. But it is not until the real estate investor focuses on these differences that it becomes easier to find more efficient investments that provide the highest return for the amount of risk or the capital invested. Because property prices are a function of local supply and demand, the appearance, functionality, and maintenance of the physical structure will certainly impact value, but these factors have less impact than one may think. Understanding how location and the future prospects of land values influence property returns allows investors to make better choices between competing assets. The reason that land is an appreciating asset is a simple one. It is in limited supply, and no one is producing any more. The demand for land is constantly growing as the population increases, and since its supply is finite, its price must increase over time. Unless something happens to limit demand for a given area or make it unusable, the grounds should be expected to increase in value over time. The question is how much the land will appreciate and how much the improvements will enhance or degrade overall value. The actual building on a property is a depreciating asset. As it ages, it requires capital infusions for maintenance, updating to stem functional obsolescence and, depending on its design, updating to prevent it from falling out of style. Even the Internal Revenue Service IRS acknowledges this fact by allowing depreciation of the physical structure for tax obligations. The land underneath the structure, however, is not depreciated. The degree of depreciation or physical obsolescence will be specific to each property, but it is fair to say that, if left alone, a property will continue to depreciate until it no longer adds value to the land, or even reduces its value. Some land parcels with inferior structures, as compared to the surrounding properties, will actually be worth more unimproved. Owners will often raze the physical structure to maximize the value of the parcel. So why are advisors always suggesting that property owners commit capital to update their homes? Basically, to counteract some or all of the depreciation that is slowly reducing the value of the structure. Experienced real estate investors realize that this asset class is capital-intensive , requiring periodic injections to maintain and maximize value. The implication is that home buyers have to look past the physical attributes of the home and focus how its physical site in the local market will affect overall return. This is extremely difficult for home buyers who expect to live in their homes for an extended period of time. However, even the most lackluster of purchases can be improved over time and create significant wealth if located in an area of high demand. The following are four considerations for new home buyers to consider: Smaller or less-attractive homes can provide greater investment returns. To understand this point, envision two functionally sound houses on equal land parcels in the same neighborhood, one valued near the maximum and another selling at half that price. Since local supply and demand factors drive land values, houses in a neighborhood tend to appreciate by approximately the same amount per year. Locations within neighborhoods will affect land values. Not all spots within an area are considered equal. Residences tucked into cul-de-sacs, due their constraint on traffic and implied safety for children, are usually in higher demand than houses on more frequently used roadways. The appreciation of land values underscores the importance of choosing between neighborhoods. Most middle- and upper-class, single-family-home neighborhoods already limit new construction; these limits are set when developers purchase most of the available land to construct the subdivisions. Because of this, most neighborhoods evolve their own social, cultural and demographic characteristics that impact demand for houses there. The average

age of neighbors can provide clues to appreciation. Many investors do not consider this when selecting locations. New home buyers with small children will often avoid locations with older homeowners who will not provide playmates for their children. Also, most homeowners are aware of the influence that specific public schools have on the demand for homes in that particular school district. Since homes in the area are not homogeneous, the appreciation is all due to location and the value of land. Plans concerning schools, hospitals, traffic patterns and other public infrastructure will have as much influence on land values as present and future development of commercial amenities in a particular locale. Single-family property investors must factor into their purchase offers the potential effect of vacant or developable land on future supply and home prices. This is a continual risk borne by purchasers of condominiums. Condo prices are affected by the same demand factors as single-family homes and the appreciation of the land that their building is on. A unique issue for condo owners is supply. Unlike most single-family homes, which are built in infill locations, a significant number of condos can be built on small parcels of land and in short periods of time, increasing supply and potentially driving down prices. It is difficult for condo owners to gauge the potential for new development and land values, since multi-unit structures and high rises can easily be built on parcels that were initially home to other types of residential or commercial real estate. This requires overlooking the most attractive houses in a target location and concentrating on those that provide opportunities for improvement that will enhance the value of the land. Understanding land values will change the investment view of that under-maintained ranch house from "unattractive" to "money-maker. Trading Center Want to learn how to invest? Get a free 10 week email series that will teach you how to start investing. Delivered twice a week, straight to your inbox.

Chapter 6 : Between Realism and Constructive Empiricism - Science & Mathematics - Objectivist Living

26 Healey () p. "The non-localized gauge potential properties view is motivated by the idea that the structure of gauge potential properties is given by the gauge-invariant content of.

See the MathJax documentation for a list. There is no proof that we must only work with "gauge theories". Other approaches are just unexplored. Youre absolutely right though. I mostly meant reformulation or a "strong coupling" approach that do not consider the gauge fields perturbatively, with those unavoidable complications like soft diagram summation and renormalization. But this is already off topic. You are therefore free to choose a zero to your liking. Is this an example of gauge invariance in the same sense as the graduate examples above? More on that below. If I had to write a one sentence answer to your title, it would be this: The physics of a configuration is independent of the choice of equivalence class member. In its barest terms, gauge invariance is simply an assertion that there is redundancy in a mathematical description of a physical system. Otherwise put, the system has a symmetry, an invariance with respect to a group of transformations. A global gauge symmetry is one where the configuration space is a simple Cartesian product i. The gauge group, i. Subtraction of a constant potential from an electrostatic potential is such a symmetry, and a huge advance for Corvid Civilization, as it lets crows sit on high tension powerlines and happily shoot the breeze together, discussing their latest thoughts on gauge theories, and declaring that "Nevermore! However, usually when physicists speak of a gauge theory, they mean one where the symmetry group can act in a more general way, with a different group member acting at each point on the configuration space. The corresponding fiber bundle is no longer trivial. Incidentally, as an aside, I always like to visualize EM potential in Fourier space, which we can do with reasonable restrictions e. There are two things I believe you should take from the EM example: Even though practically it leads to quite a bit of further complexity, conceptually, it is only a small jump from your simple global gauge symmetric example; we simply allow the symmetries to act locally instead of acting on all configuration space points equally; Taking a lead from the experimentally real electromagnetism, we postulate that this gauge invariance might be relevant more generally, and so we look its presence in other physical phenomena. This is nothing more than a deed motivated by a hunch. Experimentally, we find that this is a fruitful thing to do. In physics, there is no deeper insight than experimental results. The cat can flip whilst conserving angular momentum using cyclic deformations of its own shape owing to the curvature of the connexion that arises from the notion of parallel transport that is implied by angular momentum conservation.

Chapter 7 : What, in simplest terms, is gauge invariance? - Physics Stack Exchange

account treats gauge potentials much like the vector potential in classical electromagnetism prior to the discovery of the Aharanov-Bohm eï¬€ect â€” that is, as a useful calculational device that does not represent new physical properties.

Our result provides a step towards a realistic model building of the brane-world scenario using topological solitons. Introduction The gauge hierarchy problem is a good guiding principle to construct theories beyond the standard model SM. The brane-world scenario [1â€”5] is one of the most attractive proposals to solve this problem, besides models with supersymmetry SUSY [6â€”8]. In order to realize such a scenario dynamically, we may use a topological soliton. For instance, let us consider a domain wall solution as the simplest soliton. After integrating over massive modes, one obtains a low-energy effective field theory describing the effective interactions of massless modes. Massless matter fields have been successfully localized on domain walls [9], but localization of the gauge field on domain walls in field theories has been difficult [10]. It has been noted that the broken gauge symmetry in the bulk outside the soliton inevitably makes the localized gauge field massive with a mass of the order of the inverse width of the wall [11 , 12]. To localize a massless gauge field, one needs to have the confining phase rather than the Higgs phase in the bulk outside the soliton. Earlier attempts used a tensor multiplet in order to implement the Higgs phase in the dual picture, but this approach successfully localized only the U 1 gauge field [13]. More recently, a classical realization of the confinement [14â€”17] through position-dependent gauge coupling has been successfully applied to localize the non-Abelian gauge field on domain walls [18]. The nontrivial profile of this position-dependent gauge coupling was naturally introduced on the domain wall background through a scalar-field-dependent gauge coupling function resulting from a cubic prepotential of supersymmetric gauge theories. The appropriate profile of the position-dependent gauge coupling was obtained from domain wall solutions using two copies of the simplest model or from a model with fewer fields and a particular mass assignment. However, it was still a challenge to introduce matter fields in nontrivial representations of the gauge group of the localized gauge field. The parameters of soliton solutions are called moduli and can be promoted to fields on the world volume of the soliton. Massless fields in the low-energy effective field theory on the soliton background are generally given by these moduli fields. Moduli with non-Abelian global symmetry are often called the non-Abelian cloud, and have been explicitly realized in the case of domain walls using Higgs scalar fields with degenerate masses in U N c gauge theories [19]. If we turn this global symmetry into a local gauge symmetry, we should be able to obtain the usual minimal gauge coupling between these moduli fields and the gauge field. Since we wish to localize the gauge field on the domain wall, it is essential to choose the global symmetry of moduli fields to be unbroken in the vacua of both the left and right bulk outside the wall. This choice will guarantee that the bulk outside the domain wall is not in the Higgs phase. Therefore we are led to an idea where we introduce gauge fields corresponding to a flavor symmetry group of scalar fields that will be unbroken in the vacuum. If we introduce the additional scalar-field-dependent gauge coupling function, similarly to the supersymmetric model, we should be able to localize both massless matter fields and the massless gauge field at the same time on the domain wall. We also derive the low-energy effective field theory of these localized matter and gauge fields. In order to obtain the field-dependent gauge coupling function for the gauge field localization mechanism [18], we also introduce a coupling between a scalar field and gauge field strengths inspired by supersymmetric gauge theories, although we do not make the model fully supersymmetric at present. This scalar-field-dependent gauge coupling function gives an appropriate profile for position-dependent gauge coupling through the background domain wall solution. With this localization mechanism for the gauge field, we find massless non-Abelian gauge fields localized on the domain wall. We also obtain the low-energy effective field theory describing the massless matter fields in the nontrivial representation of non-Abelian gauge symmetry. Since our flavor symmetry resembles the chiral symmetry of QCD before introducing gauge fields that are localized, we naturally obtain a kind of chiral Lagrangian as the effective field theory on the domain wall. We find an explicit form of full nonlinear interactions of moduli fields up to the second order of derivatives. In analyzing the model, we mostly use the strong coupling limit for the domain wall sector. The strong coupling is merely to describe our result explicitly at every stage. Even if we do not use the strong coupling, the physical features are unchanged. It is easy to expect that part of the gauge symmetry is broken when the walls separate in each copy of the domain wall sector. This geometrical Higgs mechanism is quite similar to D-brane systems in superstring theory. So our domain wall system provides a genuine prototype of field theoretical D3-branes. This is an interesting problem, which we plan to analyze more in future. We also find indications that additional moduli will appear in the supersymmetric version of our model, which will also be an interesting future problem to study. The organization of the paper is as follows. By introducing the scalar-field-dependent gauge coupling function, we arrive at the localized massless gauge field interacting with the massless matter field in a nontrivial representation of the flavor gauge group. The low-energy effective field theory is also worked out. New additional features of the supersymmetric models are also described. Appendix B describes the derivation of the effective Lagrangian that includes full nonlinear interactions between moduli fields. Appendix C contains the derivation of the positivity condition for the potential appearing in Sect. Abelianâ€”Higgs model of gauge field localization 2. Both of these features are motivated by supersymmetry. Indeed, we can embed this bosonic Lagrangian into a supersymmetric model with eight supercharges by adding appropriate fermions and bosons, which will not play a role in obtaining domain wall solutions. We have taken this special relation between the coupling constants only to simplify the concrete computations below. One may repeat the following procedure in models with more generic coupling constants without changing the essential results. The first term of the potential is the wine-bottle type and the Higgs fields develop nonzero vacuum expectation values. There are two discrete vacua for each copy i: Let y be the coordinate of the direction orthogonal to the domain wall and we assume that all the fields depend only on y. Then, as usual, the Hamiltonian can be written as follows: The corresponding solution is shown in Fig. The generic solutions of the domain wall are generated by the generic moduli matrices after fixing the V -transformation: In this way, the strong gauge coupling limit has a great advantage compared to the finite gauge coupling case. One can exactly solve the BPS equation and see the moduli parameter in the analytic solutions. Furthermore, there are no important differences between domain wall solutions in the finite coupling Abelianâ€”Higgs model and the strong coupling nonlinear sigma model. Both solutions have the same domain wall tension and the same number of moduli parameters. As can be seen from the figure, there are no significant differences. Let us next derive the low-energy effective theory on the domain wall. We integrate all the massive modes while keeping the massless modes. This can be done explicitly as follows. This is the free-field Lagrangian.

Chapter 8 : Conceptual Foundations of Yang-Mills Theories | Alexandre Guay - racedaydvl.com

Newton's world with absolute time and space or the non- localized gauge potential properties view considered by Healey are perfectly intelligible empirical racedaydvl.com (ii) The second focuses on issues about reference and argues that if we have a theory in which we purport to refer to distinct elements that are not distinguishable by.

The yet unknown nontrivial physics is believed to be located somewhere between these two regimes. Relativistic quantum field theory[edit] In the relativistic quantum field theory the physical vacuum is also assumed to be some sort of non-trivial medium to which one can associate certain energy. This is because the concept of absolutely empty space or "mathematical vacuum" contradicts the postulates of quantum mechanics. According to QFT, even in absence of real particles the background is always filled by pairs of creating and annihilating virtual particles. However, a direct attempt to describe such medium leads to the so-called ultraviolet divergences. In some QFT models, such as quantum electrodynamics, these problems can be "solved" using the renormalization technique, namely, replacing the diverging physical values by their experimentally measured values. In other theories, such as the quantum general relativity , this trick does not work , and reliable perturbation theory cannot be constructed. According to SVT, this is because in the high-energy "ultraviolet" regime the Lorentz symmetry starts failing so dependent theories cannot be regarded valid for all scales of energies and momenta. Correspondingly, while the Lorentz-symmetric quantum field models are obviously a good approximation below the vacuum-energy threshold, in its close vicinity the relativistic description becomes more and more "effective" and less and less natural since one will need to adjust the expressions for the covariant field-theoretical actions by hand. Curved space-time[edit] According to general relativity , gravitational interaction is described in terms of space-time curvature using the mathematical formalism of Riemannian geometry. This was supported by numerous experiments and observations in the regime of low energies. However, the attempts to quantize general relativity led to various severe problems , therefore, the microscopic structure of gravity is still ill-defined. There may be a fundamental reason for thisâ€”the degrees of freedom of general relativity are based on may be only approximate and effective. The question of whether general relativity is an effective theory has been raised for a long time. Outside this requirement the curved-space description of gravity in terms of the Riemannian geometry becomes incomplete or ill-defined. Cosmological constant[edit] The notion of the cosmological constant makes sense in a relativistic theory only, therefore, within the SVT framework this constant can refer at most to the energy of small fluctuations of the vacuum above a background value, but not to the energy of the vacuum itself. Gravitational waves and gravitons[edit] According to general relativity , the conventional gravitational wave is: Superfluid vacuum theory brings into question the possibility that a relativistic object possessing both of these properties exists in nature. As a result, it may be not just a coincidence that in general relativity the gravitational field alone has no well-defined stressâ€”energy tensor , only the pseudotensor one. Though, SVT does not a priori forbid an existence of the non-localized wave -like excitations of the superfluid background which might be responsible for the astrophysical phenomena which are currently being attributed to gravitational waves, such as the Hulseâ€”Taylor binary. However, such excitations cannot be correctly described within the framework of a fully relativistic theory. Mass generation and Higgs boson[edit] The Higgs boson is the spin-0 particle that has been introduced in electroweak theory to give mass to the weak bosons. The origin of mass of the Higgs boson itself is not explained by electroweak theory. Instead, this mass is introduced as a free parameter by means of the Higgs potential , which thus makes it yet another free parameter of the Standard Model. Another known issue of the Glashowâ€”Weinbergâ€—Salam model is the wrong sign of mass term in the unbroken Higgs sector for energies above the symmetry-breaking scale. Thus, the Higgs boson, even if it exists, would be a by-product of the fundamental mass generation phenomenon rather than its cause. It was shown that the relativistic gravitational interaction arises as the small-amplitude collective excitation mode whereas relativistic elementary particles can be described by the particle-like modes in the limit of low energies and momenta. This allows to fully recover the relativity postulates in the "phononic" linearized limit. They are based on the fact that at high energies and momenta the behavior of the particle-like modes eventually becomes distinct from the relativistic one - they can reach the speed of light limit at finite energy. It was shown that masses of elementary particles can arise as a result of interaction with the superfluid vacuum, similarly to the gap generation mechanism in superconductors. One can also derive an effective potential for the Higgs sector which is different from the one used in the Glashowâ€”Weinbergâ€”Salam model , yet it yields the mass generation and it is free of the imaginary-mass problem [nb 2] appearing in the conventional Higgs potential.

Chapter 9 : Gauge fixing - Wikipedia

Oxford University Press , pp. It is not a book about the interpretation of quantum mechanics or quantum field theory, nor is it about space and time or causality. Rather it focuses on the conceptual foundations of specific theories of interaction, namely gauge theories of the Yang-Mills YM type including elec- trodynamics. The book aims at a delicate balance of readability while being exhaustive. Most subjects already present in the philosophical litera- ture are discussed, even if it is sometimes briefly. Healey takes remarkable steps to make his book accessible to a large community of researchers. For example there are no less than six pedagogical appendixes. Not surprisingly, in this context many questions would require a much more detailed discussion to satisfy the specialist. But GR is obviously not his main target. Most of the time comments are made in order to contrast GR with Yang-Mills theories. In this review I discuss only YM theories. Preprint submitted to Elsevier 1 August But as Healey says himself: The relative rarity of books about fundamental interaction theories gives us more than enough reason to forgive some too short discussions. The introductory chapter presents, among other things, the principal fibre bundle formalism. It is obviously an especially ap- propriate tool in this context. After this first chapter follow three chapters focusing mostly on classical YM theories. The first of these is about the Aharonov-Bohm AB effect, a quantum phenomenon predicted by a model of quantized charged particles subjected to the influence of a classical electromagnetic gauge potential. The importance of the AB effect should not be underestimated. In the philosophi- cal literature it is clearly one of the main empirical reasons to reconsider the usual field ontology of classical electromagnetism. Moreover, even if it is a quantum ef- fect, it has a significant impact on the interpretation of classical YM theories. The model of a quantized charged particle for example represented by a wave func- tion subjected to a classical gauge potential can be modelled by a U 1 principal fibre bundle. This geometrical construction is also the natural setting to represent the classical U 1 YM theory the classical theory associated with quantum elec- trodynamics. Therefore an interpretation of the AB effect can possibly be trans- posed to the U 1 YM theory and vice versa. Moreover a convincing interpretation of the U 1 YM theory can serve as a foundation for interpreting classical non- Abelian YM theories. About the AB effect, Healey proposes three interpretations, each transposable as an ontological interpretation of all classical YM interaction: But also it seems that in non-Abelian theories there may be physically distinct situations in a region even though the gauge field is the same throughout the region in each situation. New properties seem needed to distinguish these situations. Since there is no empirical application of a non- Abelian classical YM theory, this argument relies on a certain interpretation of the mathematical formalism that could be contested. In the recent literature numerous philosophers defend one version or another of the second position, for example Leeds, and Maudlin, If this geometrical formalism represents adequately classi- 2 cal YM theories and we have no reason to believe the contrary , it excludes the possibility of localized gauge properties. For a recent enlightening analysis of the ontological implications of the principal fibre bundle formalism, see Catren, So it seems we are left with the third position. Thus, the holonomy interpre- tation of classical YM theory asserts that the theory represents intrinsic holonomy properties of regions of space-time, each of which consists of all points on a loop. If this interpretation is correct, the main metaphysical consequence is the unavoidable non-separability of physical processes in classical physics. Healey answers many objections to the holonomy interpretation but some questions remain: Other representations can be formulated. For example, if the asymptotic boundaries are empty Minkowskian we can use, as variables, gauge invari- ant line integrals coming from infinity. For other boundary conditions other choices are possible. Does this freedom in representation have an impact on the ontological conclusions? As Healey explains, for holonomies to capture intrinsic properties of a principal bundle, one or more reference points in a particular fibre have to be chosen. The apparent space-time realism implied by the introduction of loops and ref- erence points in the interaction ontology could be problematic if we aim, like many physicists, for a background free theory. The fact that the paradigmatic example of a locally defined entity, the matter field, cannot be considered re- alistically since it is not gauge invariant inclines us to look with suspicion on an interpretation relying on a realist position about space-time points. Should we not look for a way to identify gauge orbits that involve, in a transparent way, matter degrees of freedom? This is a significant assertion. Healey discusses an impressive number of subjects that often are presented for the first or almost for the first time in the philosophical literature. Not surprisingly many sections feel too compact. Let us briefly expose the main content of each chapter. The fifth chapter is an introduction to the quantization of YM theories, mainly YM free field theories. This chapter is a good introduction but does not allow the reader 3 to grasp all the complexity and the subtleties involved in the quantization of a gauge theory. For example, the fact that the BRST symmetry is not discussed when ghost fields are introduced is a weakness. Also, only two pages are devoted to theories with interacting terms with matter fields. In fact this is one of the advantages of using the principal fibre bundle formalism in which matter fields are easily represented. Chapter six is a defence of the formal character of gauge symmetry. Familiar ap- proaches to this question are extensively discussed, like the possible observation of gauge transformations and the empirical implication of the gauge argument. More interestingly, much less discussed approaches are exposed and criticized: In each case Healey argues in a compact way against the position that gauge symmetry is empirical. The seventh chapter is an introduction to what a gauge reduced quantum YM theory would look like. The version the author is presenting is based on a loop representa- tion of the YM fields. Healey forthrightly does not hide the problems encountered by this representation, especially when interaction with a matter field is included. Nevertheless, the potential significance of such representation is not to be under- estimated. Philosophers, as Healey is rightly pleading, should take a particular in- terest in this area of research since these representations are presumably based on physicalâ€”in other words, gauge invariantâ€”variables. YM quantum theories are models of the more general quantum field theory QFT. Could this problem be clarified if we focus on YM theories? The author explores briefly this question in the eight and final chapter of the book, pushing his loop inter- pretation in the framework of Bohm, Copenhagen and modal interpretations. This chapter is not the strongest but it makes an interesting general point. Philosophers of physics have the tendency to focus on the more general theories. Healey suggests that specific theories, like YM theories, can give us a new perspective on interpre- tative questions about quantum physics. This chapter could induce new research to clarify this possibility. The remainder of the book consists in a concluding chapter, asserting the importance of acknowledging the possibility of non-localized proper- ties, and of six useful appendixes. The next section discusses in more details the interpretation of the AB effect. The third section approaches the problem of the language in which conceptual foundations questioning is taking place. Schematically, 1 since there is an observable effect a phase shift in the interference pattern on quantized charged particles, something, let us call it X, must have acted on them. Action at a distance is excluded. This is why the AB effect is a pure quantum effect. In consequence the electromagnetic field becomes a derived entity. First a remark about this common argument. A reader might worry about 2 be- cause the localization of quantum particles is not a well defined concept. For example, in the Feynman functional quantization method, the AB effect can be predicted without including in the sum over histories any path crossing a region where the electromagnetic field is not zero. Therefore no direct electromagnetic field interaction is involved in the production of the AB effect. There are many ways to modify, with an electromagnetic field, an interference pat- tern obtained by a two-slit scattering of charged particles. For example, A we can introduce a enclosed magnetic flux between the slits. In this case we obtain a fringe shift with respect to the unperturbed pattern, while the pattern envelope remains the same. This is a case of the magnetic AB effect. Or B we could add a uni- form magnetic or electric field behind the slits and then obtain a displacement of the pattern without an envelope or relative phase change. Also C we could install an electromagnetic source, like a light, behind the slits. If the source is sufficiently intense, it can destroy the interference pattern. In this case the envelope and the pat- tern become identified. We could imagine other examples, but these will suffice for my purpose. The point is that only in cases B and C is a net change, caused by the addition of an electromagnetic field, of average momentum and energy recorded. In B, a net transfer of transversal momentum explains the displacement of the pattern. In C, the destruction of the interference pattern implies a strong enough electromagnetic interaction in order for the charged 5 particles to behave classically. Thus the AB effect is a pure quantum beyond clas- sical effect because it is a measurable effect that does not require the transfer of a physical quantity that we usually associate with classical interaction. Before returning to the AB effect let us discuss briefly the ontological status of the electromagnetic field in classical physics. The best reason we have to include a field in our ontology is clearly provided by Einstein discussing the special theory of relativity: We now shall inquire into the insights of definite nature which physics owes to the special theory of relativity. I There is no such thing as simultaneity of distant events; consequently there is also no such thing as immediate action at a distance in the sense of Newtonian mechanics. Although the introduction of actions at a distance, which propagate with the speed of light, remains thinkable, according to this theory, it appears unnatural; for in such a theory there could be no such thing as a reasonable statement of the principle of conservation of energy. It therefore appears unavoidable that physical reality must be described in terms of continuous functions in space. Retarded action as a mode of electromagnetic interaction violates conser- vation of energy and momentum Lange, , chapter 5.