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A Modest Redirection of Quantum Field Theory Solves All Current Problems

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Short Communication

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ABSTRACT

Standard quantization using, for example, path integration of field theory models, includes paths of momentum and field reach infinity in the Hamiltonian density, while the Hamiltonian itself remains finite. That fact causes considerable difficulties. In this paper, we represent $\pi(x)$ by $k(x)/\phi(x)$. To insure proper values for $\pi(x)$ it is necessary to restrict $0 < |\phi(x)| < \infty$ as well as $0 \leq |k(x)| < \infty$. Indeed, that leads to Hamiltonian densities in which $\phi(x)^p$, where p can be even integers between 4 and ∞. This leads to a completely satisfactory quantization of field theories using situations that involve scaled behavior leading to an unexpected, $\hbar^2/\hat{\phi}(x)^2$ which arises only in the quantum aspects. Indeed, it is fair to claim that this symbol change leads to valid field theory quantizations.

Keywords: Quantum field; Redirection; Quantizations; Hamiltonian

INTRODUCTION

Infinity is a difficult aspect of any issue in classical and quantum physics. Interestingly, this also infects zero as part of values that run between plus and minus infinity. It is evident that infinity as a symbol leads to $\infty+\infty=\infty$ as well as $\infty \bullet \infty=\infty$. It is evident here that zero follows the same procedure. Namely, 0+0=0 as well as 0 • 0=0. It is noteworthy that zero was banned from using for 1500 years long, ago, but if a symbol, for example A, stands for an object which is specific, namely a brick or a tree or a screwdriver but these are un-equivalent to each other having no screwdriver as a zero is just as saying that book equals zero and therefore book equal screwdriver equal zero. A field of nature, such as a particle of creation, is as unique as anything else and therefore its zero value deserves better treatment. In fact, if zero represents nothing then it could be that $\phi(x)=0$ also serves as nothing and $\phi(x)=\pi(x)=0$ leads to the fact that different kind of fields that appear are poorly labeled. A field $\phi(x)$ can represent a particle of nature, but $\pi(x)$ we choose to use for the time derivative of $\phi(x)$. $\pi(x)=0$ with no wrong interpretation, but $\phi(x)$ should not equal zero at all. Our current field theories would use $-\infty < \phi(x) <+\infty$. In this case field theory has gone its happy way certainly classically but it really upsets things during quantization. One manner to be useful in eliminating $\phi(x)=0$ all together is to introduce a friendly new classical function. In particular, we introduce $k(x)=\phi(x)\pi(x)$. $\phi(x)$ we said can be zero and k(x) then equals zero as well. But $\phi(x)=0$ when $\pi(x)=300$ does not fit the physics of $k(x)=0$. It is natural that we withhold any $\phi(x)$ equaling zero, they are abandoned from our business and therefore we have correct $\phi(x)$ and $\pi(x)=k(x)/\phi(x)$ and have arranged to have $\phi(x)$ withdrawn from our arithmetic if it is zero. Now why can that be useful.

Consider the field functions in a Hamiltonian density which are π(x) and ϕ(x) such as $\pi(x)^2$ and $\phi(x)^2+g\,|\phi(x)|^p$ is a toy example for our analysis. It is a fact that when π and ϕ reach infinity in such a fashion that the integral Hamiltonian can still remain finite. In other words a finite Hamiltonian function can include density $\phi(x)$ and $\pi(x)$ which reach infinity. Why would we want that? Because the quantization, most clearly in a path integration, has paths which actually reach infinity in such a slim way and therefore include fields that contribute to the Hamiltonian itself. Nature should not reach infinity! How can we take our fields into the density and retain them from ever reaching infinity. If that can happen, a very much should be more correct in its behavior than normally used.

We change variables in such a fashion that was having $k(x)=\phi(x)\pi(x)$ and now use our toy Hamiltonian density our functions become $k(x)^2/\phi(x)^2+\phi(x)^2+g\,|\phi(x)|^p$. It is clear that $\phi(x)=0$ is helpful here and helpful at infinity because if infinity of ϕ is allowed then k(x) could not properly serve π(x). Moreover, we can have $|k(x)|<\infty$, but equal zero is fine, and since $|\phi(x)|$ is also less than infinity, it follows that $|\phi(x)|^p$ never reaches infinity as desired. Summarizing this paragraph it says that π and ϕ can completely substitute instead k/ϕ. There is complete confidence that although the standard variables for classical theory don't want to reach infinity and do not, that means they are fully equivalent to our choice of the second version of the Hamiltonian density. Now however, we have a set of classical variables that are guaranteed to not reach infinity in the entire Hamiltonian density. Clearly it would seem that those variables deserve to become quantum variables. Our challenge now is to accept these two new variables $\hat{k}(x)$ and $\hat{\phi}(x)$, along with $\hat{\pi}^\dagger(x) \neq \hat{\pi}(x)$ we accept that and introduce $\hat{k}(x)=[\hat{\pi}^\dagger(x)\hat{\phi}(x) + \hat{\phi}(x)\hat{\pi}(x)]/2=\hat{k}^\dagger(x)$.

DESCRIPTION

Wrestling with infinities and quantization

Nonrenormalizability in canonical field quantization: In standard canonical quantization, we find the equation $[\hat{\phi}(x), \hat{\pi}(y)] = i\hbar\,\delta(x-y)$. Implicitly, that applies that $[\hat{\phi}(x), \hat{\pi}(x)]=i\hbar\,\infty$ which evidently leads to absolute value of $|[\hat{\pi}(x), \hat{\phi}(x)]|=\hbar\,\infty=\infty$! In addition, while $\hat{\pi}(x)^2 + \hat{\phi}(x)^2$ is chosen as a simple toy mode for Hamiltonian density. This has a domain of vectors that can be normalized. However, the domain of those vectors will shrink if the expression has $|\hat{\phi}(x)|^{2+\epsilon}$ where $\epsilon > 0$. However if ϵ reduces to zero the domain does not recover itself therefore that can introduce complications. Another way to state that kind of problem is to choose $\hat{\pi}(x)^2 + \hat{\phi}(x)^2 + g\,|\hat{\phi}(x)|^p$. Once the g is positive, it determines the new domain, but if g goes to zero, the initial domain which is bigger than the case where g is positive does not return. Issues like that complicate conventional canonical field quantization. Initially, we now start a procedure that simplifies matters greatly.

Eliminating infinities through a change of variables and a scaling: We have already found in classical formulation of the Hamiltonian density that fields could reach infinity conventionally, however in using the variables $\pi(x)=k(x)/\phi(x)$, can eliminate classical infinities in path integration. This is because our density contains $k(x)^2/\phi(x)^2=\pi(x)^2$. Therefore $\phi(x)$ should not be zero or infinity in magnitude to complicate π itself while k(x) cannot reach infinity again to not complicate π. In this section we treat the kinetic factor $\pi(x)=k(x)/\phi(x)$ as a term needed in the quantum Hamiltonian. We choose $\pi(x)= k(x)/\phi(x)$ which has been discussed in several articles as a suitable quantum feature of the kinetic term in several papers already. It is possible to change the term $\hat{k}\,\hat{\phi}^{-2}\,\hat{k}$ into $\hat{\pi}^2 + a\hbar^2\infty/\hat{\phi}^2$ which now introduces infinities again. It is greatly noteful that the kinetic term has now increased itself in giving a "potential type term". That implies that the original kinetic term $\hat{\pi}^2$ has introduced as well a field potential albeit infinity. To obtain the equation there could be simply to take the following result somewhat reduced by introducing $\hat{\pi}^2 + a\hbar^2 W^2/\hat{\phi}^2$, where W will be sent to infinity fairly soon. Now we do some rescaling in which we take $W\hat{\pi}^2$ & $W\hat{\phi}^2$. This modification leads to $W\hat{\pi}^2 + a\hbar^2 W^2/W\hat{\phi}^2$. It is clear now that all terms are proportional to W and therefore the final story will be taking the quantity $W\hat{\pi}^2 + a\hbar^2 W/\hat{\phi}^2$. We will multiply the previous equation by W^{-1} to remove W from both terms. This leads to finally $\hat{\pi}^2 + a\hbar^2/\hat{\phi}^2$ which permits us to say the result can be any factor A for the potential namely, $\hat{\pi}^2 + A/\hat{\phi}^2$, in which $A=a\hbar^2$ and we require that $0<A<\infty$. This potential, $A/\hat{\phi}^2$, is a kind of potential because it is not possible to reduce A back to zero in doing this quantization relation. It is only when quantum theory sends $\hbar \rightarrow 0$ to recover classical theory and then in that case A would disappear.

Affine field quantization: So far in our story we begin to close up by establishing the essence of what we have said. If a classical mood for a classical Hamiltonian listed as $H_1=\int\{[\pi(x)^2+(\nabla\phi)(x)^2+m^2\phi(x)^2]/2+g\ \phi(x)^p\}\ d^sx$ which represents relativistic classical Hamiltonian has difficulties especially when dealing with $\phi 4$ which has seen multiple records using Monte Carlo studies that do not lead to acceptable answers. Indeed in the model $H_2=\int\{[\pi(x)^2+m^2\phi(x)^2]/2+g\ \phi(x)^p\}\ d^sx$, which represents our ultralocal model, it will certainly fail, and has in fact done so, and done more poorly than the model H_1. However that has been using canonical quantization. A new quantization procedure, called affine quantization, has been able to rigorously solve H_2 and H_1 automatically then. Indeed a respectable number of Monte Carlo studies have shown that using affine quantization can lead to very acceptable results for H_2 and H_1. A complete story for both cases is well documented in reference [1].

Standard field theory quantization has some problems such as $\emptyset_4^4$ as well certainly as $\emptyset_4^{24}$, stay as failures. Remarkably, if the simple factor, $a\hbar^2/\hat{\phi}(x)^2$, where $0<a<\infty$, as this article exhibits, yields valid results for quantum field theory. You might like to try it. Readers, who are interested in the details, can be made avail- able in that strong article. That article contains quantizations of field theory along with gravity and offers a very complete version of their being solved. For those readers, we hope you find whatever you will need to know.

Monte Carlo examination leads to correct results of our analysis

Monte Carlo calculations are rough examples of path integration. Several Monte Carlo examinations by R. Fantoni have supported the results that using canonical quantization fails while affine quantization, the variation of quantization in this small paper, has proved successful. This deserves to be well known [2,3].

CONCLUSION

In this paper, we have shown that a simple switch of classical variables to represent $\pi(x)=k(x)/\phi(x)$. These variables all live below infinity in magnitude as well as field values must be greater in magnitude than zero. This procedure has been called upon to eliminate $\phi(x)=0$ points of nature because zero can also complicate equations involved. As we have seen, removing $\phi(x)$ values when they are zero can remarkably help in the complete and correct quantization of common field theories. The HERO of this paper is the ZERO.

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DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts to disclose.

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