Teaching and Advising Philosophy

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I firmly believe that every student harbours immense potential and embarks on a distinct creative journey. My teaching philosophy centers on nurturing this potential with utmost care, never encroaching on their creative space through indoctrination.

In my approach to teaching physics, I prefer to avoid axiomatization. Instead, I prioritize three interconnected aspects: observation, conceptual framework and detailed calculations. These facets work in harmony, with observation informing the conceptual framework, which, in turn, guides the detailed calculations. They are intertwined in a manner that tries to foster an intuitive yet robust comprehension of the subject.

To deepen understanding, I carefully curate problem-solving exercises that complement our lectures. These exercises are designed not only to reinforce concepts but also to ignite curiosity and inspire a sense of wonder.

My true passion lies in elucidating how a conceptual framework transforms into a detailed mathematical one where one tries to associate meanings to the technical details. This not only nourishes my own passion for physics, but also creates a fertile ground for the students to ask insightful questions. Importantly, I also emphasize the significance of recognizing the limits of a conceptual framework. This cultivates open-mindedness and also fuels an appetite for further exploration and discovery.

Physics, with its wide-ranging applications, captivates the mind at various depths of study. Regardless of their chosen path, I advise students to dedicate themselves to mastering this intricate subject. It sharpens their thought processes and prepares them for any endeavor. In my role as an advisor, I tailor my guidance to meet each student's unique needs and aspirations. Recognizing that every student's journey is distinct, I offer personalized advice to help them navigate their chosen path effectively.

As an illustrative example of my teaching philosophy, in the open access course **QFT in Path Integral Approach I**, I begin with the following question: *Given non-relativistic quantum mechanics, how could we generalize it to the relativistic context?* Assuming knowledge of the prerequisites, this is a good starting point because of the question's observational and conceptual relevance[1]. A series of arguments then follows which demonstrates that the natural answer is given by what is called the world-line path integral. This discussion advocates the path integral framework to be the fitting one for the purpose, explains why that is so and then goes on to develop the framework in detail. Through the process, the lectures address and clarify issues like function space, classical limit, subtleties and limitations involved in computing functional integrals, gauge redundancies and so on. The discussions are supported by explicit calculations, wherever needed.

Subsequently, a case is made for the following proposition: *The world-line theory and the spacetime QFT are equivalent.* To establish this one shows that subject to certain mathematical conditions, the world-line theory (with interactions) can be efficiently described by a set of topological graphs[2] which is equivalent to the set of Feynman diagrams that emerge in the conventional treatment of QFT. Furthermore, the following conclusion naturally emerges from this analysis: *The theory is essentially a tool for computing a set of multi-point Green's functions that are directly related to scattering amplitudes.* Hence the final goal is to understand how these observables can be predicted in terms of the parameters of the theory. The rest of the course then elaborates on how this is achieved through the program of renormalization. The latter is demonstrated with detailed calculations and take-home exercises.

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[1] This is also a standard question, as we know, though it is answered in my lectures following an unconventional approach which is logically smoother and conceptually more intriguing. This offers an alternative path to arrive at QFT that is usually not discussed.

[2] The arguments of how to introduce interactions in the world-line theory and how such graphs emerge in this context were discussed in detail in a few Q&A sessions (content yet to be published online).

There are three elaborate sets of take-home assignments which include many exercises that complement the lectures. For example, one exercise asks to solve a non-linear equation using Green's function method and show that the terms in the perturbative solution can be given diagrammatic interpretation. These are exactly the tree-level diagrams that arise in the corresponding QFT, which is why such diagrams are designated as classical contributions and loop diagrams as quantum contributions. This distinction is made in the lectures in a different way, by counting factors of $\hbar$. The exercise offers another angle to it by relating the tree level diagrams to constructing classical solution.