Editor's statement

Guest-Editor Matti Pitkänen′s Statement on Steven K. Kauffmann's Work

Matti Pitkänen

For 26 years superstrings have been seen as the only game in the town. Besides the well-known problems of M-theory there are also some other clouds in the horizon. For instance, the recently discovered Lamb shift anomaly of muonic hydrogen can be seen as a challenge of either QED or QCD and even of the entire QFT approach underlying M-theory. Second anomaly relates to neutrino mixing indicating that the masses of neutrino and antineutrino are not quite the same. This questions the validity of the assumptions behind CPT theorem, which is one of the basic implications of Lorentz invariant quantum field theory. For this reasons a return to the roots might be unavoidable. In fact, string models actually mean this kind of return to the roots in the sense that particle description in terms of string like objects becomes explicit part of the theory whereas in quantum field theories the particle picture appears only at the level of Feynman diagrams.

With inspiration coming from these anomalies Steven Kauffmann discusses in this issue his own proposal about what the return to the roots could mean. His starting point is quantum classical correspondence, which as such is of course a very delicate and debatable notion. What is clear that quantum classical correspondence leads to non-sensical results when applied to Dirac spinors and Maxwell fields interpreted as generalizations of Schrödinger amplitudes so that position operator and momentum can be made operators. Also probability interpretation fails. This led to the birth of quantum field theories as quantization of fields rather than quantization of the dynamics at single particle level. Quantum field theories are however plagued by both UV and IR infinities (even the celebrated $\mathcal{N} = 4$ SYM has IR divergences) and the recent experimental indications for anomalies challenging the basis of quantum field theories suggest that some of the cherished assumptions might be wrong.

In this kind of situation one has full right to consider alternatives and Steven Kauffmann's proposal is to give up Dirac and d'Alembert type equations altogether and return to single particle level. This means that one identifies single particle Hamiltonian as a generalization of the relativistic formula for the energy of charged particle and allows only positive energies so that only the positive square root is allowed. In this approach CP and CPT are not automatic symmetries: C or CP, together with "crossing" of "charge equivalence" symmetry, must be explicitly imposed– the resulting field theory is explicitly non-local in its configuration regime due to the influence of the square root even at the second-quantized level. This could make it easier to understand CP and CPT breaking. The approach has to meet burdensome technical challenges due to the appearance of the square root, and the usual puzzles of massless gauge theories, which are only partially dynamical and quantizable, remain to be fully assimilated into its particular context. Also the construction of counterparts of Feynman diagrams in this framework is a considerable challenge. These problems are discussed in the articles of this issue.

I hope that the work of Steven Kauffmann can serve as inspiration for other thinkers.

With Warm Regards,

Matti Pitkänen

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