Applying the variational principle to $(1 + 1)$-dimensional relativistic quantum field theories

Jutho Haegeman[1], J. Ignacio Cirac[2], Tobias J. Osborne[3], Henri Verschelde[1] and Frank Verstraete[4]

[1]Ghent University, Department of Physics and Astronomy, B-9000 Ghent, Belgium

[2]Max-Planck-Institut für Quantenoptik, Garching D-85748, Germany

[3]Wissenschaftskolleg zu Berlin, Berlin D-14193, Germany

[4]University of Vienna, Faculty of Physics, A-1090 Wien, Austria

In 1987, Feynman devoted one of his last lectures to highlighting some serious objections against the usefulness of the variational principle in the theory of relativistic quantum fields [1]. Since then, little progress has been made on the non-perturbative application of the variational principle to relativistic quantum fields.

In this presentation, we will explain how continuous matrix product states, the class of variational ansatz states for $(1 + 1)$-dimensional quantum field theories that was recently introduced by F. Verstraete and J. I. Cirac [2], can also be applied to relativistic quantum field theories for fermions. The manifestation of Feynman's objection against such an approach, as well as the solution to overcome them, will be treated in full detail. The power of this approach will be illustrated using two applications, namely the study of dynamical symmetry breaking in the Gross-Neveu model and the study of the Casimir energy for free fermions [3]. We will conclude by briefly touching the current research goals, in particular the question of how to treat bosonic systems and the possibility of obtaining the spectrum of low-energy excitations.

References

[1] R. P. Feynman in Proceedings of the International Workshop on Variational Calculations in Quantum Field Theory (L. Polley and D. E. L. Pottinger, eds.), World Scientific Publishing, Singapore, pp. 28–40 (1987).

[2] F. Verstraete, J. I. Cirac, *Phys. Rev. Lett.* **104**, 190405 (2010); T. J. Osborne, J. Eisert and F. Verstraete, arXiv:1005.1268.

[3] J. Haegeman, J. I. Cirac, T. J. Osborne, H. Verschelde and F. Verstraete, arXiv:1006.2409.