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Some problems in the foundations of QFT

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This talk will consist of two parts, addressing recent investigations into some foundational problems in quantum field theory.

I. Impact of relativity on particle localizability and ground state entanglement (arXiv:1902.10684):

Can a relativistic quantum field theory be consistently described as a theory of localizable particles? There are many known issues with such a description, indicating an answer in the negative. Here we trace how these obstructions (partially) subside in passing to an approximation of ordinary quantum mechanics in the non-relativistic regime. Perhaps unexpectedly, we find that there are persisting issues in the localizability of particle states. The other main undertaking of this work is to quantify the fate of ground state entanglement and the Unruh effect in the non-relativistic regime. It happens that this is closely related to the former issues through the Reeh-Schlieder theorem.

II. Measurements on quantum fields:

Although quantum field theory inherits much of the basic structure laid out by the postulates of ordinary quantum mechanics, it is known that the measurement theory cannot go through unscathed. There are examples of idealised measurements in quantum field theory which produce superluminal signalling. These examples indicate that endowing quantum theory with a relativistic spacetime structure restricts the set of admissible quantum operations. There is, as of yet, no characterisation of these operations. To this end, here we proceed to clarify the causality issues which arise in measurements of quantum fields, as well as characterise a class of permissible measurements.