

Seminar

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Perturbative construction of a string-localized Dirac field in a Hilbert space representation of QED - A programme and some results.

The construction of charged physical states in QED [Morchio and Strocchi 1983/2003; Steinmann 1984] has been a difficult task due to the infrared problems related to Gauss' law, which imply that the charge cannot be localized in finite regions and that the electron is an infra-particle, i.e., it does not correspond to a discrete eigenvalue of the mass operator.

I propose a new strategy for a straightforward perturbative construction of the interacting Dirac field acting in a Hilbert space, which describes the electron as an infra-particle. It is not point- but "string-localized", i.e., localized on half-rays extending to space-like infinity.

The construction works in a new framework which relates the free (Gupta-Bleuler) vector potential acting in a Krein space with its string-localized version acting in the physical (positive semidefinite) subspace. I construct the string-localized scalar field χ which implements the gauge transformation between the two potentials, and consider the free string-localized "dressed Dirac field" $\exp(iex)\psi$, where ψ is the free Dirac field and e is the electron charge. The adiabatic limit of its interacting version in the Epstein-Glaser perturbative scheme is my candidate for the Dirac field.

My conjecture that it exists and satisfies the mentioned properties has the following basis. Firstly, it has been verified at lower orders that this field leaves the physical subspace invariant before the adiabatic limit. Therefore the weak adiabatic limit (whose existence was shown by Blanchard and Seneor) satisfies positivity by a recent result of Duch. Secondly, the field χ has the same infrared structure as the free scalar field in 2 dimensions, whose exponentiation leads to an infraparticle representation [Schroer 1963]. I expect that the same holds true for our χ in the adiabatic limit. This would mean that our free "dressed Dirac field" already describes the free (but dressed) electron as an infra-particle. Then there is no obstruction from general reasons to the conjecture that the Hilbert space of the free dressed Dirac field is the GNS space of the adiabatic limit.

Friday, 13.07.2018, 14:15 Uhr

Ort: D5-153