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Title: Perturbative construction of a string-localized Dirac field in a Hilbert space representation of QED

Abstract:

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. The latter implies that the electron is an infra-particle, i.e., it does not correspond to a discrete eigenvalue of the mass operator, and that the physical Dirac field cannot be pointlike localized. (Physical means acting in a Hilbert space, and locality is understood in the sense of commutators). One aspect of the IR problem is that the (LSZ) relation of the S-matrix to the Dirac field has not been understood.

I report on an alternative strategy for a perturbative construction of the interacting physical
Dirac field. It satisfies Gauss' law and is not point- but "string-localized", i.e., localized on half-rays extending to space-like infinity. We conjecture that its (GNS reconstruction) Hilbert space describes the electron as an infra-particle, and allows for infrared finite matrix elements of the S-matrix. The "photon clouds" accompanying the electron are not put in by hand (like in the work of Faddeev and Kulish), but come out of the construction.

Our only input is the usual interaction density with a string-localized vector potential. Then the Epstein-Glaser construction leads straightforwardly to an interacting Dirac field with the mentioned properties.

Open problems are a renormalizability proof and the identification of scattering states.