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Quantum field theories of relativistic Luttinger fermions

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We propose relativistic Luttinger fermions as a new ingredient for the construction of fundamental quantum field theories. We construct the corresponding Clifford algebra and the spin metric for relativistic invariance of the action using the spin-base invariant formalism. The corresponding minimal spinor has 32 complex components, matching with the degrees of freedom of a standard-model generation including a right-handed neutrino. The resulting fermion fields exhibit a canonical scaling different from Dirac fermions and thus support the construction of novel relativistic and perturbatively renormalizable, interacting quantum field theories. In particular, new asymptotically free self-interacting field theories can be constructed, representing first examples of high-energy complete quantum field theories based on pure matter degrees of freedom. We then investigate a class of quantum field theories with self-interacting relativistic Luttinger fermions using mean-field theory to explore their long-range behaviour with a classification of the set of possible mass terms that can be constructed.

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