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Synthesis of Majorana mass terms in low-energy quantum systems (Q)

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We discuss the problem of how Majorana mass terms can be generated in low-energy systems. We show that, while these terms imply the Majorana condition, the opposite is not always true when more than one flavour is involved. This is an important aspect for the low-energy realizations of the Majorana mass terms exploiting superfluid pairings, because in this case the Majorana condition is not implemented in the spinor space, but in an internal (flavour) space. Moreover, these mass terms generally involve opposite effective chiralities, similarly to a Dirac mass term. The net effect of these features is that the Majorana condition does not imply a Majorana mass term. Accordingly the obtained Majorana spinors, as well as the resulting symmetry breaking pattern and low-energy spectrum, are qualitatively different from the ones known in particle physics. This result has important phenomenological consequences, e.g. implies that these mass terms are unsuitable to induce an effective see-saw mechanism, proposed to give mass to neutrinos. Finally, we introduce and discuss schemes based on space-dependent pairings with nonzero total momentum to illustrate how genuine Majorana mass terms may emerge in low-energy quantum systems.

Summary

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