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Electroweak Phase Transitions with BSM Fermions

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Negative results of searches for BSM physics at the LHC are pushing the soft-SUSY-breaking scale of colored superpartners beyond the TeV scale. On the contrary, there exist only very weak constraints on the masses of additional light fermions gauged under the SM gauge group. Therefore, split-/high-scale-SUSY scenarios are an appealing alternative to weak-scale SUSY since they automatically fulfil both experimental constraints by assuming a large separation between the soft-breaking
squared-scalar and gaugino masses. However, heavy or even decoupled scalar masses are in general non-beneficial for the realisation of a strong first order electroweak phase transition (EWPT).

We study the impact of additional beyond-the-Standard Model (BSM) fermions, charged under the Standard Model (SM) SU(2)xU(1) gauge group, on the EWPT in a 2-Higgs-Doublet-Model (2HDM) of type II. We find that the strength of the EWPT can be enhanced by about 40% compared to the default 2HDM. Therefore, additional light fermions are a useful tool to weaken the tension between increasing mass constraints on BSM scalars and the requirement of additional light scalar degrees of freedom to accommodate a strong first order EWPT. The findings are of particular interest for a variety of (non-minimal) split supersymmetry scenarios.

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