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Higher dimensional operators in thermal EFTs impact gravitational wave predictions

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Thermal effective theories are an important tool for describing the thermodynamics of cosmological phase transitions. Using the Abelian Higgs model as a toy setup, we examine the impact of marginal, higher-dimensional operators that arise at higher orders in the high-temperature expansion used to construct such theories. We demonstrate consistent matching, using field redefinitions to construct a complete, minimal, and gauge-invariant basis for the leading sextic operators. Marginal operators are found to weaken the transition strength and induce large uncertainties for strong transitions, signalling slow convergence of the high-temperature expansion. For even stronger transitions that could lead to gravitational wave backgrounds strong enough to be detected by LISA, the validity of the high-temperature expansion becomes questionable, which limits the regime of applicability of thermal effective theories, including for non-perturbative lattice studies.

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