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The electroweak phase transition and Effective Field Theory

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About a picosecond after the Big Bang, when the universe had cooled down to a temperature of around 100 GeV, the electroweak symmetry was broken, as the Higgs field condensed into a state with a non-zero vacuum expectation value. This process is known as the Electroweak Phase Transition (EWPT). If the EWPT was a first-order phase transition, it was an abrupt and violent process with formation of bubbles of the new phase, whose dynamics could potentially explain the observed baryon-antibaryon asymmetry of the universe, and it could also yield a detectable gravitational wave background.

The Standard Model, however, predicts a smooth transition. This can be traced back to the large Higgs mass that makes a first-order transition impossible. Going beyond the Standard Model, a first-order transition could be possible, for example through new scalar fields with masses close to the electroweak scale that contribute to the Higgs potential. It is also possible that the new physics may be heavier, and to investigate this we have studied the EWPT in the Standard Model Effective Field Theory (SMEFT) with higher dimension operators. I will discuss various possibilities for obtaining a strong first-order EWPT in the SMEFT and in other theories, and the theoretical and experimental constraints. I will also briefly discuss the prospects for probing the allowed parameter space using di-Higgs production in colliders.

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