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Massless Preheating and Electroweak Vacuum Metastability

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Current measurements of Standard-Model parameters suggest that the electroweak vacuum is metastable. This metastability has important cosmological implications because large fluctuations in the Higgs field could trigger vacuum decay in the early universe. For the false vacuum to survive, interactions which stabilize the Higgs during inflation—e.g., inflaton-Higgs interactions or non-minimal couplings to gravity—are typically necessary. However, the post-inflationary preheating dynamics of these same interactions could also trigger vacuum decay, thereby recreating the problem we sought to avoid. This dynamics is often assumed catastrophic for models exhibiting scale invariance since these generically allow for unimpeded growth of fluctuations. In this talk, we examine the dynamics of such "massless preheating" scenarios and show that the competing threats to metastability can nonetheless be balanced to ensure viability. We find that fully accounting for both the backreaction from particle production and the effects of perturbative decays reveals a large number of disjoint "islands of (meta)stability" over the parameter space of couplings. Ultimately, the interplay among Higgs-stabilizing interactions plays a significant role, leading to a sequence of dynamical phases that effectively extend the metastable regions to large Higgs-curvature couplings.

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