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Baryogenesis and gravity waves from a UV-completed electroweak phase transition

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We study gravity wave production and baryogenesis at the electroweak phase transition in a real singlet scalar extension of the Standard Model, including vectorlike top partners, to generate the CP violation needed for electroweak baryogenesis (EWBG). The singlet makes the phase transition strongly first order through its coupling to the Higgs boson, and it spontaneously breaks CP invariance through a dimension-five contribution to the top quark mass term, generated by integrating out the heavy top quark partners. We improve on previous studies by incorporating updated transport equations, compatible with large bubble wall velocities. The wall speed and thickness are computed directly from the microphysical parameters rather than treating them as free parameters, allowing for a first-principles computation of the baryon asymmetry. The size of the CP-violating dimension-five operator needed for EWBG is constrained by collider, electroweak precision, and renormalization group running constraints. We identify regions of parameter space that can produce the observed baryon asymmetry or observable gravitational wave (GW) signals. Contrary to standard lore, we find that for strong deflagrations, the efficiencies of large baryon asymmetry production and strong GW signals can be positively correlated. However, we find the overall likelihood of observably large GW signals to be smaller than estimated in previous studies. In particular, only detonation-type transitions are predicted to produce observably large gravitational waves.

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