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Left-Right Symmetry Breaking and Gravitational Waves : A Tale of Two Phase Transitions

We study possible ways gravitational waves (GW) get sourced in a theory with minimal left-right symmetry breaking. First order phase transitions (FOPT) generically lead to gravitational waves sourced by bubble collisions, while second order phase transitions (SOPT) do not. Interesting variants on the standard classification of phase transitions occur due to the breaking of discrete parity combined with the limitation of light cone in the early Universe. If local effective potential signals SOPT or a cross over, breaking of discrete parity in conjunction with the finiteness of the causal horizon leads to a causal horizon limited second order phase transition, which results in domain walls (DWs) separating left-like and right-like domains. Thus the putative SOPT also gives rise to GW via decaying domain walls, testable at experiments such as IPTA, DECIGO, and LISA. On the other hand, for the case of FOPT, we get the usual signal from spontaneously created bubbles, but also a late forming domain wall structure separating the two types of vacua. Thus the traditional FOPT case gives rise to two distinct peaks in the spectrum of GW, verifiable for the low symmetry breaking scales 10^4–10^6 GeV, but beyond the reach of currently planned experiments for a high scale ~10^10 GeV. Finally, we point out that a version of the left-right symmetric model which separates parity breaking from gauge symmetry breaking is also subject to domain wall formation and amenable to GW observations.

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