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Early Universe phase transitions in a Scale Invariant Standard Model

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The mass hierarchy problem is concerned with the large differences in scale present in our universe, namely between the Higgs mass (125 GeV) and the Planck mass (10^{19} GeV). The Standard Model currently offers no explanation for this difference which prompts the investigation of other fundamental theories. It has been argued that scale invariance of physical laws may be a solution to hierarchy problem. In this theory, physical laws are invariant under mass, energy or length scalings and it is only through quantum mechanical effects that scales and the hierarchy of scales emerge. A general cosmological consequence of this theory is that electroweak symmetry breaking doesn't occur until later in the universe's evolution, at lower temperatures. Here, it is triggered by chiral symmetry breaking, when the unbound quarks of the universe cool and condense into bound hadron states. This change in conditions results in the electroweak symmetry breaking occurring via a first-order phase transition. In this talk, I present preliminary estimates for the peak frequency and amplitude of the gravitational waves that would be produced by such a transition, along with the peak mass and abundance of primordial black holes that would be produced.

Author: CESCA, Joshua

Presenter: CESCA, Joshua

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