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SMART $U(1)_X$ - Standard Model with Axion, Right handed neutrinos, Two Higgs doublets and $U(1)_X$ gauge symmetry

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To address five fundamental shortcomings of the Standard Model (SM) of particle physics and cosmology, we propose a SMART $U(1)_X$ model which is a $U(1)_X \times U(1)_{PQ}$ extension of the SM, where the $U(1)_X$ gauge symmetry is a generalization of the well-known $U(1)_{B-L}$ symmetry and $U(1)_{PQ}$ is the global Peccie-Quinn (PQ) symmetry. Three right handed neutrinos required to cancel $U(1)_X$ related anomalies play a crucial role in understanding the observed neutrino oscillations and explain the observed baryon asymmetry in the universe via leptogenesis. The PQ symmetry helps resolve the strong CP problem and also provides axion as a compelling dark matter candidate. The $U(1)_X$ gauge symmetry enables us to implement the inflection-point inflation scenario to realize Hubble parameter during inflation smaller than 2×10^7 GeV. This allows us to overcome a potential axion domain wall problem as well as the axion isocurvature problem. As an example, we show that SMART $U(1)_X$ model can be merged with $SU(5)$.

Summary

Primary authors: Dr RAUT, Digesh (University of Alabama); OKADA, Nobuchika (University of Alabama); Prof. SHAFI, Qaisar (University of Delaware)

Presenter: Dr RAUT, Digesh (University of Alabama)

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