Exploration of a TeV-Scale Higgs Troika Scenario for Baryon Asymmetry

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November 12, 2020

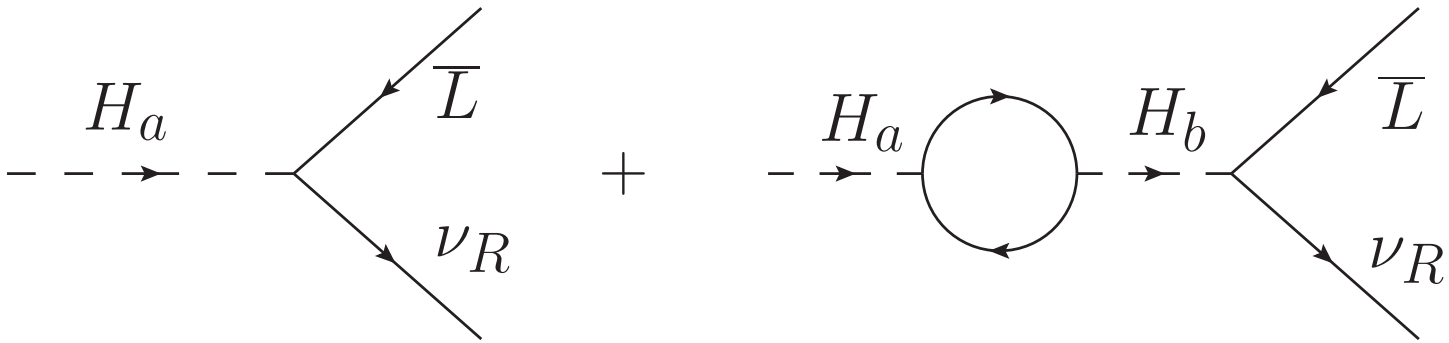
The Troika: Three Higgs Doublets

- Standard Model (SM) has three generations of fermions but only one Higgs doublet - why?
- We propose adding two more Higgs doublets
- More Higgs doublets means more Yukawa couplings
- Also add three right handed neutrinos, tackling neutrino masses
- General Troika framework covered in Phys. Rev. D 101, 055010 (arxiv:1909.02044)

Baryogenesis

- Sakharov conditions
  - Baryon number violation
  - C and CP violation
  - Interactions out of thermal equilibrium
- Standard Model has non-perturbative sphalerons that violate baryon number
- Yukawa couplings can give CP violation
- The decay of heavy Higgses in the early universe can give interactions out of equilibrium

The General Baryogenesis Mechanism



- Before EW symmetry breaking, a population of heavy Higgs doublets H_a is created by the decay of a heavy modulus
- We use an asymmetry of decays of H_3 into a lepton doublet and right-handed neutrino:

$$\varepsilon \equiv \frac{\Gamma(H_a \to \bar{L}\nu_R) - \Gamma(H_a^* \to \bar{\nu}_R L)}{2\Gamma(H_a)} \tag{1}$$

- Washout constraints for light mediators make using H_1 difficult
  - This is why we need two heavy doublets for our mechanism

Experimental Avenues

- Search for heavy scalars at colliders
  - Dipole moments
  - Flavor-changing neutral currents
- Previous work: new doublets, masses around $1 - 2$ TeV, couple primarily to leptons
  - Limited focus to pair production of heavy scalars
- Current work: new doublets, masses of a few TeV, coupling significantly to light quarks
  - Can get $\mathcal{O}(0.1)$ couplings to first or second generation quarks (Egana-Ugrinovic, Homiller, Meade, Phys. Rev. D 100, 115041)
  - Opens up single-production of scalars
- Also potential low energy precision physics prospects

Conclusions

- Three Higgs doublets can generate the baryon asymmetry of the universe
- No first order phase transition is necessary, unlike electroweak baryogenesis
- High energy search avenue of scalar production
- Also potential low energy precision physics prospects

Thank you!