Contribution ID: **24** Type: **not specified**

Flavour Effects in Resonant Leptogenesis from Semi-classical and Kadanoff-Baym Approaches

Friday, 5 December 2014 17:00 (25 minutes)

Flavour effects play an important role in the statistical evolution of particle number densities in several particle physics phenomena. We present a fully flavour-covariant formalism for transport phenomena, in order to consistently capure all flavour effects in the system. We explicitly study a Resonant Leptogenesis (RL) scenario, and show that flavour covariance requires one to consider generically off-diagonal number densities, rank-4 rate tensors in flavour space, and non-trivial generalization of the discrete symmetries C, P and T.

The flavour-covariant transport equations, obtained in our semi-classical framework, describe the effect of three relevant physical phenomena: coherent heavy-neutrino oscillations, quantum decoherence in the charged-lepton sector, and the standard resonant CP violation due to heavy-neutrino mixing. We show quantitatively that the final asymmetry is enhanced by up to an order of magnitude, for electroweak-scale heavy neutrinos, as compared to that obtained from flavour-diagonal or partially flavour off-diagonal equations.

A full field-theoretical treatment in the weakly-resonant regime, based on the so-called Kadanoff-Baym (KB) equations, confirms that heavy-neutrino oscillations and mixing are two *distinct* phenomena, and reproduces the results obtained in our semi-classical framework. Finally, we show that the quasi-particle ansaetze, often employed in KB approaches to RL, discard the phenomenon of mixing, capturing only oscillations and leading to an underestimate of the final asymmetry by a factor of order 2.

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Session Classification: Parallel 8: Early universe Physics (Inflation, Lepto(Baryo)genesis)