

M2 Internship offer – Year 2023-2024

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Research field: Theoretical Physics : Particle theory and Cosmology

Internship title: Neutrino masses and Leptogenesis in minimal aGUTs

Traditional Grand Unification (GUT) occurs when all gauge couplings become identical at a finite energy scale. In the aGUT framework, the gauge couplings tend to the same value asymptotically at high energies. Minimal models are based on a $SU(6)$ gauge symmetry in 5 dimensions. For this internship, we plan to study how neutrino masses can be generated in $SU(6)$ aGUTs and their implication for high scale leptogenesis, i.e. the spontaneous generation of a lepton asymmetry in the early Universe. This class of models do not require supersymmetry, guarantee the stability of the proton and contain extra compact dimensions. The ultraviolet fixed point appears as asymptotically free in the effective theory at 4 space-time dimensions, but is non-trivial in the full theory with de-compactified dimensions at high energy. We have in particular already built a minimal model based on the $SU(5)$ gauge group, with a very rich phenomenology which can be explored at future colliders. The typical mass of the first tier of resonances is in the few TeV range if the stable and neutral particle of the model is the dark matter candidate. The $SU(6)$ case is even more promising.

The aim of this internship is to study the neutrino sector and leptogenesis for this class of models. The candidate will have to familiarise with the basics of Unification and asymptotic unification, and study their implications. The internship will be followed by a thesis proposal.

References:

G.Cacciapaglia, *Systematic classification of aGUT models in five dimensions: The $SU(N)$ kinship*, Systematic classification of aGUT models in five dimensions: The $SU(N)$ kinship e-Print: 2309.10098 [hep-ph]

G.Cacciapaglia, A.Deandrea, R.Pasechnik, Zhi-Wei Wang, *Asymptotic Ultraviolet-safe Unification of Gauge and Yukawa Couplings: The exceptional case*, e-Print: 2302.11671 [hep-th]

G. Cacciapaglia, A.S. Cornell, C. Cot and A. Deandrea, *Minimal $SU(5)$ asymptotic grand unification*, Phys. Rev. **D104** (2021) no.7, 075012 [arXiv:2012.14732 [hep-th]].

A.Abdalgabar, M.O. Khojali, A.S. Cornell, G. Cacciapaglia and A. Deandrea, *Unification of gauge and Yukawa couplings*, Phys. Lett. **B776** (2018), 231-235 [arXiv:1706.02313 [hep-ph]].