Associated seminars: Abstracts

Indian Summer School of Physics 2017: Topics in Particle Cosmology

4 – 8 September 2017

Non-Standard Neutrinoless Double Beta Decay and its Implications

Author: *Lukáš Gráf*

The talk will focus on the effective approach to lepton number violation and the implications of potential future observation of lepton number violating (LNV) processes, primarily of neutrinoless double beta decay. The interplay between lepton number violation at high and low energies is of particular interest, as constraints on theories of baryogenesis can be obtained. For a model independent description the LNV effective operators on top of the SM Lagrangian are considered. Each such operator contributes to neutrinoless double beta decay in a number of ways and the understanding of the mutual relations among all the operators is crucial when determining the dominant contribution. Moreover, the nuclear side of the problem plays an important role, as a thorough calculation of corresponding nuclear matrix elements is needed for the estimation of the effective couplings and it can also help to pinpoint the dominant mechanism triggering neutrinoless double beta decay. Apart from the effective field approach, I will also outline the possible extension of our arguments to a general UV-completed model.

Dark Matter Scenarios in a Constrained E6 Inspired Model

Author: *Dylan Harries*

E_6 inspired SUSY models are a well-motivated class of models that can solve the μ problem in the MSSM and allow for the tree-level Higgs mass to be increased. In the simplest variants of these models, multiple exact and approximate discrete symmetries must be introduced for the model to be phenomenologically viable. Here we study a constrained version of a recently proposed E_6 inspired model, the CSE$_6$SSM, in which only a single, exact custodial symmetry is required. The breakdown of E_6 also leads to an automatically conserved matter parity, implying the existence of two dark matter candidates in this model. We demonstrate that, while one of these can be extremely light and contributes negligibly to the relic density, a predominantly Higgsino or mixed bino-Higgsino MSSM-like neutralino can account for the observed relic abundance of dark matter. However, recent limits from direct detection searches place severe constraints on the mixed bino-Higgsino scenarios that account for the full relic abundance. We show that a large part of the parameter space with a predominantly Higgsino dark matter candidate will be discoverable at XENON1T. In these scenarios, the exotic states can still be light enough to be observable at

the LHC, allowing for the discovery of the model in collider searches even in scenarios with an otherwise heavy supersymmetric particle spectrum.

Holographic Correlators and Cosmology

Author: *Savan Kharel*

I will talk about some work under progress regarding the computation of five-point functions of conserved current in (A)dS/CFT. In this talk, I will review the recursion relation developed to compute correlators of current and stress tensor which sidesteps complicated evaluation of Feynman-Witten diagrams. Using the recursion relation, we will show that the five-point function can be computed using similar recursive techniques. We will also show how some color-ordered identities are useful in checking the answer for the four-point and five-point functions. Finally, we will end with the comment about generalizing such recursion relation to compute higher point correlation functions of current and stress tensor. Finally, I will address how some of these calculations can be useful in computing correlation function in dS which could be useful to compute cosmological Correlators.

Linear Regime of Structure Formation with Scalar Field Dark Matter considering an Axion-like potential

Author: *Francisco Linares*

Axion dark matter models have been thoroughly studied in the recent literature, in particular under the prescription of a free scalar field, but a full treatment of the axion field is still required mainly because nonlinearities in a more realistic potential may play an important role in the cosmological dynamics. We solve the cosmological equations of an axion field for both the background and the linear perturbations with the aid of an amended version of the Boltzmann code CLASS, and contrast our results with those of cold dark matter and the free axion case. In particular, we quantify the differences between the axion and free cases and discuss how the two models could be distinguished by the properties of their mass power spectrum (MPS).

Inflation driven by scalar field and solid matter

Author: *Peter Mészáros*

I will talk about a model of inflation driven by a scalar field with standar kinetic term and three fields which enter the action in the same way as body coordinates of a solid matter enter the equation of state.

Dark Matter Candidates in Composite Higgs Models

Author: *Daniel Murnane*

Recent work has been completed on descriptions of fundamental interaction symmetry breaking giving rise to a Composite Higgs (SU(4)->Sp(4)), as well as those extending extra dimensional models (SO(6)->SO(5)). Both developments include a scalar singlet that can function as a dark matter candidate. I will present the two sets of models, recent developments, and how natural these candidates could be.

Testing gravity theories using tensor perturbations

Author: *Jan Novák*

We will study tensor-mode modified gravity parameters including current bounds on the parameters and future constraints. We will introduce tensor modes in the propagation equation for a mode with non-zero source term.

Gamma rays from MeV dark matter in light of CMB data

Author: *Javier Reynoso-Cordova*

Self annihilating dark matter (DM) in the MeV mass regime can produce radiation via prompt and secondary photons. Future detectors like e-ASTROGAM will focus on the detection in the MeV energy regime. In this work we consider a certain dark matter particle model which is capable of producing such signals and we studied the possibility of having a five sigma detection for some hypothetical detector built according to the e-ASTROGAM features. We performed an analysis to obtain the optimal energy window that maximize the detection for each individual channel, This was done considering two different targets: the Dwarf Spheroidal Galaxy Draco and the Galactic Center (GC). Then we obtained the values of the thermal averaged cross-section needed for a detection at five sigma as a function of the mass and compare them with the current CMB constraints coming from Planck. It was found that for those channels including monochromatic photons and neutral pions, the detection is possible in both targets considering the current constraints. For DM annihilating into leptons and charged pions, the detection is ruled out for Draco but it is possible in the Galactic Center.

Dynamical Generation of Fermion Mixing

Author: *Luca Smaldone*

A careful non perturbative study of flavor mixing reveals an interesting structure of the flavor vacuum. This is deeply related to the existence of unitarily inequivalent representations of field algebra in Quantum Field Theory. Far from being a mathematical curiosity, this study leads to phenomenological corrections to the neutrino oscillations formula. The particle-antiparticle condensate structure of the flavor vacuum suggests the idea of fermion mixing as an emergent dynamical phenomenon.

We present some general ideas, in models presenting chiral symmetry, showing how an anomalous vacuum condensation is required in order to dynamically generate mixing. This can be achieved by studying the algebra of charges and currents.

Then we show how these ideas apply in a simple, but instructive, toy model a la Nambu–Jona Lasinio, looking at the vacuum structure thanks to the formalism developed by Umezawa, Takahashi and Kamefuchi to study dynamical symmetry breaking and mass generation.