

## T 23: Theoretische Astroteilchenphysik und Kosmologie I

Convenor: Frank Steffen

Zeit: Mittwoch 14:00–16:30

Raum: HG XV

T 23.1 Mi 14:00 HG XV

**Light inflaton – connecting inflation and low energy experiments** — ●FEDOR BEZRUKOV — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

We study the phenomenology of a minimal extension of the Standard Model, where the inflation is provided by an additional light scalar field. It turns out, that the requirements of successful inflation and reheating after inflation bound the mass of the inflaton to the region 270 MeV – 1.8 GeV. This mass region allows for experimental search of the inflaton in laboratory experiments, with rare meson decay and dedicated beam-target experiments being the most promising ones.

T 23.2 Mi 14:15 HG XV

**Chaotic Inflation in Supergravity with Heisenberg Symmetry** — STEFAN ANTUSCH<sup>1</sup>, MAR BASTERO-GIL<sup>2</sup>, KUSHIK DUTTA<sup>1</sup>, STEVE F. KING<sup>3</sup>, and ●PHILIPP M. KOSTKA<sup>1</sup> — <sup>1</sup>Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), Föhringer Ring 6, 80805 München, Germany — <sup>2</sup>Departamento de Física Teórica y del Cosmos and Centro Andaluz de Física de Partículas Elementales, Universidad de Granada, 19071 Granada, Spain — <sup>3</sup>School of Physics and Astronomy, University of Southampton, Southampton, SO17 1BJ, United Kingdom

We propose the introduction of a Heisenberg symmetry of the Kähler potential to solve the problems with chaotic inflation in supergravity, as a viable alternative to the use of shift symmetry. The slope of the inflaton potential emerges from a small Heisenberg symmetry breaking term in the superpotential. The modulus field of the Heisenberg symmetry is stabilized and made heavy with the help of the large vacuum energy density during inflation. The observable predictions are indistinguishable from those of typical chaotic inflation models, however the form of the inflationary superpotential considered here may be interpreted in terms of sneutrino inflation.

T 23.3 Mi 14:30 HG XV

**Sneutrino Inflation in GUTs** — STEFAN ANTUSCH<sup>1</sup>, MAR BASTERO-GIL<sup>2</sup>, ●JOCHEN P. BAUMANN<sup>1</sup>, KUSHIK DUTTA<sup>1</sup>, STEVE F. KING<sup>3</sup>, and PHILIPP M. KOSTKA<sup>1</sup> — <sup>1</sup>Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Germany — <sup>2</sup>Departamento de Física Teórica y del Cosmos and Centro Andaluz de Física de Partículas Elementales, Universidad de Granada, Granada, Spain — <sup>3</sup>School of Physics and Astronomy, University of Southampton, Southampton, United Kingdom

We discuss sneutrino inflation in SUSY GUTs, in particular in Pati-Salam and SO(10). Since under these gauge groups the right-handed sneutrino is no longer a singlet, several problems arise. Not being a singlet, the scalar potential of the sneutrino in general receives large D-term contributions, which would violate the slow-roll conditions. Furthermore, with a charged inflaton problematic effects at the one- and two-loop level might arise, which again threaten the flatness of the potential. Additionally the problem of the production of stable topological defects has to be addressed. We present a simple model of sneutrino inflation in Pati-Salam and discuss the aforementioned problems in this framework. Furthermore, we discuss the prospects of embedding such a model into SO(10).

T 23.4 Mi 14:45 HG XV

**The Higgs Field as an Inflaton** — ●CHRISTIAN STEINWACHS — Institut für Theoretische Physik, Universität zu Köln, Zùlpicherstr. 77, 50937 Köln

It is shown that the Higgs boson can also serve as an inflaton in the early Universe if one assumes its strong non-minimal coupling to gravity and takes quantum corrections from Standard Model particles to the tree action into account. This builds a bridge between modern cosmology and particle physics without introducing any new particles. We predict the range for allowed values of the Higgs mass in this scenario which can be tested at LHC. Ref.: JCAP 12 (2009) 003; [arXiv:0904.1698]

T 23.5 Mi 15:00 HG XV

**Boltzmann equations including quantum coherence** — CHRISTIAN FIDLER<sup>1</sup>, ●MATTI HERRANEN<sup>1</sup>, KIMMO KAINULAINEN<sup>2,3</sup>, and

PYRY M. RAHKILA<sup>2,3</sup> — <sup>1</sup>Institut für Theoretische Physik E, RWTH Aachen University, D - 52056 Aachen, Germany — <sup>2</sup>Department of Physics, P.O. Box 35 (YFL), FIN-40014 University of Jyväskylä, Finland — <sup>3</sup>Helsinki Institute of Physics, P.O. Box 64, FIN-00014 University of Helsinki, Finland

Based on the Schwinger-Keldysh formalism, we develop a novel approximation scheme (cQPA) to study the nonequilibrium dynamics of fermionic quantum fields in the limit of weak interactions and slowly varying background. Compared to standard kinetic approach with Boltzmann equations, we are able to include the effects of quantum coherence in the presence of decohering collisions. The key element in our formalism is the finding of new singular shell solutions for 2-point Wightman functions in noninteracting theory, which are located in the phase space at  $k_0 = 0$  in single flavor case and at  $k_0 = (\pm\omega_i \pm \omega_j)/2$  in the mass basis of multiple flavor mixing fields. These new shell solutions are shown to encode the information on quantum coherence between particles and antiparticles of possibly different flavor states. Imposing this phase space structure as an ansatz to the interacting theory leads to a closed set of equations of motion (extended Boltzmann equations) for the corresponding on-shell distribution functions, with a well defined collision integral. This formalism has potentially a variety of applications in particle physics of the early universe, including baryogenesis, leptogenesis and neutrino flavor oscillations.

T 23.6 Mi 15:15 HG XV

**Resonant Dirac Leptogenesis on Throats** — ●ANDREAS BECHINGER and GERHART SEIDL — Universität Würzburg

We consider resonant Dirac leptogenesis on a multi-throat geometry. The baryon asymmetry in the universe is generated by resonant decays of heavy Kaluza-Klein scalars that are copies of the standard model Higgs. Discrete exchange symmetries between the throats are responsible for establishing two key features of the model. First, they ensure a near degeneracy of the scalar masses and thus a resonant decay of the scalars. Second, the discrete symmetries connect the observed baryon asymmetry with the Yukawa couplings of the low-energy theory. This enables to discuss possible phenomenological implications.

T 23.7 Mi 15:30 HG XV

**Axions in the Early Universe** — ●PETER GRAF and FRANK DANIEL STEFFEN — Max-Planck-Institut für Physik, München, Germany

The smallness of the CP violating term in the QCD Lagrangian is the well known strong CP problem. If it is solved via the Peccei-Quinn (PQ) mechanism, the pseudo-Nambu-Goldstone boson associated with the spontaneous breaking of the new chiral U(1)<sub>PQ</sub> symmetry is the axion. We study the behavior of axions in the early Universe and calculate the temperature at which the axion decouples from the early QCD plasma.

T 23.8 Mi 15:45 HG XV

**Thermal production of Majorana fermions in the early Universe** — ●DENIS BESAK, DIETRICH BÖDEKER, and ALEXEY ANISIMOV — Universität Bielefeld, Universitätsstraße 25, D-33615 Bielefeld

Majorana fermions, spin 1/2 fermions which are their own antiparticles, play a prominent role in the evolution of the Universe, both as an essential ingredient for thermal leptogenesis and as potential dark matter candidates. Since the early universe was in the state of a hot and dense plasma, it is mandatory to take finite temperature effects into account to compute the resulting baryon asymmetry from leptogenesis, or the abundance of thermally produced dark matter particles. Yet a consistent computation to leading order in the coupling is still an open issue.

As a first step to a consistent finite temperature treatment of thermal leptogenesis, we compute the thermal production rate of Majorana neutrinos whose decays create the lepton asymmetry, to leading order in the electroweak gauge and top Yukawa coupling. In particular we present a method to deal with the Landau-Pomeranchuk-Migdal (LPM) effect whose relevance in fermion production from (inverse) decays was overlooked so far. Our method is sufficiently general that it can also be applied to the production of other particles, such as e.g. axinos or gravitinos where the role of the LPM effect has never

been studied either. To obtain the leading order production rate of Majorana neutrinos, we study in addition 2-body scattering processes and show how to cure the arising IR divergencies with the so-called Braaten-Yuan prescription.

T 23.9 Mi 16:00 HG XV

**CMB polarisation at second order** — MARTIN BENEKE, CHRISTIAN FIDLER, and KLAUS KLINGMÜLLER — Institut für Theoretische Physik E, RWTH Aachen U., 52056 Aachen

Inflation generates primordial gravitational waves which leave a distinctive gradient-free imprint on the polarisation pattern of the cosmic microwave background (CMB). At first order in cosmological perturbation theory, they are the sole source for this imprint. However, experimental data indicate that their amplitude is small. Thus, second order effects from primordial scalar fluctuations, for example weak lensing,

contaminate the gravitational wave signal. To take all such effects into account, we derive the full polarised Boltzmann equation—the equation describing the evolution of fluctuations from primordial times to the present—at second order.

T 23.10 Mi 16:15 HG XV

**Novel sources for B-mode polarisation** — MARTIN BENEKE, CHRISTIAN FIDLER, and KLAUS KLINGMÜLLER — Institut für Theoretische Physik E, RWTH Aachen U., 52056 Aachen

In the newly derived second order Boltzmann equation we identify novel sources for the gradient free component of the CMB polarisation pattern, the B-mode polarisation. We evaluate their contribution numerically and compare the result to known second order effects such as corrections due to second order terms in the Einstein equation and weak lensing.