T 21: Astroteilchenphysik und Kosmologie (Theorie)

Convenor: Michael Kachelrieß

Zeit: Mittwoch 16:45–19:00 Raum: WIL-B122

T 21.1 Mi 16:45 WIL-B122

DM@NLO and the impact of SUSY-QCD-corrections to (co-)annihilation-processes on Neutralino Dark Matter — Julia Harz[1], Björn Herrmann[2], Michael Klasen[3], Karol Kovařík[4], Quentin Le Boulc'h[5], •Moritz Meinecke[3], and Patrick Steppeler[3] — [1]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [2]Laboratoire d'Annecy de Physique Théorique, Annecy-le-Vieux, France — [3]Institute of Theoretical Physics Münster, Germany — [4]Karlsruhe Institute of Technology — [5]Laboratoire de Physique Subatomique et de Cosmologie, Grenoble, France

A powerful method to constrain the parameter space of theories beyond the Standard Model is to compare the predicted dark matter relic density with cosmological precision measurements, in particular with WMAP- and the upcoming Planck-data. On the particle physics side, the main uncertainty on the relic density arises from the (co-)annihilation cross sections of the dark matter particle. After a motivation for including higher order corrections in the prediction of the relic density, the DM@NLO-project will be presented, a software package that allows for the computation of the neutralino (co-)annihilation cross sections including SUSY-QCD corrections at the one-loop level and the evaluation of their effect on the relic density using a link to the public codes MicrOMEGAs and DarkSUSY. Recent results of the impact of SUSY-QCD corrections on the neutralino (co-)annihilation cross section as well as further ongoing projects in the context of the DM@NLO-project will be discussed.

T 21.2 Mi 17:00 WIL-B122

Dark matter signals at the LHC: forecasts from ton-scale direct detection experiments — •Riccardo Catena — Institut fuer Theoretische Physik, Goettingen, Germany

The complementarity between dark matter searches at colliders and in underground laboratories is an extraordinarily powerful tool in the quest for dark matter. In the vast majority of the analyses conducted so far these dark matter detection strategies have been profitably combined either to perform global fits in the context of certain particle physics models (e.g. the CMSSM) or to estimate the prospects for a direct dark matter detection given the LHC potential of discovering new physics beyond the Standard Model. In this talk I propose an alternative strategy to combine direct and collider dark matter searches: employing the potential of the upcoming generation of 1-ton direct detection experiments, we show that for certain supersymmetric configurations it is possible to translate the information encoded in an hypothetically discovered direct detection signal into classes of expected signals at the LHC. As an illustrative application of our method, we show that for a 60 GeV neutralino thermally produced via resonant annihilations and identified by a 1-ton direct detection experiment, our approach allows to forecast a clearly identifiable prediction for a LHC final state involving three leptons and missing energy. The strategy presented in this talk to systematically translate a direct detection signal into a prediction for the LHC has the potential to significantly strengthen the complementarity between these two dark matter detection strategies.

T 21.3 Mi 17:15 WIL-B122

On the spin-dependent sensitivity of XENON100. — Mathias Garny[1], Alejandro Ibarra[2], Miguel Pato[2], and •Stefan Vogl[2] — [1]Desy — [2]TUM

The latest XENON100 data severely constrains dark matter elastic scattering off nuclei, leading to impressive upper limits on the spin-independent cross-section. We show that the constraints set by XENON100 on the spin-dependent neutron cross-section are by far the best at present, whereas the corresponding spin-dependent proton limits lag behind other direct detection results. The effect of nuclear uncertainties on the structure functions of xenon isotopes is analysed in detail and found to lessen the robustness of the constraints, especially for spin-dependent proton couplings. We apply our constraints to well-motivated dark matter models and demonstrate that in both mass-degenerate scenarios and the minimal supersymmetric standard model the spin-dependent neutron limits can actually override the spin-independent limits. This opens the possibility of probing additional unexplored regions of the dark matter parameter space.

T 21.4 Mi 17:30 WIL-B122

Multi-Component Dark Matter Systems and Their Observation Prospects — Mayumi Aoki[1,2], •Michael Duerr[2], Jisuke Kubo[1], and Hiroshi Takano[1] — [1]Institute for Theoretical Physics, Kanazawa University, Japan — [2]Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The dark matter (DM) sector does not have to consist of only one stable particle. In a multi-component DM sector, processes such as the conversion and semi-annihilation of DM particles are allowed in addition to the standard annihilation. We discuss these non-standard processes in a three-component DM system and find that the relic abundance of DM can be very sensitive to them, a fact that has been recently found for two-component DM systems. To consider a concrete model of a three-component DM system, we extend the radiative seesaw model of Ma by a Majorana fermion and a real scalar boson. The inert Higgs boson and the two new particles are assumed to be DM. The semi-annihilation process in this model produces monochromatic neutrinos, and we estimate the observation rate of these neutrinos from the Sun at IceCube. We find that observations of such high energy monochromatic neutrinos from the Sun may indicate a multi-component DM system.

T 21.5 Mi 17:45 WIL-B122

Ultra-high energy cosmic ray escape from gamma-ray bursts, and the cosmic ray-neutrino connection — •Philipp Baerwald[1], Mauricio Bustamante[1], Svenja Hümmer[1], Amyad Spector[2], Eli Waxman[2], and Walter Winter[1] — [1]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, 97074 Würzburg, Germany — [2]Physics Faculty, Weizman Institute of Science, POB 26, Rehovot, Israel

Recent IceCube searches for GRB neutrinos have strongly constrained current models predicting GRBs as the source of UHECR. We show that updated calculations based on the connection of gamma-rays and neutrinos give significantly lower neutrino bounds [Phys. Rev. Lett. 108 (2012) 231101]. However additional constraints from the theoretical connection of cosmic rays to neutrinos, based on the assumption that UHECR escape as neutrons, still persist. We therefore explore the possibility of having an additional direct cosmic ray escape component which circumvents these constraints. We show that it is possible to distinguish three distinct regimes with this approach, with the standard (one neutrino per cosmic ray) escape via neutrons only accounting for a small range in the parameter space. Moreover we show how this additional component could improve cosmic ray predictions.

T 21.6 Mi 18:00 WIL-B122

Analyzing the propagation of cosmic rays — •Robert Rettig — Universität Potsdam, Institut für Physik und Astronomie, Karl-Liebknecht-Strasse 24/25, 14476 Potsdam

The origin of cosmic rays is still unknown. In addition to studying potential sources, one can also investigate the propagation of these particles from their sources to Earth, which is a transition from a diffusive mode to ballistic trajectories at very high energies. For that purpose, we investigate the early-time charged particle transport using numerical three-dimensional Monte-Carlo test-particle simulations, in which the test-particles propagate in a time-independent spatially fluctuating magnetic field derived from a three-dimensional isotropic turbulence power spectrum. To avoid the superluminal transport appearing in a classical treatment of diffusion processes, the Jüttner distribution, originally derived to be the relativistic Maxwell distribution, has been proposed to describe the propagation of ultra high energy cosmic rays. With regard to the anisotropy measured at high energies, we can test whether a propagator based on the Jüttner distribution correctly describes the particle transport at the highest energies.

T 21.7 Mi 18:15 WIL-B122

Nonequilibrium QFT approach to leptogenesis — •Tibor Frossard[1], Mathias Garny[2], Andreas Hohenegger[3], David Mitrouskas[4], and Alexander Kartavtsev[1] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland — [4]Ludwig-

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The observed baryon asymmetry of the Universe can be elegantly explained in the leptogenesis scenario, where a net lepton asymmetry produced by the decay of heavy right-handed neutrinos is then transfered to the baryon number through the Standard Model sphalerons.

Being an intrinsicly quantum effect the generation of such an asymmetry in the hot early Universe can be described systematically only using nonequilibrium quantum field theory tools. Starting from first principles one derives a quantum Boltzmann-like equation for the lepton asymmetry which is free of the double counting problem and which incorporates consistently the medium corrections to the masses and decay widths.

Medium corrections are particularly large for the CP-violating parameters. The total decay widths are affected to a lesser extent. We also investigate the Higgs decay, which becomes kinematically allowed at high temperature due to thermal mass. We find that the CP-violating parameters for the Higgs decay are larger that the one for the Majorana decay by several orders of magnitude.

T 21.8 Mi 18:30 WIL-B122

Time Evolution of the Large-Scale Tail of Non-Helical Primordial Magnetic Fields — •Andrey Saveliev[1], Karsten Jedamzik[2], and Günter Sigl[1] — [1]II. Institut für Theoretische Physik, Universität Hamburg, Hamburg, Germany — [2]Laboratoire de Physique Theorique et Astroparticules, Université Montpellier II, Montpellier, France

After a general overview on Extragalactic Magnetic Fields (EGMFs) we present a derivation of the time evolution equations for the energy content of nonhelical magnetic fields and the accompanying turbulent flows from first principles of incompressible magnetohydrodynamics in the general framework of homogeneous and isotropic turbulence. This is then applied to the early Universe, i.e., the evolution of primordial magnetic fields which are a reasonable possible seed for EGMFs.

Numerically integrating the equations, we find that most of the energy is concentrated at an integral wavenumber scale k_I where the turbulence turn over time equals the Hubble time. At larger length scales L, i.e., smaller wavenumbers $q = \frac{2\pi}{L} \ll k_I$, independent of the assumed turbulent flow power spectrum, mode-mode coupling tends to develop a small q magnetic field tail with a Batchelor spectrum proportional to the fourth inverse power of L and therefore a scaling for the magnetic field of $B \sim L^{-5/2}$.

T 21.9 Mi 18:45 WIL-B122

The 130 GeV gamma-ray line and generic dark matter model building constraints from continuum gamma rays, radio and antiproton data — •Martin Vollmann, Masaki Asano, Torsten Bringmann, and Guenter Sigl — II. Institut fuer Theoretische Physik - Universitaet Hamburg

An analysis of the Fermi LAT data has recently revealed a resolved gamma-ray feature close to the galactic center which is consistent with monochromatic photons at an energy of about 130 GeV. If interpreted in terms of DM annihilating into gamma gamma (gamma Z, gamma h), this would correspond to a DM particle mass of roughly 130 GeV (145 GeV, 155 GeV). The rate for these loop-suppressed processes, however, is larger than typically expected for thermally produced DM. Correspondingly, one would generically expect even larger tree level production rates of standard model fermions or gauge bosons. Here, we quantify this expectation in a rather model-independent way by relating the tree level and loop amplitudes with the help of the optical theorem. As an application, we consider bounds from continuum gamma rays, radio and antiproton data on the tree level amplitudes and translate them into constraints on the loop amplitudes. We find that, independently of the DM production mechanism, any DM model aiming at explaining the line signal in terms of charged standard model particles running in the loop is in rather strong tension with at least one of these constraints, with the exception of loops dominated by top quarks. We stress that attempts to explain the 130 GeV feature with internal bremsstrahlung do not suffer from such difficulties.