Soft lepton number violation in multi-Higgs doublet models

Elke Aeikens

University of Vienna

Extensions of the Standard Model with right-handed neutrinos ν_R in the framework of a seesaw mechanism are popular to explain the smallness of the neutrino masses. In our model, we additionally allow an arbitrary number of Higgs doublets. Since such models have flavour-changing neutral-scalar interactions (FCNIs) at tree level, we impose conservation of the family lepton numbers L_α $(\alpha = e, \mu, \tau)$ in the Yukawa interactions whereas the Majorana terms violate the L_α. An interesting feature of this model is that FCNI processes are finite at one-loop level and amplitudes like $\mu \to e^- e^+ e^-$ containing Higgs-scalar exchanging subprocess, in contrast e.g. to $\mu \to e\gamma$, do not vanish when the ν_R-mass scale m_R becomes infinitely large. Therefore, they could be testable in future experiments. Furthermore, processes provide bounds on Yukawa couplings and the seesaw scale m_R.

NoMoS: Realization of an RxB drift momentum spectrometer

BOSINA, Joachim (SMI-Wien, ILL-Grenoble); ABELE, Hartmut (TU Wien -Atominstitut); FILLUNGER, Harald (SMI-Wien, TU Wien - Atominstitut); KLOPF, Michael (TU Wien - Atominstitut); PITSCHMANN, Mario (TU Wien - Atominstitut); SOLDNER, Torsten (ILL - Grenoble); SUZUKI, Ken (SMI-Wien); WANG, Xiangzun (TU Wien - Atominstitut); ZMESKAL, Johann (SMI-Wien); KONRAD, Gertrud (TU Wien - Atominstitut, SMI-Wien)

An R×B spectrometer is a novel momentum spectrometer in which charged particles are dispersed in a circularly curved magnetic field. The curved field results in a drift of the charged particles perpendicular to the radius of the curvature (R) and to the magnetic field (B), the so called RxB drift. This drift is proportional to the particle's momentum. A spatial-resolving detector determines the momentum spectra. The aim of the first R×B spectrometer, NoMoS (Neutron decay prOducts MOmentum Spectrometer), is to measure several correlation coefficients in the beta decay of free neutrons in order to test the Standard Model of particle physics and to search for physics beyond. The realization of this new, accurate method of spectroscopy requires the design of a complex magnet system to provide a curved, homogeneous magnetic field, of a spatial-resolving detector for electrons and protons of low energy, and of calibration techniques to characterize the detector and the spectrometer. Currently, the focus is on the design and the construction of the magnet system. The physics motivation, the measurement principle and the current status of the RxB spectrometer will be presented.

The quark propagator at non-zero temperature

Romain Contant

University of Graz

We investigate the chiral and deconfinement transitions of QCD and QCD-like theories using the standard and dual quark condensates. Within the framework of Dyson-Schwinger equations, the quark propagator is computed with a quark-gluon vertex model and a gluon propagator as extracted from lattice results for different gauges groups. The external input is replaced step by step by dynamically calculated quantities with the goal to obtain a self-consistent description of the crossover. This will also open up to the possibility to proceed to non-zero chemical potential within a self-consistent approach.

Parity-Violating Muonic Forces and Flavour

Fagner Correia

IFT Sao Paulo and Josef Stefan Institut Ljubljana

Proton size anomaly can be explained by an exotic parity violating gauge interactions of the right handed muons. We examine constraints on this interaction in the missing energy processes of Kaons, D and B mesons and discuss the impact on flavour physics observables.

CPT and T symmetry tests with entangled kaons

Eryk Czerwinski

Institute of Physics, Jagiellonian University in Kraków, Poland

Quantum entangled system of neutral kaon pair allows for precise test of discrete symmetries violation. Results already obtained in this field at KLOE experiment and preview of upcoming analysis will be presented. Additionally prospects of KLOE-2 will be shortly discussed.

Pinning down four top quarks at the LHC in run-II

Darius Faroughy

Josef Stefan Institute and University of Ljubljana

We propose a dedicated search strategy for detecting four top quarks at the LHC at 13 TeV energies. We focus exclusively on the same-sign dilepton decay channel. The strategy is primarily based on a high b-tagging working point and a dynamical isolation cone for leptons. Our analysis also includes reducible backgrounds with electron charge flip mis-identifications and fake leptons. We apply the strategy to 4-top production in the SM and in non-resonant new physics scenarios. We argue that the LHC should find strong evidence for SM (or possibly BSM) 4-top production in run-II at higher luminosities.

Development of a new type of free-space neutron interferometer

Hanno Filter

TU Vienna – Atominstitut

This contribution describes the design and construction of a new type of neutron interferometer with a very-cold neutron beam at the Institut Laue-Langevin. The main goal is the preparation of a free-space neutron interferometer similar to a double-slit configuration. This could then be used to probe physics beyond the standard model of particle physics i.e. dark matter and dark energy models in a new parameter region. The collimation and wavelength selection apparatus, the planed interferometer as well as simulations for the expected interference pattern will be discussed.

Direct Dark Matter Detection with XENON1T

Michelle Galloway

University of Zürich

Observations at cosmological and astronomical scales indicate that the majority of matter in our Universe is in the form of non-relativistic and long-lived dark matter. Its observed relic abundance is consistent with the existence of a neutral, massive particle with little or no self-interaction. A dark matter candidate favoured by extensions of the Standard Model is a Weakly Interacting Massive Particle (WIMP) whose interaction with normal matter can be

probed directly via elastic scattering off target nuclei, thus motivating searches through direct detection. XENON1T, a dual-phase time projection chamber using a 1-ton liquid xenon fiducial volume, was recently constructed in the Laboratori Nazionali del Gran Sasso. It aims to observe primarily low-energy nuclear recoils of WIMPS with unprecedented sensitivity. This presentation describes the XENON1T detector and gives an overview of the detection methods, an initial characterization of the detector, and the predicted sensitivity based on Monte Carlo simulations.

^{3}He spin hyperpolarization for nuclear physics experiments

Bartosz Głowacz

Institute of Physics, Jagiellonian University in Kraków, Poland

email: b.glowacz@uj.edu.pl

Experiments with polarized targets give an access to a large number of observables, hidden in the unpolarized case, when one averages over spin states. The polarization observables, *e.g.* the analyzing powers, are sensitive to spin-dependent part of the interaction, that makes them interesting for testing theoretical calculations based on various approaches to model the interaction in few nucleon systems. In case of neutrons polarized Helium-3 (^{3}He) has been found as an effective spin filter [1] and has been used in particle accelerators to study properties of the neutron. Current progress in the theoretical calculations for four-nucleon (4*N*) systems is also a main motivation to investigate *p*−3He scattering [2].
Nowadays two methods are being used to polarize gaseous ^{3}He spin targets, namely spin-exchange optical pumping (SEOP) and metastability-exchange optical pumping (MEOP). I will focus mainly on a development of MEOP method that has been made at Jagiellonian University however comparison with the SEOP will be also made to some extent. Starting with a low field standard MEOP polarization setup [3] I will introduce the method and emphasize its main advantages and drawbacks in terms of possible gas use in particle physics application. Going further to the non-standard-MEOP conditions I will present our latest achievement – high field polarizer for ^{3}He that allows for efficient production of polarized ^{3}He gaseous samples [4].

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Quarkonium production at the LHC: A polarized perspective

Ilse Krätschmer

HEPHY - Vienna

Despite over 40 years of research in quarkonium physics, quarkonium production is still not satisfactorily understood. In the Non-Relativistic QCD factorization approach, the production of a quarkonium proceeds in two steps: the production of a quark-antiquark pair followed by the formation of the bound state from the initial pair. To determine the non-perturbative parameters of the bound-state formation global fits to quarkonium production data are performed. They usually exclude polarization observables which are only used a posteriori as verification of the obtained predictions, with perplexing results. As polarization data provide strong fundamental indications about production mechanisms, the polarization data is moved to the centre of this study of quarkonium production. Results from a global fit to charmonium data from the LHC, using NLO short-distance calculations describing the production of the initial quark-antiquark pair, are presented.

Search for CPT symmetry violation in neutral flavour meson oscillations

Wojciech Krzemien

National Centre for Nuclear Research, Swierk, Poland

CPT is the simultaneous combination of three transformations: charge conjugate C, parity P and time reversal T. The discrete CPT symmetry is believed to be strictly conserved in the nature. This statement is strengthened by the general theorem formed in 50s by Pauli, Luders, Schwinger and Jost. The theorem states that any local, Lorentz-invariant quantum field theory must be also CPT-invariant. The precise experimental tests of indirect CPT symmetry violation can be performed by exploiting the neutral-meson oscillation phenomena, one of the fascinating effects predicted by Quantum Mechanics, in which the meson - bound state of quark and antiquark - oscillates back and forth between particle and antiparticle states. The overview of the last experimental results will be given.

Porous insertion for the J-PET detector aiming at studies of discrete symmetries in decays of positronium atom

E. Kubicz[1], A. Wieczorek[1,2], D. Alfs[1], T. Bednarski[1], P. Białas[1], E. Czerwiński[1], A. Gajos[1], B. Głowacz[1], M. Gorgol[3], B. Jasińska[3], D. Kamińska[1], G. Korcyl[1], P. Kowalski[5], T. Kozik[1], W. Krzemień[5], M. Mohammed[1] , M. Pawlik-Niedźwiecka[1], S. Niedźwiecki[1], M. Pałka[1], L. Raczyński[4], Z. Rudy[1], O. Rundel[1], N.G. Sharma[1],M. Silarski[1], A. Strzelecki[1], W. Wiślicki[4], M. Zieliński[1], B. Zgardzińska[3], P. Moskal[1]

[1]*Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, S. Łojasiewicza 11, 30-348 Kraków, Poland*

[2]*Institute of Metallurgy and Materials Science of Polish Academy of Sciences, W. Reymonta 25, 30-059 Kraków, Poland*

[3] *Department of Nuclear Methods, Institute of Physics, Maria Curie-Sklodowska University, Pl. M. Curie-Sklodowskiej 1, 20-031 Lublin, Poland*

[4]*Świerk Computing Centre, National Centre for Nuclear Research, A. Soltana 7, 05-400 Otwock-Świerk, Poland*

[5]*High Energy Physics Division, National Centre for Nuclear Research, A. Soltana 7, 05-400 Otwock-Świerk, Poland*

Recently the cost-effective method of the whole-body positron emission tomography scanner was developed by the Jagiellonian Positron Emission Tomography (J-PET) Collaboration [1-5]. Apart from the main application, it could be used as a multi-purpose detector for e.g. studies of the positronium atoms decays and test of C, CP, T and CPT symmetries in that decays [6]. Positronium consisting of an electron and positron, is the lightest purely leptonic object decaying into photons. As an atom bound by a central potential, it is a parity eigenstate, and as an atom built out of an electron and an anti-electron, it is an eigenstate of the charge conjugation operator. Therefore, the positronium is a unique laboratory to study discrete symmetries whose precision is limited, in principle, by the effects due to the weak interactions expected at the level of ($\sim10^{-14}$) and photon–photon interactions expected at the level of ($\sim10^{-9}$) [7].

The aim of the study and is to develop silica cylinder insertion for the vacuum chamber having large lifetime and enabling to observe large fractions of 3γ decays. In the J-PET experiments, positronium will be created by irradiation of porous materials with positrons emitted from radioactive isotopes for e.g. ^{22}Na or ^{68}Ge. To make the experiment as efficient as possible and to lower its systematic uncertainties, it is crucial to use materials with high positronium production probability and long survival time of positronium inside the pores. A number of porous materials with different structure were studied in order to check for which one the fraction of 3γ is the largest. One of the best materials for such study are silica aerogels in which empty voids (pores) account to more than 90 % of the entire volume [8]. Cylinder made from the material with similar structure to aerogel is currently under development.

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Impact of LHC dark matter searches on new physics scenarios

Suchita Kulkarni

HEPHY Vienna

Dark matter searches at the LHC are exploring new models and new regime with every new result. I take a specific example of monojet dark matter searches at the LHC and sketch their impact on two dark matter scenarios. The two models under considerations are, dark matter motivated explanations of the 750 GeV diphoton excess and dark matter interactions with the Standard Model involving derivative couplings.

One-Loop Corrections to the Fermion Masses and Flavour Symmetries

Maximilian Löschner

University of Vienna

Extensions of the Standard Model which explain non-vanishing neutrino masses and some of the peculiar features of the lepton mixing matrix by flavour symmetries always lead to a proliferation of scalars in the model. Then, the relation between Yukawa couplings and fermions in general involves several vacuum expectation values. It is therefore expedient to devise a renormalization procedure which is adapted to this situation. We will present first results of an ongoing PhD project addressing this subject. The idea is to calculate one-loop corrections to fermion masses in a toy model featuring an arbitrary number of Majorana or Dirac fermions and scalar fields, testing the stability of tree level predictions for masses and mixing angles and investigating the possibly large corrections at the one-loop level. Instead of using the mass parameters for renormalization, we will use a scheme that imposes renormalization conditions on the Yukawa couplings and vacuum expectation values.
The analytic results in this framework will later be applied to explicit neutrino mass models known from the literature which often introduce specific flavor symmetries in the form of discrete symmetry groups. Then, the focus will lie on producing numerical results for the mass and mixing angle corrections in promising candidate theories, delivering data that can be compared to experiments.

Measurement of |Vub| CKM matrix element with charmless semileptonic B-meson decays

Matic Lubej

Josef Stefan Institute and University of Ljubljana

We are interested in precision measurements of the |Vub| CKM matrix element, because one finds a discrepancy in the value between |Vub| determined with the inclusive and exclusive method (a.k.a. the |Vub| puzzle). It turns out that the discrepancy is at a level of about 3 sigma. We are working on performing this measurement with the exclusive method. At B factories you can also reconstruct the accompanying B meson and use it as an additional source of information by reconstructing the hadronic modes (hadronic tagged), semileptonic modes (semileptonic tagged) or not focusing on any particular mode (untagged). In our measurement we will make use of the untagged method of reconstruction of the accompanying B meson, since it has been applied very rarely so far.

Search for Neutrino-less Double Beta Decay with the Gerda Experiment

Rizalina Mingazheva

University of Zürich

The GERDA experiment has been designed to search for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{76}Ge, which takes place via process $^{76}\text{Ge}\to^{76}\text{Se}+2e^-$. This process violates the lepton number conservation and it is possible if only neutrinos have a Majorana mass component. Two emitted electrons share all energy released in the $0\nu\beta\beta$ decay, therefore the signature of the reaction is a peak in the tail of the energy spectrum of Q-value, $Q_{\beta\beta}$. For ^{76}Ge $Q_{\beta\beta}$= 2039 keV.

The GERDA experiment is located in the undeground Laboratori Nazionali del Gran Sasso (LNGS) of INFN, Italy. Its physics program is divided in two phases. Phase I has been completed in June 2013, and yielded the world's best limits on the half-life of the decay. After substantial improvements of the experiment setup the Phase II program has started in Decemeber 2015. The aim is to reach a sensitivity of $T_{1/2} = O(10^{26})$y with a background index (BI) of 10^{-3} cts/keV·kg·yr after an exposure of 100 kg·yr.

We plan to present the current status of the GERDA experiment and its future plans.

Search for anomalous production of prompt same-sign lepton pairs and pair-produced doubly charged Higgs bosons with √s=13 TeV pp collisions using the ATLAS detector

Miha Muškinja

Josef Stefan Institute and University of Ljubljana

The search uses proton-proton collisions at a centre-of-mass energy of 13 TeV with the ATLAS detector at the LHC. Pairs of isolated leptons with the same electric charge and large transverse momenta of the type $e^{\pm}e^{\pm}$, $e^{\pm}\mu^{\pm}$, and $\mu^{\pm}\mu^{\pm}$ are selected and their invariant mass distribution is examined. The results will be used to set upper limits on the cross-sections for processes beyond the Standard Model and to set the limits for a specific model of the Doubly Charged Higgs boson in the Left-Right Symmetric model.

Search for stop pair-production in the single-lepton channel in SUSY models with highly compressed spectra with the CMS detector at the LHC

Navid Rad and Mateusz Zarucki

HEPHY – Vienna

Supersymmetry (SUSY) is one of the most promising candidates to solve central problems with the Standard Model (SM), such as the hierarchy problem or the nature of dark matter. In particular, compressed SUSY models are very well motivated by naturalness and dark matter constraints. This search focuses on a compressed scenario where the mass gap between the light stop (supersymmetric partner of the top quark) and lightest supersymmetric particle (LSP) is smaller than the W boson mass. The signal events consist of stop pair-production followed by 4-body decay into a lepton and neutrino (or quark-antiquark pair), b-quark jet and neutralino (LSP in considered model) final state. The neutralino and neutrino escape the detector and are represented in the form of missing transverse energy. Compressed regions are challenging to study as the visible decay products have low momentum and generally do not pass detector acceptance thresholds, however, this difficulty can be mitigated by the system being boosted by initial-state radiation (ISR). The results from the CMS Experiment at the Large Hadron Collider (LHC), CERN, for the centre-of-mass √s = 8 TeV, are presented, along with an outlook on new √s = 13 TeV data.

How General Is Holography?

Max Riegler

TU – Vienna

The holographic principle is a proposed duality between a theory of (quantum) gravity in D+1 dimensions and a quantum field theory in D dimensions that is located at the boundary of the gravity theory. Since most explicit realizations of such a holographic correspondence either involve string theory and/or spacetimes with constant negative curvature a natural question to ask is: "How General Is Holography?" My research evolves around this question that I try to answer by establishing new holographic correspondences as well as extending known ones in 2+1 spacetime dimensions. This poster focuses on a specific part of my research on a holographic correspondence involving asymptotically flat spacetimes. I will provide explicit checks on such a holographic correspondence such as e.g. holographic entanglement entropy.

Mesonic Effects in Ground and Resonant States

Regina Schmidt[1], Luciano Canton[2], Willibald Plessas[1], Wolfgang Schweiger[1]

[1] Theoretical Physics, Institute of Physics, University of Graz, Universitätsplatz 5, A-8010 Graz, Austria

[2] Istituto Nazionale di Fisica Nucleare, Via F. Marzolo 8, I-35131 Padova, Italy

We investigate mesonic effects in baryon ground and resonant states by including meson loops in a relativistic coupled-channels approach. From calculations, so far done on the hadronic level, we obtain results for the dressed mass of the nucleon ground state and for dressed masses and decay widths of resonances, notably of the Δ, due to coupling to the pion channel. At this stage an improvement is found over the single-channel treatment with no explicit mesonic degrees of freedom. The experimental data for decay widths, however, are still underestimated and further ingredients seem to be needed.

(presented by R. Schmidt)

Scattering of particles with spin on the lattice

Ursa Skerbis

Josef Stefan Institute and University of Ljubljana

All stable hadrons under strong interactions have already been studied in lattice QCD. Previous studies have discussed scattering of hadrons without spin. Almost no work has been done in lattice QCD for scattering of particles with spin. On this poster we give a short introduction to the scattering of particles with spin. Appropriate creation and annihilation operators for scattering systems are required in these simulations. Analytical derivations in different methods are described and some of our results

Search for He-eta bound states with the WASA-at-COSY facility

Magdalena Skurzok

Jagiellonian University, Krakow

The existence of eta-mesic nuclei in which the eta meson is bound in a nucleus by means of the strong interaction was postulated already in 1986 but it has not been yet confirmed experimentally. The discovery of this new kind of an exotic nuclear matter would be very important as it might allow for a better understanding of the eta meson structure and its interaction with nucleons. The search for eta-mesic helium (^{4}He-eta) is carried out with high statistics and high acceptance with the WASA detector, installed at the cooler synchrotron COSY of the Research Center Juelich. The search is conducted via the measurement of the excitation function for selected decay channels of the ^{4}He-eta system. In the experiment, performed in November 2010, two reactions dd → ^{4}He-eta → ^{3}He p pi- and dd → ^{4}He-eta → ^{3}He n pi0 were measured with a beam momentum ramped from 2.127GeV/c to 2.422GeV/c. The presentation will include description of the experimental method used at WASA and the results of the data analysis.

Holographic Entanglement Entropy in Heavy Ion Collisions

Philipp Stanzer

TU - Vienna

Entanglement entropy, a measure for entanglement in quantum systems, attracts a lot of attention in seemingly unrelated branches of physics like quantum information, condensed matter and conformal field theories. While computing entanglement entropy in quantum field

theories turns out to be notoriously hard, the holographic principle maps the problem to the much easier task of finding minimal (hyper)surfaces in a higher dimensional gravity theory. In this presentation I will present our recent numerical relativity computations of entanglement entropy using a system of colliding gravitational shock waves as holographic toy model for the early stage of heavy ion collisions.

Simulation of Backgrounds in CRESST-II Experiment

Cenk Turkoglu

HEPHY, ÖAW, Vienna

The CRESST is a direct detection experiment looking for potential rare event signals caused by dark matter particles using CaWO4 crystal based detectors. In order to understand the data more clearly, it is imperative that the background is understood well. This poster will include my work regarding the background contamination of CRESST-II experiment using the Geant4 simulations.

Study of the η meson production with the polarized proton beam

Marcin Zielinski, Iryna Schätti-Ozerianska and Pawel Moskal

Institute of Physics, Jagiellonian University, 30059 Cracow, Poland

The η meson production process was studied via measurements of the analyzing power, A_y for the $\vec{p}p \to pp\eta$ reaction. The measurement was performed with the WASA-at-COSY detector at excess energies of 15 MeV and 72 MeV. The missing mass and invariant mass techniques were used to identify η meson. Angular distribution for the analyzing power of the η meson was determined. The result is more than order of magnitude more precise than achieved in the previous experiments. The result of the studies show disagreement between experiment and predicted theoretical behavior of the A_y. The data indicates that at excess energy of 15 MeV there is no contribution from the Sd and Pp partial waves. Thus we prove experimentally for the first time that in the $\vec{p}p \to pp\eta$ reaction the η meson is produced in the s-wave with respect to protons at least up to 15 MeV. Whereas at excess energy of 72 MeV contributions form Pp wave is significant.