Spåtind 2018 - Nordic Conference on Particle Physics

Tuesday 02 January 2018 - Sunday 07 January 2018

Skeikampen, Norway

Book of Abstracts

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Welcome and practicalities

Wednesday AM / **77**

Recent results from the LHC

Albert De Roeck[1]

[1] *CERN*

In these lectures we will introduce the LHC and experiments, and walk through the physics program as it has been conducted so far. Special attention will be given to our present understanding of the Standard Model measurements including the studies related to the Higgs particle, and to searches for new physics beyond the Standard Model. These searches encompass the search for direct production for new particles or forces, as well indirect search channels via precision measurements for examples via heavy flavour production. A bit of the recent history of excesses seen at the LHC will be included as well.

Summary:

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The Future of Particle Physics: Charting Fundamental Interactions

francesco Sannino[1]

[1] *CP3-Origins*

I will provide a critical overview of the state-of-the-art in particle physics. I will then introduce new Wilsonian theories of fundamental interactions that have recently been put forward that are able to address old paradigms and that offer novel avenues for (astro) particle physics and cosmology.

Summary:

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Critical point of nuclear matter and beam energy dependence of net proton number fluctuations

Mark Gorenstein[1]

[1] *Bogolyubov Institute for Theoretical Physics*

Critical point of nuclear matter and beam energy dependence of net proton number fluctuations

Summary:

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Heavy Ion Physics

Eero Aleksi Kurkela[1]

[1] *CERN*

I will discuss recent developments in theory of heavy ion physics. In particular, I will discuss how relativistic fluid dynamics arises from fundamental interactions and how the emergence of collective phenomena can be studied by focusing in questions where the hydrodynamical paradigm is under stress.

Summary:

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Heavy ion physics - experimental results

Sonja Kabana[1]

[1] *Centre National de la Recherche Scientifique (FR)*

Heavy ion physics - experimental results

Summary:

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Study of the SM Higgs boson decaying to WW with ATLAS

Edvin Sidebo[1]

[1] *KTH Royal Institute of Technology (SE)*

After the discovery of the Standard Model Higgs boson in 2012, we have entered the era of precision measurements of this particle. The decay to two W bosons constitutes the second largest branching ratio for the decay of the Higgs. An overview of the analysis strategy in the Higgs boson cross section measurement in the H->WW(*)->evμv decay channel performed by the ATLAS experiment will be presented. The measurement is made using proton-proton collision data at sqrt(s)=13 TeV collected during 2015 and 2016, corresponding to an integrated luminosity of 36/fb. As the analysis is currently being finalised, focus will be on the analysis method and selections.

Summary:

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On interference and non-interference in the SMEFT

Andreas Helset[None]

We discuss interference in the limit m^2W/s⟶0 in the Standard Model Effective Field Theory (SMEFT). Dimension six operators that contribute to ψ¯ψ⟶ψ′¯1ψ′2ψ′¯3ψ′4 scattering events can experience a suppression of interference effects with the Standard Model in this limit. This occurs for subsets of phase space in some helicity configurations. We show that approximating these scattering events by 2⟶2 on-shell scattering results for intermediate unstable gauge bosons, and using the narrow width approximation, can miss interference terms present in the full phase space. Such interference terms can be uncovered using off-shell calculations as we explicitly show and calculate. We also demonstrate that the SMEFT expansion and the narrow width approximation do not commute, and discuss some phenomenological implications of these results

Summary:

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The Little Bang of Heavy Ion Collisions

Meera Vieira Machado[1]

[1] *Niels Bohr Institute*

The Quark Gluon Plasma (QGP) produced in the Large Hadron Collider (LHC) undergoes a similar evolution to that of our Universe. The collision produces an explosive expansion caused by high pressure gradients and it then cools down, forming free-streaming hadrons. The earliest stages of the Universe are probed through the cosmic microwave background (CMB). In a similar manner to the analysis performed on it, we calculate the multiplicity power spectrum of heavy ion collisions and present the issues of dealing with a partial "sky" coverage.

Summary:

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Investigation of hadron collisions with angular correlations

Malgorzata Anna Janik[1]

[1] *Warsaw University of Technology (PL)*

Two-particle angular correlations as a function of pseudorapidity difference, $\Delta\eta$, and azimuthal angle difference, $\Delta\varphi$, are a comprehensive tool which allows the explaration of the underlying physics phenomena of particle production in collisions of both protons and heavy ions. These correlations open up the possibility to study a number of mechanisms simultaneously. Many phenomena, including mini-jets, elliptic flow, Bose-Einstein correlations, resonance decays, conservation laws, are sources of correlations. In this talk I will present an short overview of two-particle angular correlation measurements, with emphasis on recent surprising results of the correlations of identified particles (π, K, p, Λ) in pp collisions at sqrt(s) = 7 TeV from ALICE.

Summary:

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Dynamical vs. geometric anisotropy in relativistic heavy-ion collisions

Larisa Bravina[1]

[1] *University of Oslo (NO)*

We study the influence of geometric and dynamical anisotropies on the development of flow harmonics and, simultaneously, on the second- and third-order oscillations of femtoscopy radii. The analysis is done within the Monte Carlo event generator HYDJET++, which was extended to dynamical triangular deformations. It is shown that the merely geometric anisotropy provides the results which anticorrelate with the experimental observations of either (or) or second-order (or third-order) oscillations of the femtoscopy radii. Decays of resonances significantly increase the emitting areas but do not change the phases of the radii oscillations. In contrast to the spatial deformations, the dynamical anisotropy alone provides the correct qualitative description of the flow and the femtoscopy observables simultaneously. However, one needs both types of the anisotropy to match quantitatively the experimental data.

Summary:

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Charmed states on the lattice

Elena Lushchevskaya[1]

[1] *ITEP*

Study of the charmonium states play important role in understanding of the strong interaction. The most interesting charmonium states lie near or above open charm threshold. Nature of such states is of interest to modern physics. Recent lattice calculations have performed the necessary extrapolations and considered spectra as well as certain radiative transitions. The lattice QCD simulations of X(3872) with J P C = 1++ have been performed in this study. The mass of this state , 3872 MeV, is very close to the sum of the masses of the D0 and D0∗ mesons and decays to D0 and D0∗ were observed, giving rise to two other explanations for what the mysterious X could be: a loosely-bound "molecule" of the D0 and D0∗ mesons, or a "tetra-quark" binding a di-quark and a di-antiquark. We also have proposed the approach to determine the nature of this state.

Summary:

100 years of gravitational waves: history and discovery / 60

100 years of gravitational waves - history and discovery

In 1916 Albert Einstein showed that gravitational waves were a natural consequence of his theory of general relativity (GR) . Nothing much was done about this feature of GR until the 1950s since it was deemed to be either an unphysical mathematical oddity or simply too unfathomably small to ever be useful. In fact, if they were to ever be detected then the only things in the universe that could generate them would be exotic astrophysical objects exhibiting highly dynamic behaviour. 100 years on, based on the vision of a handful of key players and the hard work of thousands of others, we are now able to detect these ripples in space-time and obtain an entirely new view of the universe.

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Recent results from the LHC (II)

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Dark matter - theoretical overview

Kai Ronald Schmidt-Hoberg[1]

[1] *Deutsches Elektronen-Synchrotron (DE)*

Dark matter - theoretical overview

Summary:

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GAMBIT: What is it and where is it going?

Anders Kvellestad[1]

[1] *Nordita*

I will introduce the recently released software package *the Global and Modular BSM Inference Tool* (GAMBIT), focusing on the core features of GAMBIT and highlighting its collider physics module, *ColliderBit*. I will also briefly discuss some ongoing work within the GAMBIT collaboration, both in terms of software extensions and physics analyses.

Summary:

Thursday PM / 103

Particle physics in the era of Artificial Intelligence

Kyle Stuart Cranmer[1]

[1] *New York University (US)*

The present landscape and the open questions in particle physics will be briefly reviewed, showing that they call for new means of investigation both towards higher energy and towards more sensitivity to small couplings.
CERN is preparing actively, according to the recommendation of the 2013 European Strategy, for an ambitious post-LHC accelerator complex. The 100km circumference Future Circular Collider (FCC) study comprise an e+e- high luminosity collider covering the full electroweak scale (90-365 GeV E_CM), a 100 TeV pp collider as ultimate goal; the possibility of heavy ions and and e-p collisions are considered. A similar project is under study in China. Linear e+e- colliders would be of interest if electroweakly coupled particles exist above the top quark mass and below about 1.5 TeV are indicated at the LHC. For higher energy lepton collisions, muon colliders become attractive.

Summary:

Thursday PM / **78**

The proposed ESS neutrino Super Beam and its physics case

Tord Johan Carl Ekelof[1]

[1] *Uppsala University (SE)*

Searching for a difference between neutrino and anti-neutrino oscillations may open the way towards new fundamental physics and an explanation of why the world is made of only matter and no anti-matter. To discover such a difference, the development of a very large neutrino detector and a high-intensity neutrino beam is needed. The same detector will make possible investigations of cross-disciplinary phenomena like the energy generating processes in the Sun, the mechanism of Supernovae explosions and the radiogenic heating in the Earth's interior. The planned location of the neutrino detector, called GRIPnu, is in the Garpenberg mine ca 150 km north of Stockholm. The uniquely high-intensity ESS neutrino Super Beam will be generated using an upgraded ESS proton linac in Lund. Physicists from Sweden, France, Turkey, Spain, Greece, Italy, Croatia, Bulgaria, Poland, Switzerland and United Kingdom contribute to the EU H2020-supported Design Study of this neutrino research infrastructure and its physics case.

Summary:

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First physics results with GAMBIT

Are Raklev[1]

[1] *University of Oslo (NO)*

I will present the first Beyond the Standard Model (BSM) global fit results obtained using the new Global And Modular BSM Inference Tool (GAMBIT). With GAMBIT we have analysed the GUT-motivated supersymmetry models CMSSM, NUHM1 and NUHM2; the weak-scale MSSM7; and a scalar singlet dark matter model. Our analyses improve on existing results in terms of the number of included observables and the level of detail in the treatment of these, in the employed scanning techniques and the treatment of nuisance parameters.

Summary:

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Sterile neutrinos in GAMBIT

Tomas Gonzalo[None]

The type-I seesaw mechanism, able to explain the lightness of the three active neutrinos, requires the existence of exotic heavy neutral fermions, with a mass ranging from a few MeV to around a TeV. We propose a model with three such sterile neutrinos where the mixing matrices are parametrized using the Casas-Ibarra scheme. Direct dectection constrains coming from DELPHI and ATLAS among others have been implemented, as well as indirect constraints such as big bang nucleosynthesis, neutrinoless double beta decay and lepton flavour violation. Using the GAMBIT framework we then have performed global fits on the model parameters and looked for regions of the parameter space that are statistically preferred.

Summary:

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Separating heavy Higgses using machine learning

Inga Strumke[1]

[1] *University of Bergen (NO)*

We study the prospects for using deep neural networks to distinguish collider signals from heavy and mass degenerate CP-odd and CP-even Higgs bosons. The close overlap in the kinematic features highlights a challenge related to the bias introduced by training data.

Summary:

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Deep learning particle tracks in the CMS detector

Joona Juhani Havukainen[1]

[1] *Helsinki Institute of Physics (FI)*

In order to improve track reconstruction in Run 2 and to prepare for the increasingly difficult detector conditions of Run 3 at the Compact Muon Solenoid (CMS) detector, the use of novel machine learning methods in the CMS tracking are being studied. These methods provide ways to deal with for example the high particle densities, growing combinatorics and track quality assignments in the tracker. In this talk I will discuss the CMS track reconstruction, it's challenges in Run 2 and Run 3 and how we can use machine learning to ensure the continued high level of performance in track reconstruction.

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Using Machine Learning for a Fast Evaluation of Supersymmetric NLO Cross Sections

Jon Vegard Sparre[1]

[1] *University of Oslo*

In this Masters thesis we have developed a faster way to calculate supersymmetric cross sections at next-to-leading order (NLO) by using machine learning techniques. This method teaches the computer software to imitate the cross section function, facilitating the evaluation of a large number of parameter points in a short period of time. Training is carried out based on data generated with SoftSUSY and Prospino 2.1. We have used the phenomenological MSSM-24 as an example model with the production of gluino pairs as an example process.

Summary:

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Embedding simulated particles into real data in search for charged Higgs bosons

Santeri Henrikki Laurila[1]

[1] *Helsinki Institute of Physics (FI)*

Particle physics experiments typically require that background processes affecting the measurement are taken into account in the data analysis. In collider experiments, this means estimating how large fraction of the observed collision events actually originate from background processes and not from signal events.

The background event yields are usually estimated from simulation or with a separate background measurement, conducted in a control region where possible signal does not affect the measurement. However, simulated results always always rely on certain theoretical models and suffer from both theoretical and statistical uncertainties. On the other hand, measuring background from data is feasible only when there exists a control region that is similar enough to signal region but free of signal contamination.

In this talk, a third approach to background estimation is presented. The embedding method aims to combine the best features of background simulation and measurement. This method uses collision events that are very similar to actual signal, except that some of the particles present in the collision events are of "wrong" type. For example, if signal contains tau leptons, similar events containing muons (instead of taus) can be used for embedding. Then the "wrong" type of particles (muons) are carefully removed from event data, and replaced with simulated particles of the correct type (taus). The outcome is a hybrid data sample, where each collision event contains an underlying event from data and only a few simulated particles that were not present in the original event.

Examples of recent applications of the embedding method are given, and a current project to apply embedding in a search of charged Higgs bosons in the CMS experiment is presented. An ongoing analysis is searching for charged Higgs bosons decaying to a hadronic tau and a neutrino. The embedding method allows estimation of the large background of standard model events containing a hadronic tau, using a data sample with muons instead of taus in the final state. The discovery of a charged Higgs boson would be a clear signature of physics beyond the standard model.

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Teaching particle physics to teacher students

Nils-Erik Bomark[None]

Since Norwegian high school teacher are required to teach particle physics, it is important to give them as good an understanding of the topic as possible. Since also many students who does not venture into more advanced physics courses, show an interest in particle physics, we face a challenge in how to teach these topics in a non-technical fashion. I will discuss aspects of coming to grips with the notion of particles, which is causing a lot of confusion in quantum mechanics, especially how to difuse the "particle-wave" confusion. Here the idea of particles as some kind of energy-quanta, as first discussed by Einstein, plays an important role. In addition, gauge theory is a vital component in understanding particle physics at a deeper level, and especially understanding the Higgs mechanism at all. Here a simple but accurate analogy will be presented that can do this without resorting to too complicated mathematics.

Summary:

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LHC discoveries and particle physics concepts for education

Eirik Gramstad[1] ; Magnar Kopangen Bugge[1] ; Farid Ould-Saada[1]

[1] *University of Oslo (NO)*

With the advent of higher energies and higher collision rates, the LHC continues the exciting voyage towards new physics, allowing physicists all over the world to explore a previously unknown territory full of promise. So far the International Particle Physics Outreach Group (IPPOG) international masterclass developers, with the help of physicists and in close contact with teachers, have been successful in designing educational material and in engaging high school students to work, with real LHC data, on current hot topics, such as the discovery of the Higgs boson. One of the current challenges is to convey advanced physics concepts and to introduce new ideas beyond today's theoretical framework describing the content of the Universe and its evolution. How can we influence the teaching at schools in order to provide a better basis for attending masterclass-like events, and in general for understanding experimental results and new theoretical ideas? An IPPOG initiative deals with effective ways of explaining new physics. Moreover, physicists, in close contact with high school teachers and university departments of education, are investigating a more professional and research-based view on methods and ideas for introducing and explaining new physics concepts. A program plan, together with relevant material, must be created and incorporated to suit the high school curriculum and even replace the ordinary text book on the subject. This is crucial in order to enable us to explain new physics concepts and related enigmas such as dark matter, the role of gravity at the quantum scale, the possible unification of all fundamental forces and the physics of the early Universe. Eirik Gramstad, Farid Ould-Saada, Magnar Bugge

Summary:

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Direct detection of dark matter

Jan Conrad[1]

[1] *Stokcholm University*

In my contribution I will review the status of direct detection of dark matter, currently focusing on Weakly Interacting Massive Particle. I will also discuss some future direction and if time allows comment on complementarity with other detection techniques.

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Dark Matter and Dark Sector at the LHC

Christian Ohm[1]

[1] *KTH Royal Institute of Technology (SE)*

Dark Matter and Dark Sector at the LHC

Summary:

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The BSM Electroweak Phase Transition

Anders Tranberg[None]

The Electroweak Phase Transition in the Minimal SM is known to be an equilibrium crossover. But extended scalar sectors (extra singlet, doublet) may render the transition first order, opening up the possibility of explaining the cosmological baryon asymmetry and providing a cosmological source of gravitational waves. I will present recent work on determining the order of the phase transition perturbatively and non-perturbatively.

Summary:

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Advances in software and computing for HEP

Graeme Stewart[1]

[1] *CERN*

High energy particle physics faces huge challenge in software and computing in the coming decade. At the LHC ALICE and LHCb will make major upgrades for Run 3, requiring much improved software, while the challenges faced by ATLAS and CMS for High Luminosity LHC imply that software and computing must improve by around x10 beyond technology evolution alone to fit into the anticipated resources. Belle II and DUNE will also start their data taking with comparable rates. This problem is made all the harder to solve because developments in computing hardware do not provide the simple Moore's Law scaling of the past. Concurrency, multi-core and vector, has become essential for achieving performance on CPUs. Adapting many pieces of HEP code that were developed decades ago for this is a major challenge. GPUs and FPGAs are now increasingly used and require a complete rethinking of many algorithms and software frameworks. In each case software sustainability also needs to improve.

To tackle this challenge the HEP Software Foundation launched a Community White Paper process to lay out a roadmap for HEP computing evolution into the 2020s. I will outline the process that was undertaken to gather input from across the HEP community. I will look at the main areas of work, from event generation to analysis, and survey the research and development projects for the coming years. Finally, I will conclude on how the community can turn the white paper proposals into a genuine "software upgrade" process that matches the ambition of the rest of the HEP experimental program.

Summary:

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Connecting the Dots - Track reconstruction in the era of Data Science

Andreas Salzburger[1]

[1] *CERN*

The reconstruction of trajectories from charged particles in the ATLAS Inner Detector is the most single CPU intensive part of the event reconstruction. The currently implemented combinatorial approach with track following will suffer strongly from the increasing event complexity foreseen with the future high luminosity programs in high energy physics. On the other hand, machine learning (ML) is a rapidly growing sector in academics and industry, which has large potential overlap and opportunities for application in track reconstruction. One such attempts to foster external expertise for high luminosity track reconstruction is the upcoming track reconstruction machine learning challenge, a follow-up initiative of the ATLAST Higgs machine learning challenge hosted by kaggle.

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Search for direct production of sleptons in proton-proton collisions at √s = 13 TeV with the ATLAS detector

Even Simonsen Haaland[1] ; Eirik Gramstad[1] ; Farid Ould-Saada[1]

[1] *University of Oslo (NO)*

The Standard Model (SM) of particle physics is currently the best theory for describing elementary particles and their interactions, but there are several problems and open questions related to it. For instance it does not incorporate gravity, and it does not explain dark matter, hence there is a need for new fundamental theories of nature beyond the current theory. A theory that addresses some of the problems with the SM is Supersymmetry, as a symmetry between fermions and bosons, which predicts a superpartner for each SM particle.
Here we present a search for direct production of sleptons, which are the supersymmetric partners of the leptons. The sleptons are assumed to decay to leptons and neutralinos, where the latter is considered to be a good dark matter candidate particle. The data set used in the analysis consists of an integrated luminosity of 36.1 1/fb from proton-proton collisions at 13 TeV centre-of-mass energy collected by the ATLAS experiment at the Large Hadron collider at CERN in 2015 and 2016. No significant excess above the expected Standard Model background is observed.

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Search for new phenomena in the dilepton final state using proton-proton collisions at √s = 13 TeV with the ATLAS detector

Simen Hellesund[1] ; James Catmore[1] ; Vanja Morisbak[1] ; Magnar Kopangen Bugge[1] ; Farid Ould-Saada[1]

[1] *University of Oslo (NO)*

A search is conducted for new resonant and nonresonant high-mass phenomena in di-electron and dimuon final states. The search uses 36.1 fb−1 of proton-proton collision data, collected at √s = 13 TeV by the ATLAS experiment at the LHC in 2015 and 2016. No significant deviation from the Standard Model prediction is observed. Upper limits at 95% credibility level are set on the cross-section times branching ratio for resonances decaying into dileptons, which are converted to lower limits on the resonance mass, up to 4.1 for the E6-motivated Z'χ. Lower limits on the qqℓℓ contact interaction scale are set between 24 TeV and 40 TeV, depending on the model. The analysis strategy is being reworked in the next iteration of the analysis, including going from a Monte Carlo based analysis to a data driven approach. The next publication is planned for early 2018, as soon as the current LHC run 2 ends.

Summary:

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Search for electroweak production of supersymmetric particles in the two and three lepton final state at √s = 13 TeV with the ATLAS detector

Knut Oddvar Hoie Vadla[1]

[1] *University of Oslo (NO)*

A search for the electroweak production of charginos, neutralinos and sleptons decaying to final states involving two or three electrons or muons is presented. The analysis is based on 36.1 fb^{-1} of √s=13 TeV proton-proton collisions recorded by the ATLAS detector at the Large Hadron Collider. No significant deviations from the Standard Model expectation are observed and results are interpreted in a range of scenarios based on simplified models. Considered scenarios include the associated production of mass-degenerate next-to-lightest neutralino and lightest chargino, followed by their decays to final-state leptons and lightest neutralinos via either sleptons or Standard Model gauge bosons; direct production of chargino pairs, which in turn decay to leptons and lightest neutralinos via intermediate sleptons; and slepton pair production, where each slepton decays directly to the lightest neutralino and a lepton. Stringent limits at 95% confidence level are placed on the masses of relevant supersymmetric particles in each of these scenarios.

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Search for new resonances in events with one lepton and missing transverse momentum in pp collisions at √s = 13 TeV with the ATLAS detector

Magnar Kopangen Bugge[1]

[1] *University of Oslo (NO)*

The results of a search for new heavy W' bosons decaying to an electron or muon and a neutrino using proton-proton collision data at a centre-of-mass energy of 13 TeV are presented. The dataset was collected in 2015 and 2016 by the ATLAS experiment at the Large Hadron Collider and corresponds to an integrated luminosity of 36.1 fb-1. As no excess of events above the Standard Model predictions is observed, the results are used to set upper limits on the W' boson cross-section times branching ratio to an electron or muon and a neutrino as a function of the W' mass. Assuming a W' boson with the same couplings as the Standard Model W boson, W' masses below 5.1 TeV are excluded at the 95% confidence level. We also exploit the opportunity to discuss briefly the plan for a new MSc project devoted to a search for heavy Majorana neutrinos decaying to final states with same-sign leptons and jets.

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Gamma rays from dark matter annihilation into heavy mesons

Author(s): Jeriek Van den Abeele[1]

Co-author(s): Torsten Bringmann [1] ; Andrzej Hryczuk [1] ; Are Raklev [1] ; Inga Strümke [2]

[1] *University of Oslo*

[2] *University of Bergen*

From the perspective of indirect detection, gamma rays would make excellent messengers of a potential dark matter signal. Not only do they point towards their sources, their energy spectrum may also carry smoking-gun features that allow to pinpoint the particle nature of dark matter. In particular, Bringmann et al. (2017) recently highlighted that excited Standard Model meson states, resulting from the annihilation or decay of GeV-scale dark matter candidates, give rise to distinctive MeV gamma-ray signatures.

Currently, there is a notable lack of experimental sensitivity in the MeV range. This has prompted several dedicated satellite mission proposals, like e-ASTROGAM, that would address the so-called 'MeV gap' within roughly a decade. Given the large astrophysical backgrounds, the presence of monochromatic lines or box shapes in the observed gamma-ray spectrum could be crucial in identifying a signal. Ongoing work focuses on how quarkonium resonances can further enhance such spectral features arising from transitions between heavy-meson states.

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Enhancing detectibility of tri-lepton signatures of Tau-Sneutrino NLSP using machine learning

Author(s): Daniel Alvestad[1]

Co-author(s): Joern Kersten [1] ; Inga Strümke [1]

[1] *University of Bergen*

I would like to present my master thesis project, where I study the phenomenology of a supersymmetric model with sneutrino as the NLSP. I look at the tri-lepton signature, two hadronic taus and one lepton (electron or muon), which in my model comes mostly from slepton-sneutrino production. The aim is to improve detectability of this signal using machine learning instead of traditional cut-and-count methods.

Summary:

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Measurement of $B_s^0 \to \psi(2S)\phi$ / $B_s^0 \to J/\psi\phi$ ratio

Author(s): Haakon Midthun Kolstoe[None]

Co-author(s): Gerald Eigen [1]

[1] *University of Bergen (NO)*

In this talk we will have a brief look at the two decay modes $B_s^0 \to J/\psi\phi$ and $B_s^0 \to \psi(2S)\phi$ and the measurement of the corresponding ratio. To guarantee identical topologies between the two decays we have chosen to only look at the $\psi(2S) \to \mu^+\mu^-$ and $J/\psi \to \mu^+\mu^-$ modes. A quick look at the peaking backgrounds $B_s^0 \to J/\psi f_0(980)$ and $B_s^0 \to \psi(2S) f_0(980)$ is also given attention.

Summary:

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Small-scale intragalactic dark halos and gravitational microlensing

August Geelmuyden[None]

Structure formation in the cold dark matter scenario predicts a large number of small-scale intragalactic dark halos. The existence of these objects has not yet been verified. Can they be detected through gravitational microlensing?

Summary:

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CHY amplitudes and high N-point amplitudes

David Froelund Damgaard[None]

I would like to sketch some of the features of the method for calculating scattering amplitudes presented by Cachazo, He and Yuan. I will give a brief overview of the complex analysis method to make the integrals more manageable. Lastly, I will also provide an example of how to apply the diagrammatic representation of the integrals to calculate the CHY diagrams.

Summary:

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Environmentally-induced decoherence in IceCube

Mikkel Jensen[None]

Recent tension between two cutting edge neutrino oscillation experiments has sparked the idea of environmentally-induced decoherence. This effect alters the oscillation probability, depending on how far the neutrino travels. This search is focused on probing decoherence using the IceCube neutrino observatory, by measuring theta23 for neutrinos which have travelled different distances through the earth before reaching the detector.

Summary:

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Top mass with template fits in the di-lepton channel at 13TeV

Rosanna Ignazzi[1]

[1] *University of Copenhagen (DK)*

The top quark is the most massive particle in the Standard Model and the precise measurement of it mass could be the key to unveil new physics. The aim of the analysis is to reduce the uncertainty of the measurement by avoiding the modelling of the hadronic decay of the W from the top events. By using the di-lepton channel and, in particular, 5 leptonic observables sensible to the top quark mass (pT(l+), pT(l+l-), pT(l+)+pT(l-), M(l+l-) and E(l+) + E(l-)), the pole mass can be calculated with high precision with template fits with the ATLAS Run-2 data.

Summary:

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Using Machine Learning to improve particle identification in the ATLAS experiment.

Stefan Dahl Hasselgren[1]

[1] *University of Copenhagen (DK)*

Currently, the method for identifying particles in the ATLAS experiment relies on Likelihood estimates constructed from MC simulations. These are good and efficient, but the method has a few shortcomings compared to using ML algorithms. I will present our work so far in using BDTs to classify electrons, some preliminary results, and some of our future hopes and dreams.

Summary:

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General relativity, Gravity and the discovery of gravitational waves

Fawad Hassan[1]

[1] *Stockholm University*

I will motivate the study of theories of gravity in the presence of extra spin-2 fields and will then describe a ghost free bimetric theory of gravity, some of its physical implications, and the current status of the theory. In particular, I will focus on the notions of space and time in the theory in the presence of two metric fields.

Summary:

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Bimetric gravity and analysis of constraints

In bimetric gravity, a number of constraints are needed to ensure that the theory is free of ghosts and propagates the appropriate number of degrees of freedom. I will describe my recent work analyzing the origin and structure of these constraints. The ghost free bimetric theory has six constraints, four of which are first class and are associated with the diffeomorphism invariance of the theory. Their Poisson brackets form an algebra from which possible spacetime metrics can be identified. The remaining two constraints are second class and are responsible for removing the Boulware-Deser ghost.

Summary:

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Thoughts about supersymmetric naturalness

Summary:

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Future accelerators

Alain Blondel[1]

[1] *Universite de Geneve (CH)*

The present landscape and the open questions in particle physics will be briefly reviewed, showing that they call for new means of investigation both towards higher energy and towards more sensitivity to small couplings.
CERN is preparing actively, according to the recommendation of the 2013 European Strategy, for an ambitious post-LHC accelerator complex. The 100km circumference Future Circular Collider (FCC) study comprise an e+e- high luminosity collider covering the full electroweak scale (90-365 GeV E_CM), a 100 TeV pp collider as ultimate goal; the possibility of heavy ions and and e-p collisions are considered. A similar project is under study in China. Linear e+e- colliders would be of interest if electroweakly coupled particles exist above the top quark mass and below about 1.5 TeV are indicated at the LHC. For higher energy lepton collisions, muon colliders become attractive.

Summary:

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Future Accelerators - Ideas

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Particle colliders are quickly reaching a saturation in terms of cost and size: if not with the LHC, then probably with the next generation of colliders. How can we break through this wall and bring accelerators into the next century? The new and blossoming field of Advanced Accelerator Concepts is coming up with novel, exciting technologies aimed at making particle accelerators more compact and more efficient. In this talk, we will look at the broad strokes, understand important concepts like plasma wakefields, as well as look at an example of the problems and solutions currently under study.

Summary:

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The ATLAS Inner Tracker for the HL-LHC

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The ATLAS Experiment is currently working on a series of upgrades in preparation for the High-Luminosity LHC, which is scheduled to start in 2026. One such upgrade will be to the inner tracking system. The current Inner Detector will be completely replaced with a brand new, all-silicon Inner Tracker consisting of a pixel detector near to the beam line and a large-area strip tracking detector. This talk will present the design, expected performance and current status of the Inner Tracker, with a particular focus on the strip tracking and how the Nordic Institutes are contributing to this project.

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ATLAS pixel upgrades

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In order to be ready for the HL-LHC, the entire tracking system of the ATLAS experiment will be replaced by a new silicon detector called Inner Tracker (ITK). The new pixel system is currently being developed and could include around 14 m2 of silicon. Here we present the
status of the ongoing development of 3D silicon pixel sensors as well as the work on the very first demonstrator.

Summary:

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The High-Granularity Timing Detector proposed for ATLAS Phase II

The HL-LHC will produce around 200 pp interactions in each bunch crossing, and maintaining the reconstruction performance in this harsh environment is one of the most important experimental challenges to overcome for a successful ATLAS physics program. At the same time, big investments are done to equip the forward region up to |eta| < 4 with tracking capabilities with the ITk. The High-Granularity Timing Detector is a proposed detector for the Phase II upgrade which will help associate tracks in the forward region to the correct primary vertex by exploiting the time spread of the interactions. Through this the performance of pileup-jet tagging, flavor tagging and lepton isolation is improved dramatically to levels similar to those observed in the barrel region. In addition, this low-occupancy detector is a powerful luminometer capable of providing high-precision bunch-by-bunch luminosity measurements both online and offline.

Summary:

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Making SUSY Natural Again – Investigating the Naturalness Reach of the International Linear Collider

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When designing and selecting future collider projects, it is important to understand the physics potential of the different alternatives. Here, we investigate the naturalness reach of the International Linear Collider (ILC) in simple constrained supersymmetric models, and compare it to the reach of the High-Luminosity Large Hadron Collider (HL-LHC), based on the results in 1. The reach is quantified both in terms of the range of naturalness covered, given by the Barbieri-Giudice measure, and in terms of the information gained about naturalness, quantified by the Kullback-Leibler divergence.

Two particular scenarios (parameter choices) for the Constrained Supersymmetric Standard Model (CMSSM) are studied, and one for the second Non-Universal Higgs Mass (NUHM2) model. We find that the HL-LHC in general has a higher naturalness reach than the ILC in the two CMSSM scenarios. However, for the NUHM2 scenario, it is the other way around. In this scenario, we find that the information gain from the 1 TeV ILC searches are over ten times as large as the information gain from the HL-LHC searches. Post HL-LHC naturalness scores below $c \sim 20$, or a tuning to no worse than 5%, are allowed. Thus, the particular variant of the NUHM2 model studied in this work motivates building the ILC.

Summary:

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Prospects of Sterile Neutrino Search with the FCC-ee

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A proposed future circular e+e- collider, the FCC-ee, is suggested to search for sterile neutrinos. The Neutrino Minimal Standard Model, vMSM, is a model of sterile neutrinos, that accommodates explanations for several phenomena of physics beyond the Standard Model. This thesis presents an overview of the theoretical motivation for vMSM, an outline of the experimental conditions at the FCC-ee, and a review of previous accelerator bounds for sterile neutrinos. Two studies of sterile neutrinos with masses at the electroweak scale are introduced, an analysis of long lived sterile neutrinos, and an analysis of short lived sterile neutrinos. Both analyses include background studies and sensitivity estimates for the FCC-ee detector. The study of long lived sterile neutrinos is based on a search for detectable displaced vertices with 1012 Z decays, obtaining a search reach on the mixing angle |θ|^2 as small as 10^-11. The study of short lived sterile neutrinos is a Monte Carlo study with a cut-based analysis, where a detector parametrisation of the FCC-ee detector, inspired by the CLIC detector design, is used. Background events were generated corresponding to a total number of 1.43x10^8 Z events, corresponding to a luminosity of L = 3.33 fb^-1. A search reach on the mixing angle with coupling to the muon neutrino on |θ_μN|^2 ~ 10^-7 – 10^-6 was achieved for sterile neutrino masses from 10 to 80 GeV.

Summary: