

T 37: Search for New Particles 2

Time: Tuesday 16:15–18:30

Location: T-H22

T 37.1 Tue 16:15 T-H22

Search for heavy neutral leptons in decays of W bosons using a dilepton displaced vertex in $\sqrt{s} = 13$ TeV pp collisions with the ATLAS detector. — ●CHRISTIAN APPELT and HEIKO LACKER — Humboldt University, Berlin, Germany

We present the ATLAS search for displaced heavy neutral leptons (\mathcal{N}) using the full integrated LHC-Run 2 luminosity of 139/fb. Adding right-handed Majorana neutrinos, so-called heavy neutral leptons, to the SM Lagrangian can help explain observed phenomena such as neutrino oscillations, matter-antimatter asymmetry, and dark matter. For the first time, we test not only the single-flavor mixing scenario but also multi-flavor mixing scenarios motivated by neutrino flavor oscillation results for normal and inverted neutrino mass hierarchies. The signature involves \mathcal{N} production in W -boson decays, $W \rightarrow \mathcal{N}\mu$ or $W \rightarrow \mathcal{N}e$, and its decay into two charged leptons and a neutrino forming a displaced vertex. We interpret the search results in the \mathcal{N} coupling versus mass plane.

T 37.2 Tue 16:30 T-H22

Search for excited leptons in the contact interaction and Z decay channels with CMS — ●FABIAN NOWOTNY, THOMAS HEBBEKER, and KERSTIN HOEPFNER — III. Physikalisches Institut A, RWTH Aachen

The Standard Model of particle physics does not provide a comprehensive explanation for the observed hierarchy of three generations of fermions, for both leptons and quarks. A possible explanation is delivered by models postulating that quarks and leptons themselves are composite objects. Their constituents are bound by an asymptotically free gauge interaction below a characteristic scale Λ . Such models of compositeness predict the existence of excited lepton (l^*) and excited quark (q^*) states at the characteristic scale Λ of the new binding interaction. The theory allows the production of excited leptons via contact interactions in conjunction with a Standard Model lepton. Furthermore, the leptons can decay into several final states.

This talk focuses on the contact interaction and Z -boson decay channels, both resulting in $l^* \rightarrow lq\bar{q}$ transitions where l represents e and μ . Preliminary results are presented on the 2018 proton-proton dataset corresponding to a luminosity of 59.8 fb^{-1} at a center of mass energy of $\sqrt{s} = 13$ TeV.

T 37.3 Tue 16:45 T-H22

Search for pair-produced leptoquarks decaying into quarks of the third and leptons of the first or second generation with the ATLAS experiment at $\sqrt{s} = 13$ TeV — ●VOLKER AUSTRUP and FRANK ELLINGHAUS — Bergische Universität Wuppertal

Motivated by similarities between the quark and lepton sectors, leptoquarks (LQs) are hypothetical bosons assumed to couple to quarks and leptons at the same time. First proposed in the 1980s, the initial models included couplings only within one generation. However, hints at lepton flavor universality violation observed in several B meson decay experiments such as LHCb, BaBar, and Belle have sparked a renewed interest in LQ models, particularly extensions allowing couplings to quarks and leptons of different generations. These models introduce lepton flavor violating processes - strongly suppressed in the Standard Model - at tree level, thus modifying rare B meson decays. In this talk, a search for pair-produced scalar and vector LQs decaying into quarks of the third and leptons (neutral and charged) of the first or second generation is presented. The focus of the analysis is on final states with exactly one charged lepton and large amounts of missing transverse momentum. Neural networks are utilized to ensure good separation between signal and background processes across a wide range of the parameter space. Exclusion limits are presented, based on pp -collision data corresponding to 139 fb^{-1} at a centre-of-mass energy of $\sqrt{s} = 13$ TeV collected by the ATLAS experiment at the LHC between 2015 and 2018.

T 37.4 Tue 17:00 T-H22

Leptoquark production in a single τ , charm/bottom and met final state at the ATLAS detector — ●PATRICK BAUER, PHILIP BECHTLE, and KLAUS DESCH — Physikalisches Institut Bonn

At B -factories, anomalies were observed in decays of the B -hadrons into $D^{(*)}$ and $K^{(*)}$, which are consistent with the hypothesis of con-

tributions from Leptoquarks in the high GeV to low TeV range.

Therefore, the direct search for leptoquarks (LQ) got once again in focus at high energy collider experiments. So far most searches aimed at the pair-production via strong interaction, as it enables a almost model independent approach and is for LQ-masses below 1 TeV expected to be dominating.

However for LQ masses well above 1 TeV the single production mode becomes more relevant. The analysis presented this talk, offers the most direct approach for a search of LQ signature related to the $B \rightarrow D^{(*)}\tau\nu$ anomaly, as it incorporates essentially the same couplings. Furthermore the process to be investigated could be mediated by a U_1 -vector LQ, which is presently widely discussed among theorists, as preferred solution to B -anomalies. It could explain the two observed anomalies within one model. The talk will motivate the analysis and present the ongoing search for vector LQ in single and pair production in final states with one τ , bottom or charm jet and large met.

T 37.5 Tue 17:15 T-H22

The LHC as Lepton-Proton Collider: Searches for Resonant Production of Leptoquarks — ●DANIEL BUCHIN, MICHAEL HOLZBOCK, and HUBERT KROHA — Max-Planck-Institut für Physik, München

Searches for leptoquarks constitute an essential part of the physics programme at the ATLAS detector. These hypothetical particles couple to both leptons and quarks and are predicted by many extensions of the Standard Model such as Grand Unified Theories. In particular leptoquarks with couplings to third generation fermions are of general interest since they represent a possible solution to the tensions observed in tests of the lepton flavour universality in $b \rightarrow s$ and $b \rightarrow c$ transitions. By considering the small but non-zero lepton content of the proton due to quantum fluctuations it becomes possible to target the resonant production of leptoquarks at the LHC. Phenomenological studies indicate that this production mode yields competitive sensitivity to existing leptoquark searches.

Resonantly produced leptoquarks give rise to a lepton + jet signature. Interestingly, such a final state is currently not well covered by ATLAS and CMS. Therefore, the analysis of the resonant production is an exciting complementary approach to the current leptoquark searches that consider e.g. pair production. The talk will introduce the leptoquark models of interest for this analysis and outline its general strategy.

T 37.6 Tue 17:30 T-H22

Search for Vector Like Quarks in the decay channel to top and Higgs boson with the CMS experiment — ●GUILLAUME GREAU — Deutsches Elektronen-Synchrotron DESY, Hamburg, Allemagne

A search for vector like quarks (VLQ) using the Run 2 data collected by the CMS experiment is presented. The VLQs are searched in the decay channel into a top quark and a Higgs boson, in which the Higgs boson further decays into WW . The channel with two leptons of same sign is studied, as it suppresses considerably the standard model background. First results on distributions to discriminate the signal from the background will be shown.

T 37.7 Tue 17:45 T-H22

Suche nach vektorartigen Quarks in Endzuständen mit einem Lepton, Jets und fehlendem transversalem Impuls am ATLAS Experiment — FRANK ELLINGHAUS und ●JENS ROGGER — Bergische Universität Wuppertal

Verschiedene Modelle für Physik jenseits des Standardmodells sagen vektorartige Quarks voraus, deren rechts- und links-händige Komponenten gleichartig unter der schwachen Wechselwirkung transformieren.

Die Analyse fokussiert sich auf die Suche nach vektorartigen Top-Quarks aus Paarproduktion mit einem Zerfall in Top-Quark und Z -Boson, wobei das Z -Boson in Neutrinos zerfällt. Die betrachteten Ereignisse werden durch ein Lepton, Jets und einen hohen fehlenden transversalen Impuls im Endzustand gekennzeichnet. Weiter führen die hohen Massen der vektorartigen Quarks zu einem starken Boost der Zerfallsprodukte, was zu einer kollimierten Zerfallstopologie führt. Der Status der Analyse der ATLAS pp Daten bei $\sqrt{s} = 13$ TeV wird präsentiert, wobei Ausschlussgrenzen auf die Paarproduktion von vek-

torartigen Top- und auch Bottom-Quarks in allen Zerfallskanälen des vektorartigen Quarks in ein Boson und ein Quark gesetzt werden.

T 37.8 Tue 18:00 T-H22

Search for long-lived particles within the CMS tracker — •KARIM EL MORABIT, LISA BENATO, MELANIE EICH, GREGOR KASIECZKA, and KARLA PENA — Institut für Experimentalphysik, Universität Hamburg

Several theories for physics beyond the standard model (BSM) predict the existence of long-lived particles (LLPs) that have comparably long lifetimes leading to macroscopic flight distances. Higgs-portal models, for example, propose the existence of a dark sector with particles that are neutral under the standard model (SM) gauge groups. In such theories, the SM Higgs boson mixes with a dark partner and acts as a mediator between the SM and the dark sector. The SM Higgs boson could then decay to a pair of dark sector LLPs which subsequently decay to SM particles – predominantly into bottom quark-antiquark ($b\bar{b}$) pairs.

This talk discusses searches for LLPs using data recorded with the CMS experiment at a center-of-mass energy of 13 TeV. The searches target events in which the LLPs decay into $b\bar{b}$ pairs within the CMS tracking system after flight distances ranging from micrometers up to 1 m. The signature of the signal events consists of $b\bar{b}$ originating from displaced vertices. The searches face different challenges depending on the lifetime of the LLPs. For short lifetimes, the decay products of

LLPs need to be distinguished from those of SM particles, while the search for longer lifetimes requires dedicated tracking and vertex reconstruction methods. In both cases the challenges are tackled using machine learning approaches.

T 37.9 Tue 18:15 T-H22

Search for long-lived particles in the CMS calorimeters and muon chambers — •LISA BENATO, JÖRG SCHINDLER, and GREGOR KASIECZKA — Institut für Experimentalphysik, Universität Hamburg

Many beyond the standard model (BSM) theories predict the existence of long-lived particles (LLPs) that have long lifetimes and decay in the outermost parts of a hadron collider experiment, such as the calorimeters and muon chambers of the CMS detector. Very displaced signatures (decay length beyond 1 m) can only be reconstructed with non-standard approaches by using low-level detector information (hits in the muon chambers and scintillation time of the calorimeter crystals). LLP decays in calorimeters are identified as jets, delayed with regards to the proton-proton collision and with a small number of associated tracks. Muon chambers act as sampling calorimeters and LLP decays originate showers of hits in the gas detectors, identified as clusters, with no concurrent activity in the inner layers. No SM process produces this kind of signatures at a relevant rate. The expected background is nearly zero and due to detector noise and non-collision backgrounds. Such a clean environment allows to probe light LLPs with unprecedented sensitivity.