T 28: Forward Physics

Time: Tuesday 17:00–18:30 Location: HSZ/0101

T 28.1 Tue 17:00 HSZ/0101

QCD cross-section measurements for astroparticle physics with the LHCb experiment — Johannes Albrecht, Hans Dembinski, and •Lars Kolk — TU Dortmund University, Dortmund, Germany

A long-standing issue in the field of cosmic-ray research is the discrepancy between the observed and simulated numbers of muons in cosmic-ray-induced hadronic showers in Earth's atmosphere, which are called air showers. This discrepancy is referred to as the Muon Puzzle, as the required changes to existing models in simulation would violate either data constraints or the consistency between air shower simulations and other air shower features.
One explanation for this inconsistency lies in universal strangeness enhancement. Measurements from the ALICE and LHCb experiments show first evidence that this enhancement could truly be universal and thus potentially solve the Muon Puzzle.
To further study the impact on forward produced hadrons and to test this universality, proton-ion data from the LHCb fixed target mode are analysed. Of particular interest are proton-oxygen collisions, as they are a good proxy for air showers. Since proton-oxygen data are not yet available, the first step is to bracket oxygen with helium and neon. The current status of this analysis is presented.

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T 28.2 Tue 17:15 HSZ/0101

LHCb for astroparticle physics: Prompt production of identified charged hadrons — Johannes Albrecht[1], •Julian Boelhauve[1], Hans Dembinski[1], and Michael Schmelling[2] — [1]TU Dortmund University, Dortmund, Germany — [2]Max Planck Institute for Nuclear Physics, Heidelberg, Germany

A long-standing issue in the field of cosmic-ray research is the discrepancy in the number of muons produced in high-energy air showers between observations and simulation, referred to as the Muon Puzzle. Precision measurements of hadron production in the forward region are needed to validate and improve the hadronic-interaction models used in the simulation of air showers, with the aim of solving the Muon Puzzle. In this context, measuring the differential cross-section of prompt production of identified long-lived charged hadrons as a function of transverse momentum and pseudorapidity is of great importance.

An analysis in which this differential cross-section is determined for proton–proton and proton–lead collisions is presented in this talk. The corresponding data samples were recorded with the LHCb experiment at centre-of-mass energies of 13 TeV and 8.16 TeV in the nucleon–nucleon system, respectively. The focus of the talk is placed on the calibration of the particle-identification response of the detector, which is essential to an accurate measurement of the fractions of the three most commonly produced hadrons, i.e. pions, kaons and protons, present in the data.

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T 28.3 Tue 17:30 HSZ/0101

Obtaining the Total Cross-Section and ϱ-Parameter from Elastic Proton-Proton Scattering at $\sqrt{s} = 900\,\mathrm{GeV}$ with the ATLAS Subdetector ALFA — Wolfgang Friebel[2], Karlheinz Hiller[2], •Mustafa Schmidt[1], and Hasko Stenzel[3] for the ATLAS-Collaboration — [1]Bergische Universität Wuppertal — [2]Deutsches Elektronen-Synchrotron DESY — [3]Justus-Liebig-Universität Gießen

ALFA (Absolute Luminosity for ATLAS) is a Roman Pot (RP) detector system in the LHC tunnel, located around 240 m away from the Interaction Point (IP) downstream in the forward region of ATLAS. The ALFA subdetector contains several layers of scintillating fibers for tracking elastically scattered protons in the outgoing beams. The RPs are used as a housing for the fiber trackers and can be moved in small steps close to the beam to ensure proton tracking at small scattering angles. In 2018, 12 runs were recorded at a center-of-mass energy of $\sqrt{s} = 900\,\mathrm{GeV}$ during several fills using special LHC beam optics with $\beta^\star = 100/50\,\mathrm{m}$ parallel-to-point focusing.

This combination makes it possible to probe various important physics parameters of pp interactions in the Coulomb-nuclear interference region, providing a unique evaluation of the underlying model predictions within the non-perturbative QCD regime. A fit describing the physics models to the elastic cross-section distribution, which is obtained from the calculation of the four-vector momentum transfer, allows the extraction of the nuclear slope parameter B, the total cross-section σ, and the ϱ-parameter, defined as $\varrho = \Re[f(0)]/\Im[f(0)]$. This talk covers the current status of the ongoing analysis and future steps.

T 28.4 Tue 17:45 HSZ/0101

Physics potential of a combined data-taking of the LHCf and ATLAS roman pot detectors — •Yusuf Can Cekmecelioglu[1], Clara Elisabeth Leitgeb[1], and Cigdem Issever[2] — [1]DESY, Zeuthen, Germany — [2]Humboldt University, Berlin, Germany

The study determines a common geometrical acceptance for the LHCf and ATLAS roman pot (ARP) detectors located in the forward regions of the ATLAS interaction point. In order to better understand the soft QCD processes and to improve pileup modelling for hadron accelerators and cosmic ray air shower modelling, a simultaneous analysis of central tracks (ATLAS), forward proton (ARP) and neutral particles (LHCf) could be beneficial. Analyses of single diffraction processes especially take advantage of these kind of setup, since the final state intact proton can be detected using ARPs and the neutral particles from the dissociated proton can be detected using LHCf and ATLAS Zero Degree Calorimeter (ZDC). Delta baryons produced in a pomeron exchange can lead to a similar signature with one neutral pion and one proton in the final state. This process, which effectively represents very low mass diffraction, is also taken into account in these studies.

In the end, a good common geometrical acceptance is found, yielding an acceptable event rate with the proposed joint data-taking between the detectors. Based on these studies, the ATLAS Forward Proton detector (AFP) joined the special run for LHCf in 2022, which results the very first combined data of LHCf, ZDC, ATLAS and AFP so far, with a recorded data of about 300 millions events.

T 28.5 Tue 18:00 HSZ/0101

Prospect studies for Proton-Oxygen Collisions at ATLAS, LHCf and AFP — Yusuf Can Çekmecelioğlu[2], •Erik Dieckow[1], Cigdem Issever[1,2], and Clara Elisabeth Leitgeb[2] — [1]Humboldt Universität zu Berlin, Germany — [2]DESY, Zeuthen, Germany

In astroparticle physics, ground based analysis is done by studying cosmic ray induced showers in the Earth's atmosphere. The phenomenological models used to simulate the interaction of cosmic ray particles with the atmospheric nuclei cause large systematic uncertainties and thus need improvement. In the past, LHC has conducted proton-proton and proton-heavy nucleus (lead) collisions. In LHC run 3 there will be the opportunity to study proton-Oxygen collisions. The cross-sections and particle energy spectra in the forward regions that will be measured with this data can provide invaluable and complementary input to the aforementioned models. The main focus of these studies is on the feasibility of a combined data taking of LHCf, ATLAS and AFP detectors during the proton-Oxygen collision run. This would allow for a better reconstruction of the event kinematics, as well as a purer selection of low mass single diffraction events than would be possible with LHCf data only.

T 28.6 Tue 18:15 HSZ/0101

Measurement of Fragmentation Cross Sections of Intermediate-Mass Nuclei with NA61/SHINE at CERN — •Neeraj Amin for the NA61/SHINE-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

Cosmic-ray propagation in the galaxy can be constrained by modeling the secondary-to-primary cosmic-ray flux ratios, like the boron-to-carbon flux ratio that reaches Earth. While these fluxes are currently measured with higher precision($<5\%$) by space-based detectors like AMS, CALET, and DAMPE, insufficient knowledge of nuclear fragmentation cross sections hinders our inference of propagation parameters. Therefore, laboratory measurements of fragmentation cross section above 10 A GeV/c are essential. We remediate this situation by utilizing the NA61/SHINE experimental facility at CERN.

Pilot data on fragmentation was taken in 2018 with the main aim of probing the feasibility of performing fragmentation studies at SPS energies. Two fixed targets, polyethylene(C_2H_4) and graphite were employed to study C+p interactions at 13.5 A GeV/c beam momentum. In this contribution, we will present the isotopic production of boron including direct production of ^{10}B & ^{11}B as well as via indirect channels originating from the decay of ^{10}C and ^{11}C fragments. We also report on the feasibility of measuring light and intermediate-mass nuclei from Li to F relevant for cosmic ray propagation studies. A dedicated high statistics data-taking is scheduled in late 2023 to study the fragmentation of various primary nuclei like C, N, O & Si.