Sar WorS 2023 - 3rd Sardinian Workshop on Spin

Report of Contributions

Contribution ID: **2** Type: **not specified**

Welcome

Contribution ID: **3** Type: **not specified**

Next-to-leading power TMD factorization

Monday, 5 June 2023 12:20 (30 minutes)

In this talk I will present the results for the next-to-leading power TMD factorization of different observables. I will focus the attention on the SIDIS and Drell-Yan processes, summarizing the essential steps in the factorization theorem. Particular attention will be posed to the rapidity divergences, for which I will discuss the emergence and cancellation of a non-standard type of rapidity divergences.

Primary author: RODINI, Simone

Presenter: RODINI, Simone

Contribution ID: **4** Type: **not specified**

The revised TMD shape function in SIDIS

Wednesday, 7 June 2023 14:15 (30 minutes)

Quarkonia are very important tools to probe gluon transverse momentum dependent (TMD) distributions at lower energies as compared, for instance, to Higgs production. Among them, the □/□ meson is one of the most studied, since it frequently decays into lepton pairs, making its detection easier with respect to other quarkonia. Thus, describing observables that involve □/□ production within a proper theoretical formalism is highly valuable.
Adopting the non-relativistic QCD approach, the proper evaluation of these observables at low transverse momentum is achieved by combining the TMD distribution(s) for the initial state(s) and the TMD shape function for the final state. The latter is a generalisation of the quarkonium long-distance matrix elements, which includes smearing effects.
In this talk, I will discuss the derivation of the TMD shape functions for semi-inclusive deep-inelastic scattering. I will then propose a new TMD factorized formula and a procedure to extract these new universal functions, taking into account their evolution with respect to the factorisation scale. The phenomenological studies presented in this talk could be performed at the future Electron-Ion Collider.

Primary author: MAXIA, Luca (University of Groningen)

Presenter: MAXIA, Luca (University of Groningen)

Contribution ID: **5** Type: **not specified**

Polarised physics at LHC: the LHCspin project

Monday, 5 June 2023 11:40 (40 minutes)

The goal of LHCspin is to develop innovative solutions and cutting-edge technologies to access the field of spin physics over the next few years by exploring a unique kinematic regime and exploiting new reaction processes.
To this end, a polarized gaseous target, operated in combination with high-energy, high-intensity LHC beams and the highly performing LHCb particle detector, has the potential to open new physics frontiers and deepen our understanding of the intricacies of the strong interaction in the non-perturbative regime of QCD.
This configuration, with center of mass energies up to 115 GeV, using both proton and heavy-ion beams, covers a wide backward rapidity region, including the poorly explored high Bjorken-x and high Feynman-x regimes. This ambitious task is based on the recent installation of an unpolarized gas target (SMOG2) in the LHCb spectrometer, making it not only a unique project, but also providing an invaluable playground for its polarized upgrade. Here, an overview of the physics potential, a description of the LHCspin experimental setup, and the first output of the SMOG2 system are presented.

Primary author: DI NEZZA, Pasquale (Istituto Nazionale di Fisica Nucleare)

Presenter: DI NEZZA, Pasquale (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **6** Type: **not specified**

TMDs and COMPASS Drell–Yan program

Tuesday, 6 June 2023 14:55 (30 minutes)

Pion TMDs are not as well defined as their proton counterparts, due to a
smaller amount of data collected from high energy scattering processes involving pions.
The recent measurements of unpolarized DY cross section taken at COMPASS with different targets could improve the current understanding of pion structures.
We have been investigating, together with the Pavia group and some members of the COMPASS collaboration, how these recent measurements
affect the extraction of pion TMDs for different targets, energies and kinematic ranges.

Primary author: DELCARRO, Filippo (Istituto Nazionale di Fisica Nucleare)

Presenter: DELCARRO, Filippo (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **7** Type: **not specified**

Towards collinear helicity parton distribution functions at next-to-next-to-leading order accuracy

Wednesday, 7 June 2023 09:40 (40 minutes)

I present a preliminary determination of the collinear helicity parton distribution functions (PDFs) of the proton. The determination is performed from a set of inclusive and semi-inclusive deep-inelastic scattering data, it includes next-to-next-to-leading order QCD corrections to both processes for the first time, and it is carried out in a framework that combines a neural-network parametrisation of PDFs with a Monte Carlo representation of their uncertainties. I discuss the quality of the determination, in particular its dependence on higher order corrections and on various theoretical assumptions, such as positivity of cross sections and constraints from weak baryon decays. The generalisation power of the determination, specifically of the sea quark PDFs, is confronted to polarised collider Drell-Yan data.

Primary author: NOCERA, Emanuele Roberto (Università di Torino and INFN Torino)

Presenter: NOCERA, Emanuele Roberto (Università di Torino and INFN Torino)

Contribution ID: **8** Type: **not specified**

TMD fit at N4LL

Wednesday, 7 June 2023 11:20 (40 minutes)

In this talk I will report the recent extraction of TMD from data using the perturbative information up to N4LL. I will discuss extraction methods and error analysis.

Primary author: SCIMEMI, Ignazio (Universidad Complutense Madrid)

Presenter: SCIMEMI, Ignazio (Universidad Complutense Madrid)

Contribution ID: **9** Type: **not specified**

TMDs global fits by the MAP Collaboration

Wednesday, 7 June 2023 10:20 (30 minutes)

In this talk I will present the latest results and updates of the MAP Collaboration about the Transverse Momentum Dependent (TMD) distributions. We discuss the extraction of unpolarized quark TMD Parton Distribution Functions (TMD PDFs) and Fragmentation Functions (TMD FFs) from global fits of Drell-Yan and Semi-Inclusive Deep-Inelastic Scattering (SIDIS) data sets.

Primary author: ROSSI, Lorenzo (Istituto Nazionale di Fisica Nucleare)

Presenter: ROSSI, Lorenzo (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **10** Type: **not specified**

Theoretical perspectives on electromagnetic hadron physics

Monday, 5 June 2023 09:10 (40 minutes)

I will present an overview of recent advances in the nucleon-structure study with electromagnetic probes from the low- to the high-energy domain.
In particular, I will focus on the partonic structure of the nucleon and highlight the opportunities for future experiments in the physics of hadron tomography, nucleon spin and mass decomposition.

Primary author: PASQUINI, Barbara (U. Pavia and INFN-Pavia)

Presenter: PASQUINI, Barbara (U. Pavia and INFN-Pavia)

Contribution ID: **11** Type: **not specified**

Looking for strong parity violation in the proton structure

Tuesday, 6 June 2023 12:30 (30 minutes)

We present a study of strong parity-violating contributions that can be included in inclusive Deep Inelastic Scattering (DIS) off an unpolarized proton target. We show that a non vanishing parity-violating structure function arise even in the case of pure photon exchange, in contrast with standard results.
The size of the additional strong parity-violating term is estimated by fitting available experimental data on electron and positron beam-spin asymmetries, obtaining an improvement in the agreement with respect to Standard Model results.

Primary authors: BACCHETTA, Alessandro (Istituto Nazionale di Fisica Nucleare); RADICI, Marco (Istituto Nazionale di Fisica Nucleare); CERUTTI, Matteo (Istituto Nazionale di Fisica Nucleare)

Presenter: CERUTTI, Matteo (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **12** Type: **not specified**

A light-front model for pion parton distribution functions

Monday, 5 June 2023 14:55 (30 minutes)

Using the light-front wave functions (LFWFs) overlap representation, we built a theoretical model for the pion state, that parametrizes different pion parton distribution functions. The model is constructed with two sets of parameters, that can be fitted separately by performing two independent fits: one for the collinear, and one for the transverse direction.
At present, we have been able to fit observables sensible to the pion collinear parton distribution function (PDF), and the existing experimental data of the pion electromagnetic form factor.
Moreover, there is some work in progress in the direction to compute the pion generalized parton distributions (GPDs) and to predict the values of certain observable seinsible to pion GPDs.
In future, we plan to fit also the experimental data sensible to the pion transverse momentum dependent parton distribution functons (TMDs).

Primary authors: PASQUINI, Barbara (Istituto Nazionale di Fisica Nucleare); RODINI, Simone (University of Regensburg); VENTURINI, Simone (Istituto Nazionale di Fisica Nucleare)

Presenter: VENTURINI, Simone (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **13** Type: **not specified**

”Phenomenological analysis of $e^+e^- \to hX$ data and extraction of TMD Fragmentation Functions from thrust dependent observables”

Tuesday, 6 June 2023 11:20 (40 minutes)

Accessing TMD Fragmentation Functions through the phenomenological analysis of SIDIS data requires a non-trivial disentangling from the TMD Parton Distribution Function, that appear as convolutions in the factorized cross section. Difficulties in this kind of analyses can partly be overcome by exploiting the thrust distribution of e^+e^- annihilation into one single hadron, for which we now have a well-established factorization theorem. In this talk, I present the first phenomenological extraction of the unpolarized pion TMD Fragmentation Function from $e^+e^- \to hX$ process. This analysis can successfully describe the p_T and z dependence of the cross section as well as its thrust dependence, providing the first phenomenological success in one of the most intriguing challenges of the past few years.

Primary authors: BOGLIONE, Mariaelena (Istituto Nazionale di Fisica Nucleare); SIMONELLI, Andrea (Istituto Nazionale di Fisica Nucleare)

Presenter: BOGLIONE, Mariaelena (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **14** Type: **not specified**

Theory of TMD factorization for thrust-dependent observables

Tuesday, 6 June 2023 10:20 (30 minutes)

The study of TMDs can be extended to thrust-dependent observables, provided the role of the soft gluon radiation is properly considered.
In particular, the thrust distribution of e^+e^- annihilations into one single hadron presents a rich kinematic structure, that leads to three different factorization theorems. Each of them is associated to a distinct physics framework of transverse momentum, with the central region of the phase space specifically related to a TMD Fragmentation Function. In this talk, I present the theoretical aspects of the factorization of this process in QCD, highlighting the subtle intertwining between thrust and rapidity and how this results in a novel factorized cross section, with no direct analogous in the processes usually exploited for TMDs related studies.

Primary author: SIMONELLI, Andrea

Co-author: BOGLIONE, Mariaelena (Istituto Nazionale di Fisica Nucleare)

Presenter: SIMONELLI, Andrea

Contribution ID: **15** Type: **not specified**

Transverse-momentum-dependent hadron-pair production in e^+e^- annihilation

Tuesday, 6 June 2023 09:40 (40 minutes)

The study of the transverse-momentum dependence of pairs of hadrons
produced in e^+e^- annihilation in opposite hemispheres
provides access to transverse-momentum-dependent fragmentation functions. At present, the study of pairs of charge-separated pions, kaons and protons as a function of their relative transverse momentum and their fractional energy using the Belle e^+e^- data is ongoing. The results of this ongoing analysis will be presented.

Primary author: VAN HULSE, Charlotte

Presenter: VAN HULSE, Charlotte

Contribution ID: **16** Type: **not specified**

TMD evolution study of the azimuthal asymmetry in unpolarized J/ψ production at EIC

Wednesday, 7 June 2023 14:45 (30 minutes)

J/ψ production at the future EIC has been proposed as a tool to probe gluon TMDs. Until recently, a common assumption was to decouple the J/ψ hadronization from other soft mechanisms, even at low transverse momentum. However, at leading order in the TMD factorized expression and within NRQCD, J/ψ is produced via a color-octet state. So, soft gluon emission to become a color-singlet state should be taken into account. In general, smearing effects are not incorporated in the NRQCD formalism and therefore the TMD shape function (TMDShF), that enters as a convolution with the TMD, has been proposed recently.

Employing evolution in which one can relate the (small) transverse momentum objects to their large transverse momentum equivalent, i.e. the TMDs to the well-known PDFs and the TMDShF to its tail, we can improve on previous studies of the azimuthal asymmetry observable that arises from the linear polarization of gluons inside unpolarized protons. Subsequently, these results can be compared with future experiments to set constrains on the TMDs.

In this presentation I explain shortly how to perform the evolution calculation for this azimuthal asymmetry with the inclusion of the TMDShF, employing the correct soft gluon radiation from both the TMDShF and the soft function. This talk follows (and improves) the discussion of Ref. [arxiv:2204.01527], where a naïve TMDShF was assumed.

Primary author: BOR, Jelle (University of Groningen (VSI) & Université Paris-Saclay (IJCLab))

Presenter: BOR, Jelle (University of Groningen (VSI) & Université Paris-Saclay (IJCLab))

Contribution ID: **17** Type: **not specified**

3D proton imaging via time-reversal odd TMD gluon distributions

Monday, 5 June 2023 14:15 (40 minutes)

We present exploratory analyses of the 3D proton tomography via polarized time-reversal odd gluon TMD PDFs at twist-2, obtained in a spectator-model framework. We embody in our approach a flexible parameterization for the spectator-mass spectral function, suited to catch both small- and moderate-x effects. All these studies are relevant to unveil the gluon dynamics inside hadrons, which represents a core research line of studies at new-generation colliding machines.

Primary authors: BACCHETTA, Alessandro (Istituto Nazionale di Fisica Nucleare); Dr CELIBERTO, Francesco Giovanni (UAH Madrid); RADICI, Marco (Istituto Nazionale di Fisica Nucleare)

Presenter: Dr CELIBERTO, Francesco Giovanni (UAH Madrid)

Contribution ID: **18** Type: **not specified**

Transversely polarized Λ production in e^+e^- annihilation and SIDIS processes within a TMD approach

Tuesday, 6 June 2023 12:00 (30 minutes)

In this talk, we will present a recent re-analysis of Belle data for the transverse Λ and $\bar{\Lambda}$ polarization in e^+e^- annihilation processes within a TMD factorization approach and adopting the CSS framework.
We will also discuss the issue of isospin symmetry and the role of the charm quark contribution, with their impact on the description of the experimental data as well as on the extraction of the polarizing fragmentation function.
Estimates for the transverse Λ polarization in SIDIS processes, at typical energies of the future EIC, will be presented.

Primary author: ZACCHEDDU, Marco (University and INFN Cagliari)

Co-authors: MURGIA, Francesco (Istituto Nazionale di Fisica Nucleare); GAMBERG, Leonard (Penn State University); D'ALESIO, Umberto (Istituto Nazionale di Fisica Nucleare)

Presenter: ZACCHEDDU, Marco (University and INFN Cagliari)

Contribution ID: **19** Type: **not specified**

Transversity and tensor charge: role of the Soffer Bound

Wednesday, 7 June 2023 12:00 (30 minutes)

The transversity and the nucleon tensor charge are fundamental quantities in hadron physics as well as for our comprehension of the nucleon structure. Some tension between the values of the tensor charge, as computed on the basis of phenomenological extractions and lattice QCD simulations, has been observed.
By means of an explicit example, we present how relaxing some onstraints in phenomenological fits, related to the Soffer Bound, allows for a more accurate exploration of the parameter space and, eventually, to ease the tension between lattice and phenomenology for the nucleon tensor charge estimates.

Primary author: Dr FLORE, Carlo (Istituto Nazionale di Fisica Nucleare)

Co-authors: PROKUDIN, Alexey (JLAb); D'ALESIO, Umberto (Istituto Nazionale di Fisica Nucleare)

Presenter: Dr FLORE, Carlo (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **20** Type: **not specified**

Transverse SSA in inclusive eN collisions at the EIC

Wednesday, 7 June 2023 12:30 (40 minutes)

Some transverse single-nucleon spin asymmetries in inclusive reactions in electron-nucleon reactions are discussed within a collinear twist-3 approach. The focus will be in particular on the processes eN->gammaX and eN->piX, which may be accessible at the future Electron-Ion Collider. A report on recent, ongoing efforts to understand these observables is presented.

Primary author: SCHLEGEL, Marc (University of Tuebingen)

Presenter: SCHLEGEL, Marc (University of Tuebingen)

Contribution ID: **21** Type: **not specified**

Fragmentation functions at e+e- colliders

Tuesday, 6 June 2023 09:00 (40 minutes)

Fragmentation functions, describing the formation of hadrons from partons, are an indispensable tool in the interpretation of hadron-production data, e.g., in the investigation of nucleon structure via semi-inclusive deep-inelastic scattering. The cleanest process to access fragmentation functions is hadron production in electron-positron annihilation. However, little information can be derived on charge-separated fragmentation functions from single-inclusive hadron production. A better handle on the flavor contributions can be gotten by flavor correlations or tagging: the hadron type in one hemisphere puts constraints on the parton flavor in the other hemisphere and thus on the flavor decomposition of the hadronization process. This can be exploited in inclusive hadron-pair production in electron-positron annihilation. While two hadrons in the same hemispheres, e.g., originating from the same parton, open an avenue to an unusual class class of fragmentation functions, dihadron fragmentation functions, two hadrons in opposite hemispheres can be used for flavor, transverse-momentum, and polarization tagging of single-hadron fragmentation functions. I will review some of the activities on this subject, mainly by the BESIII and Belle collaborations.

Primary author: SCHNELL, Gunar (University of the Basque Country UPV/EHU)

Presenter: SCHNELL, Gunar (University of the Basque Country UPV/EHU)

Contribution ID: **22** Type: **not specified**

Assessing the perturbative accuracy of TMD distributions

Wednesday, 7 June 2023 09:00 (40 minutes)

In this talk I will present an accurate analysis of the theoretical accuracy of the resummation of large logarithms.
Focusing on double-logarithmic (or Sudakov) resummation relevant to the case of TMD factorisation in Drell-Yan production, I will single out the single sources of theoretical uncertainties.
Specifically, I will show how the introduction of the so-called resummation scale at the level of the running of the strong coupling is able to capture the theoretical uncertainty due to the resummation of large logarithms of the transverse momentum q_T embedded in the evolution of the TMD distributions.
In view of this analysis, I will make direct contact with the q_T-resummation formalism shedding light on the origin of the theoretical uncertainties considered in that context.
This will finally allow me to highlight limitations and advantages of the two approaches (TMD factorisation and q_T resummation) to the Sudakov resummation.
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Primary author: Dr BERTONE, Valerio

Presenter: Dr BERTONE, Valerio

Contribution ID: **26** Type: **not specified**

Drell-Yan Physics at COMPASS and AMBER

Tuesday, 6 June 2023 14:15 (40 minutes)

In 2015 and 2018 the COMPASS experiment at the M2 beamline of the CERN SPS performed measurements of the Drell-Yan process, using a 190 GeV/c negative pion beam impinging on aluminium and tungsten targets and on transversely polarized ammonia target. The goal was investigating the nucleon and the pion structure. AMBER, the newly approved fixed target facility, successor of COMPASS in the same EHN2 experimental hall, will continue this investigation, aiming at improving the knowledge of the mesons structure.
In this talk I will give an overview of the COMPASS results from the Drell-Yan and J/psi production channels and I will discuss the prospects of the future pion and kaon-induced Drell-Yan and J/Psi di-muon production measurements at AMBER.

Primary author: CHIOSSO, Michela (Istituto Nazionale di Fisica Nucleare)

Presenter: CHIOSSO, Michela (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **27** Type: **not specified**

Spin and TMD physics at the EIC

Monday, 5 June 2023 09:50 (40 minutes)

The Electron-Ion Collider (EIC) will be a powerful new high-luminosity facility in the United States with the capability to collide high-energy electron beams with high-energy proton and ion beams, providing access to those regions in the nucleon and nuclei where their structure is dominated by gluons. Electron and light ion beams will be polarized allowing unprecedented access to the spatial and spin structure of the proton, neutron.
I will shortly describe the present design of the machine, the developing detector of the ePIC collaboration, and address the expect reach for SIDIS spin physics, including TMDs.

Presenter: BRESSAN, Andrea (Istituto Nazionale di Fisica Nucleare)

Contribution ID: **28** Type: **not specified**

The TMD Physics Program at JLab

Monday, 5 June 2023 10:30 (40 minutes)

In the recent years, it has been realized that deep-inelastic scattering with polarization control could provide a variety of spin and azimuthal angle dependent observables sensitive to the quark-gluon interactions. New parton distributions and fragmentation functions have been introduced to describe the rich complexity of the hadron structure and move towards a multi-dimensional imaging of the underlying parton correlations. Besides the hard probe scale, these functions explicitly depend on the parton transverse degrees of freedom at the scale of confinement. Their study promises to open a unprecedented gateway to the peculiar nature of the strongly interacting force. This work presents a selection of available observations and upcoming measurements planned at Jefferson Lab to address the mysteries of the nucleon structure from a modern point of view.

Presenter: CONTALBRIGO, Marco