

From: Rolf Ent ent@jlab.org
Subject: Re: Re: [EXTERNAL] pion PDFs and QCD
Date: September 23, 2020 at 5:31 PM

RE

To: Hobbs, Timothy tjhobbs@mail.smu.edu, Wally Melnitchouk wmelnitc@jlab.org, Jorge Segovia jsegovia@upo.es, Arun Tadepalli arunts@jlab.org, Carlos Ayerbe Gayoso gayoso@jlab.org, Chueng Ji crji@ncsu.edu, Craig Roberts CDRoberts.INP@hotmail.com, Cynthia (Thia) Keppel keppel@jlab.org, Daniele Binosi binosi@ectstar.eu, David Richards dgr@jlab.org, Dmitry Romanov romanov@jlab.org, Douglas Higinbotham doug@jlab.org, Garth Huber huberg@uregina.ca, Huey-Wen Lin hwlin@pa.msu.edu, Ian L. Pegg ianp@vsl.cua.edu, Jianwei Qiu jqiu@jlab.org, Lei Chang leichang@nankai.edu.cn, Markus Diefenthaler mdiefent@jlab.org, Nobuo Sato Gonzalez nsato@jlab.org, Patrick Barry pbarry@ncsu.edu, Petr Stepanov stepanovps@gmail.com, rachel.montgomery@glasgow.ac.uk, Richard Trotta trotta@cua.edu, Rolf Ent ent@jlab.org, Stephen Kay ska864@uregina.ca, Tanja Horn hornt@cua.edu, Vladimir Berdnikov berdnik@jlab.org, Yoshida, Rik ryoshida@anl.gov, Yoshida, Rik ryoshida@anl.gov, Yulia Furletova yulia@jlab.org, tobias@ita.br, PETER tandy@kent.edu, Cloet, Ian C. icloet@anl.gov, Jeff Owens owens@hep.fsu.edu, Werner Vogelsang werner.vogelsang@uni-tuebingen.de, Alberto Accardi accardi@jlab.org, JArrington@lbl.gov, thobbs@jlab.org, thobbs2@iit.edu

(sorry for sending twice, JLab seems to have an outlook mail problem cutting off mailing lists, I need to change the defaults - this is with the full mailing list I think)

Dear all,

I am still a bit worried we talk "cross purposes". Let me explain from naive experimental view where my struggle is.

There is no question that in the exclusive limit, regardless of factorization, theorists can do calculations on the pion wave function and momentum distribution, in my view. That such things may not be direct experimental observables we all know, but in reality, neither is a form factor - those of us who have tried to constrain nuclear form factors near a minimum know this all too well. I read Jorge's message as such "in a nonperturbative calculation of a hadron wave function, issues of factorization, etc., do not arise." Later, others (Tobias, Peter) also came back to this with their views.

There is also no question that a pdf is not an observable, and that extraction comes from a cross section and requires factorization. Similarly, if one goes to large-x there are all kind of complications (edge of phase-space, high-order resummation, all taking extra care), as Jianwei and Ted point out. I take that. However, we have to worry a bit how much there is still "directly following from the QCD Lagrangian", as that Lagrangian definitely also has confinement as one of its main signatures.

So, we talk a bit (my experimental view) at cross purposes. One group definitely

can calculate
without worrying about factorization, another group needs it for pdf extraction from
the real
observable - the cross section. But in my naive view the real issue is that we do
have a
Drell-Yan-West relation for ages, or if one wishes one can call it an inclusive-
exclusive connection
or quark-hadron duality.

So the puzzle still remains, this leaves me very unsatisfactory, it is our job to
understand QCD
better and that has both sides, so how do we reconcile. Yes, I realize that this is
also an
ill-posed experimental question as it is like comparing an apple and an orange, but
we do
have two groups of people (three if also including the lattice) working on different
aspects
of QCD, and my personal read is that we have not really answered each other's
questions.
And even more, do we "toss" the D-Y-W relation/inclusive-exclusive
connection/QHD altogether?

I am sure my theory colleagues will set me straight, and apologies for the "poor
experimental
language" used that I am sure can be improved.

Best regards, Rolf

From: Hobbs, Timothy <tjhobbs@mail.smu.edu>
Sent: Wednesday, September 23, 2020 4:56 PM
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Cc: thobbs@jlab.org <thobbs@jlab.org>; thobbs2@iit.edu <thobbs2@iit.edu>

Subject: Re: [EXTERNAL] Re: pion PDFs and QCD

Dear Wally and all:

Many thanks for circulating these messages, which I hope will help us converge on some common ideas and language for pion structure in the EIC document. Many thanks, Jianwei and Ted, for your comments --- I believe they are very reasonable.

From the perspective of QCD global analyses, the aim is for minimal sets of assumptions in any given PDF fit, and much effort is spent trying to understand possible parametrization biases and associated uncertainties. While a limited set of theoretical assumptions are often imposed (e.g., the flavor-symmetry of high-energy QCD interactions --> PDF flavor ratios ~ 1 for the very low- x quark sea in the proton's unpolarized PDFs), the general preference is to have the data + rigorous pQCD theory/factorization teach us the hadron structure as much as possible.

From that spirit of agnosticism, I find it extremely challenging to accept that rigorous, first-principles QCD requires $\sim(1-x)^2$ (or any other polynomial) behavior for the high- x pion quark densities at the present time. This is not to denigrate anyone's QCD-inspired model/calculation(s) [after all, I have my own!]; such works are informative and have an important role to play in enlightening the physical interpretation of more first-principles lattice or other calculations (or also guiding parametric inputs in global fits). That being said, it is very important to straightforwardly disclaim things as to whether they are truly first-principles or not.

Bringing this discussion back to the EIC document itself, however, it seems to me that a judicious choice of language would go a great distance in resolving any differences of opinion here. For example, I imagine we are all in agreement that precise measurements of the pion structure function or related observables (to the extent they are feasible) at the EIC would be of strong interest. The goal of the eventual manuscript is to stress this strong motivation for taking sensitive data at the EIC, NOT to litigate all these theory issues for which there is already a vast literature. I could therefore imagine slight rewordings in the EIC document going a long way. For instance, if we simply make clear that the high- x behavior of the pion wave function has been the object of extensive interest/investigation in the context of models, PDF analyses, and, more recently, lattice calculations, I believe we will have already largely achieved the aim of motivating the meson structure portion of the EIC document.

Many thanks,
Tim

From: Wally Melnitchouk <wmelnitc@jlab.org>

Sent: Tuesday, September 22, 2020 8:34:01 PM

To: Jorge Segovia; Arun Tadepalli; Carlos Ayerbe Gayoso; Chueng Ji; Craig Roberts; Cynthia (Thia) Keppel; Daniele Binosi; David Richards; Dmitry Romanov; Douglas Higinbotham; Garth Huber; Hobbs, Timothy; Huey-Wen Lin; Ian L. Pegg; Jianwei Qiu; Lei Chang; Markus Dieffenthaler; Nobuo Sato; Gonzalez; Patrick Barry; Petr Stenovec;

Orang, Markus Diefenthaler, Nobuo Sato Gonzalez, Patrick Barry, Petr Stepanov, Rachel Montgomery; Richard Trotta; Rolf Ent; Stephen Kay; Tanja Horn; Vladimir Berdnikov; Yoshida, Rik; Yulia Furletova; tobias; TANDY, PETER; Ian Cloet; Jeff Owens; werner.vogelsang@uni-tuebingen.de; Alberto Accardi; JArrington@lbl.gov; giovanni.salme@roma1.infn.it

Subject: Fw: [EXTERNAL] Re: pion PDFs and QCD

Dear all,

I believe Jianwei's message did not go out to the full list, but only to the initial list, which did not have the additional people who joined the discussion subsequently. Here is the message again to the full list (with apologies if you receive this twice) -
- please forward to anyone else who may not be on the list.

Wally

From: Jianwei Qiu <jqiu@jlab.org>

Sent: Tuesday, September 22, 2020 6:18 PM

To: Jorge Segovia <jsegovia@upo.es>; Wally Melnitchouk <wmelnitc@jlab.org>; Reimer, Paul E. <reimer@anl.gov>

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Subject: Re: [EXTERNAL] Re: pion PDFs and QCD

Dear All,

I have been reading this very active discussion about the large- s behavior of pion PDF and how much do we really know from QCD. I found that the discussion is interesting and inspiring, although sometimes, it is confusing. Please find the attached one-page note (so that I can put in an question or so), in which I would like to share with you some of my thoughts on what we are discussing.

Best,

Jianwei

From: Reimer, Paul E. <reimer@anl.gov>

Sent: Tuesday, September 22, 2020 9:41 AM

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Subject: Re: [EXTERNAL] Re: pion PDFs and QCD

Hello,

Here I must agree with Wally, if we are to state something as a fact, it must be proven as a fact. I believe that Wally's question where the original proof of this conjecture is, or is it a conjecture that has been repeated often enough that it is now considered to be fact? In science, if there is a proof of this conjecture, it should be easily found.

Paul

On 9/22/20 01:06, Jorge Segovia wrote:

Hello Wally,

I disagree with you, Wally. The innocent are not required to prove they are not guilty. The onus is on you to identify concrete flaws in the existing proofs and illustrative calculations, especially as we just had the open and inclusive "Pion and Kaon structure functions at the EIC" CFNS workshop explicitly discussing these issues with interested QCD experts. So far, you have only expressed your own doubts. It would be great if you were to attempt to reproduce one of the calculations and display the results for us.

At a scale for which factorization is valid, hadron structure is encoded in a nonperturbative manner. In a nonperturbative calculation of a hadron wave function, issues of factorization, etc., do not arise. One can ask about the truncations and approximations used. There we have many experts who can explain their origin and reliability. This is why we say that QCD predicts the pion valence quark pdf at large-x.

Best regards,
Jorge.

Jorge Segovia

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