University of
TEHRAN

Collaboration with PANDA-EMP

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&
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Titles

- Our PANDA-Turkey Group
- My Group at University of Tehran
- Suggestions on Electromagnetic Form Factors
- Suggestions on Structure Functions & GDPs

Kazem Azizi

Phenomenology of hadrons using QCD sum rules

- Particle Phenomenology; Formation and Structure of the Standard Hadrons and Exotics
- Electromagnetic Interactions/decays of hadrons including EM form factors
- Weak and strong decays of hadrons
- Hadronic properties at finite temperature and density

Collaboration with PANDA and ALICE

- Our PANDA-Turkey Group

Charmonium/Exotics Group

Doing analyses on the tetraquarks:
$Z_c(3900)$, $Z(4430)$ & $Z_{cs}(3985)$

- PANDA-Turkey group +
- My Group @ University of Tehran

May have contribution to EMP

- **Muhammad Goharipour** (Postdoc, Parton Distribution Functions (PDFs), Nuclear PDFs, Diffractive PDFs, Generalized parton distributions (GPDs), Fragmentaion Functions (FFs), Strange quark asymmetry in the proton, prompt photon production in hadronic collisions, Intrinsic quarks)
- **Saeedeh Rostami** (Postdoc, Parton Distribution Functions (PDFs), Hadron Phenomenology, EM FFs)
- **Alireza Olamaei** (Postdoc, Hadron Phenomenology, EM FFS + Good Knowledge of Computer Programming)

+ ????

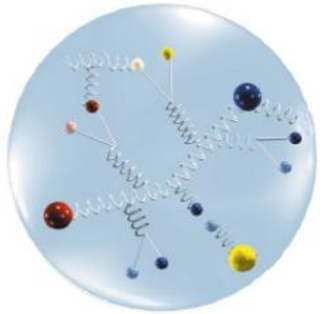
- 4 People (A Prof., A postdoc + 2 PhD Students) all working on PDFs, GPDFs and UPDFs

https://panda.gsi.de

Nucleon structure

Generalized Parton Distributions

The theoretical framework of Generalized Parton Distributions (GPDs) has recently been developed and caused excitement in the field of understanding the structure of the nucleon. It has recently been shown that exclusive pp annihilation into two photons at large s and t can be described in terms of GPDs. Estimates of the expected count rates based on a simple model predict a few thousand $\gamma\gamma$ events per month for a luminosity of $2 \cdot 10^{32}\ cm^{-2}s^{-1}$ at an energy of $\sqrt{s} = 3.2 GeV/c^2$.

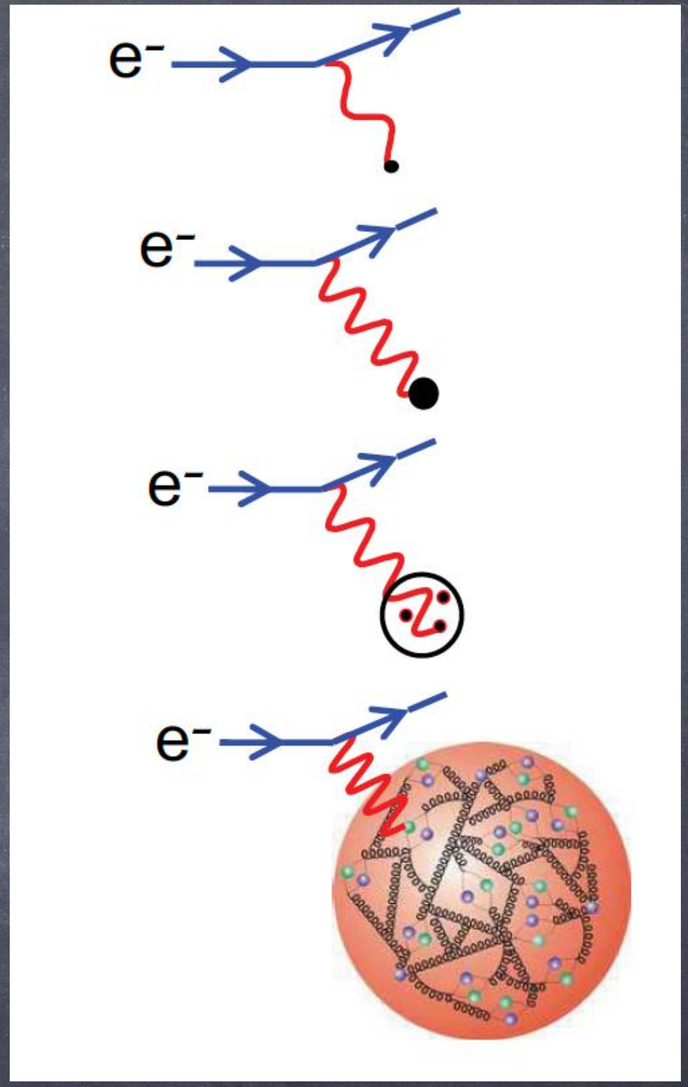


Other estimates, based on cross section measurements of the inverse process $\gamma\gamma \rightarrow pp$, predict count rates up to a factor 50 above the later estimate of but still are consistent with the handbag ansatz.

It is proposed to measure the crossed-channel Compton scattering and the related exclusive annihilation processes with a scalar meson, a vector meson, or a lepton pair in the final state. The comparison of the differential cross sections for the various processes and the comparison with GPD based models will allow new insights into the annihilation process in terms of quark models and QCD.

Time-like Form Factor of the Proton

The electromagnetic form factor of the proton in the time-like region can be extracted from the cross sections for the process $pp \rightarrow e^+ e^-$. The proton time-like form factors have been measured by several experiments in the low Q^2 region down to threshold. At high Q^2 the only measurements have been achieved by E760 and E835 at Fermilab up to Q^2 of $15 GeV^2/c^2$. However, due to limited statistics $|G_M|$ and $|G_E|$ have not been measured separately and could only be extracted using the assumption $|G_E| = |G_M|$. In PANDA, it will be possible to determine the form factors over the widest Q^2 range with a single experiment, from threshold to 20 GeV^2/c^4 and above, depending on the beam time availability. Due to much improved statistics and angular coverage it will be possible to significantly improve the results of E760 and E835 and to measure $|G_M|$ and $|G_E|$ separately.

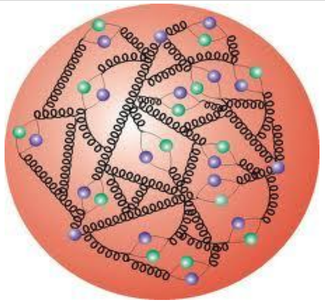


PANDA Phase 1: Paper

EMFs:

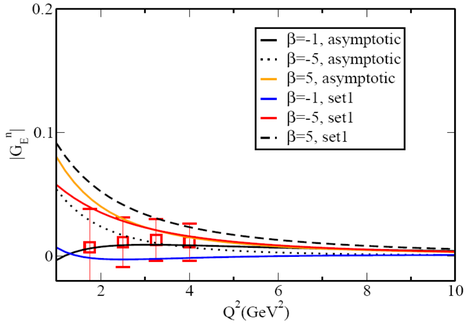
✓Electromagnetic interactions

N→N+photon



$$\langle N(p') \mid J^{el}_{\lambda}(0) \mid N(p)\rangle$$
$$= \bar{N}(p')\left[\gamma_{\lambda}F_1(Q^2) - \frac{i}{2m_N}\sigma_{\lambda\nu}q^{\nu}F_2(Q^2)\right]N(p),$$

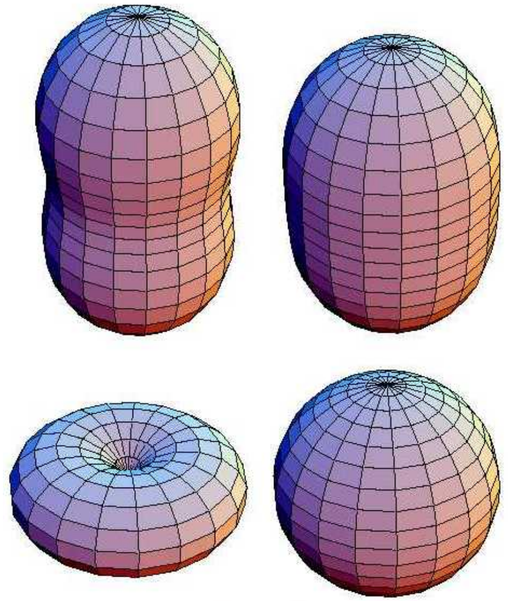
$$G_M(Q^2) = F_1(Q^2) + F_2(Q^2),$$
$$G_E(Q^2) = F_1(Q^2) - \frac{Q^2}{4m_N^2}F_2(Q^2),$$



Data from JLAB

However, there are many questions to be answered:

The shape of a proton depends on the speed of the quarks inside. Of the four shapes shown here, the spherical shape (lower right) is the shape most physicists expected to find. The peanut shape (top left) is produced by quarks traveling nearly at light speed and spinning the same direction as the proton. (Gerald A. Miller, University of Washington)



What are the exact shapes of p and n?
What are their exact radius?
How are their internal charge distributions?
Why proton is stable? While free neutron decays after 14 min?
Are their any strange and charmed components inside the nucleons?
and …….

Jefferson Lab

Suggestions on Electromagnetic Form Factors

- We can contribute to all the ongoing analyses on the time-like EMFFs of nucleons stated in Phase One Paper
- We may extend the analyses to the excited nucleons like the Negative parity N(1535)
- We may extend the analyses to hyperons and other light even charmed baryons to study their EMFFs in the time-like region

Suggestions on Structure Functions

- In the time-like region, we can calculate the generalised distribution amplitudes (GDAs) and transition distribution amplitudes (TDAs) the pseudo-data then with real data.
- ????????????
- Determination of the generalized parton distributions (GPDs) by analyzing the pseudo or real data of the antiproton-proton annihilation into two photons: By generating pseudo data of the antiproton-proton annihilation process related to the PANDA kinematics and performing a chi^2 analysis, one can study the imp of PANDA measurements on GPDs. Actually, it will be of interest to see how these data change the shape and uncertainty of GPDs. With real measurements in it will also be possible to perform, for the first time, a global analysis of GPDs including the PANDA data.
- Determination of the transverse-momentum-dependent distribution functions (TMDs) by analyzing the pseudo or real data of the Drell-Yan pair production re to the PANDA kinematics.
- Constraining GPDs by performing a chi^2 analysis of the measurements of the electromagnetic form factors (EMFFs) in addition to the axial form factor (AFF and wide-angle Compton (WACS) scattering data.

Thank You