Graduate School of Science and Technology
Physics and Mathematical Sciences

Quark distributions in hadrons and fragmentation functions

Explore the internal structure of hadrons and nuclei

Topics: Quarks, Hadrons, Nuclei

Principal investigator: Prof. Wolfgang Bentz (1)
Collaborator: Prof. Anthony W. Thomas (Univ. of Adelaide) (2)
Collaborator: Dr. Ian C. Cloet (Argonne National Laboratory) (2)

①

②

Background and Motivation

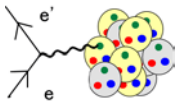
Protons and neutrons, the building blocks of nuclei, are hadrons and consist of quarks. Recent high energy accelerator experiments gave precise data on "quark distribution functions", which reflect the internal quark structure of hadrons and nuclei, and are exploring "quark fragmentation functions", which reflect the hadron production mechanisms. The aim of the present investigation is to analyze those data theoretically, and to predict new data which will be measured in future experiments.

Originality

The originality of the present investigation is that we can describe the structure of nucleons in terms of quarks, and the structure of nuclei in terms of nucleons in the same framework. Because the nucleons inside the nucleus interact with each other, their internal structure is different from the free nucleon. This "medium effect" has been highlighted in recent accelerator experiments, and we perform the theoretical analyses of those data and predict new observables.

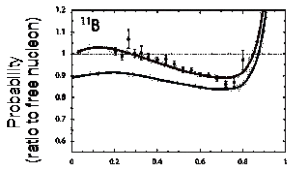
Impact and Perspective

The ultimate goal of our research is to understand the behavior of quarks in the nuclear medium, in particular their propagation and interactions. Our research has major impact on the following two subjects: (i) At the planned accelerator "Electron-Ion Collider (EIC)", the in-medium quark fragmentation functions will be measured, and we are able to make theoretical predictions. (ii) We are able to investigate whether in high density matter, like in the center of neutron stars, "quark matter" can exist as a stable phase, and whether very compact objects like "quark stars" exist in the universe.



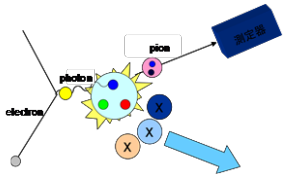
In electron scattering experiments, one can explore the momenta and spins of quarks in hadrons and nuclei.

Results for distribution functions



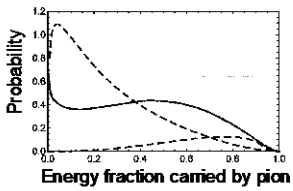
Red line . . . Decrease of quark momentum inside the nucleus (comparison between theory and experiment)

Blue line . . . Decrease of quark spin inside the nucleus (theoretical prediction)



Quark fragmentation in electron-nucleon scattering. In the experiment, the momentum distributions of produced pions are measured.

Results for fragmentation functions



Black dashed line :Only 1 pion produced (calculation)
Red Solid line : Many pions are produced (calculation)
Blue dashed line : Experimental data

Research papers from our group:

Dihadron fragmentation functions within the Nambu-Jona-Lasinio jet model. H.H. Matevosyan, A.W. Thomas, W. Bentz, Physical Review D 88, p. 094022 (2013).

Transverse momentum dependent fragmentation and quark distribution functions from NJL-jet model. H.H. Matevosyan, W. Bentz, I.C. Cloet, A.W. Thomas, Physical Review D 85, p. 014021 (2012).

◆Link : http://www.sp.u-tokai.ac.jp/~bentz/homepage.html ◆Contact e-mail : bentz@keyaki.cc.u-tokai.ac.jp

TOKAI UNIVERSITY