第十六届全国中高能核物理大会

Wednesday, August 19, 2015 - Sunday, August 23, 2015

西南大学物理科学与技术学院

Book of Abstracts

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The problems in nucleon structure study

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The energy-momentum(EM) tensor T^{μν} derived from the Lagrangian of an interacting gauge field through Noether theorem is gauge dependent and asymmetric. Due to the Einstein equation of general relativity is symmetric in the metric side one usually adds a surface term to obtain gauge invariant and symmetric EM tensor as the dynamical gravity source. The gauge invariant requirement of the decomposition of the momentum and angular momentum operators of a gauge field system into contributions due to Fermion and boson fields promoted the use of the gauge invariant and symmetric EM tensor. For the symmetric EM tensor, the momentum density flow T^{0i} and the energy density flow T^{i0} equal each other. I will show that the polarized photon diffraction pattern and the idea polarized electron beam spin and magnetic momentum density measurements disproved the identity of the momentum density flow and the energy density flow, the asymmetric EM tensor must be used in order to understand the above two measurements.
The present study of nucleon spin structure and parton momentum distribution uses the momentum and orbital angular momentum (OAM) operators derived from the symmetric EM tensor which are not the right one as what has been used since the establishment of quantum mechanics. They do not satisfy the canonical momentum and angular momentum commutation relations and so can not be used to describe the 3-dimentional parton momentum distribution and the OAM. I will show a set of momentum and angular momentum operators of quark and gluon spin and OAM can be obtained which are both gauge invariant and obey the canonical momentum and angular momentum commutation relations[3]. The debates on this topic in the last few years will be reviewed and the Lorentz transformation property of gauge potential and various gauge invariant extensions will be discussed.
The physical meaning of the present measured parton distributions will be discussed too. In the free parton model the unpolarized quark parton distribution is the quark canonical momentum distribution. However after including the quark-gluon interaction to obtain the gauge invariant parton distribution, the gluon contribution is inevitably entangled into the parton momentum distribution. I will show it is still the canonical but not the kinematic one.
The QCD evolution equation is derived from the perturbative QCD. All of the parton distributions obtained from the deep inelastic scatterings are more or less relied on the evolution equation. So these measured parton distributions are a mixing of nonperturbative and perturbative ones. How do these parton distributions related to the intrinsic non-perturbative ones of the nucleon internal structure seems to be an open question. The measured \Gamma_1(Q^2)
shows dramatic change from the perturbative high Q^2 region to the nonperturbative low Q^2 region. I will try an explanation.

[1] X.S. Chen, arXiv:1211.2360[gr-qc].
[2] X.B. Chen and X.S. Chen, arXiv:1211.4407[physics.class-ph].