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Study of Short-Range Properties of Nuclear Matter in Electron-Nucleus and Photon-Nucleus Interactions with Backward Particle Production Using the CLAS Detector

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Due to the strong nucleon-nucleon interaction and the small internucleon distances in nuclei, the short-range behavior of nuclear matter should be manifested, in general, in Short-Range Correlations (SRC) of (few) nucleons[1] . Three types of SRC can be realized in nuclei: Nucleon-Nucleon Short Range Correlations (NNSRC) in which correlated nucleons saves its (nucleonic) individuality; Barionic Short-Range Correlations (BSRC) in which at least one of the correlated nucleons is modified to the exited state, e.g., in Δ- state, and Multiquark Configurations (MQC) in which correlated nucleons re significantly overlapped and result in multiquark bags. One of the most important problems of modern high energy nuclear physics is the determination of these small components of the wave function of the nucleus and the study of their nature.

This proposal plans to study the first two types of SRC, using the CEBAF CLAS detector. As multiquark Configurations, they require higher values of energy and momentum transfers which may be realized after a CEBAF energy upgrading.

NNSRC will be investigated in the $(e,e'2N)$ reaction on Deuterium, Helium and Carbon targets. This reaction is kinematically complete for the study of two nucleon SRCs, which have a dominating role in the high momentum part of nuclear wave function[2] . One of the secondary nucleons (spectator one) with momentum ≥ 0.4 GeV will be detected in kinematically forbidden region which is good signature for selection of the SRC and provide the effective suppression of intensive background from the interactions with low momentum nucleons. The theoretical calculations[1] based on quasi-deuteron approach of NNSRC indicate that this process allows one to obtain the probability and main characteristics of NNSRC (e.g. momentum distributions of both NNSRC itself and of the nucleons in NNSRC). Moreover, it can be shown[3] that from these measurements unique information on the modification of the characteristics of deeply bound nucleons can be extracted.

Barionic Short Range correlations are planned to be investigated in the $(e,e'\Delta)$ reaction using the same targets. For selection of the preexisting Δ's, they will be detected as a spectator in the kinematically forbidden region for free stationary nucleon-target. Theoretical calculations[1] and some experimental data show that Δ state contribution in the nuclear wave function is at the one percent level which is measurable with the CLAS detector. The main problem here is the contribution from the FSI, for suppression of which the high momentum transfer (≈ 1 $(GeV/c)^2$) and light nuclei should be used.

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[1] L.L. Frankfurt and M.I. Strikman, Phys. Rev. 76, 215 (1981): 160,235 (1988).
[2] C. Ciofi degli atti, et al., Phys. Rev. C41, R2474 (1990).
[3] K.Egiyan, M.Sargasyan, CEBAF Preprint PR-93-001.

References:

1. L.L. Frankfurt and M.I.Strikman, Phys. Rep. 76, 215 (1981): 160, 235 (1988).
2. C.Ciofi degli Atti, et al, Phys. Rev. C 41, R2474 (1990).
3. K. Egiyan, M.Sargsyan, CEBAF Preprint PR-93-001.