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Reference letter on the BMN project Short range correlations

The proposed experiment represents a natural next step in the several decades long studies of the nucleonic structure of the short-range correlations (SRCs) using high energy probes.

First, inclusive experiments were performed in Dubna, ITEP, YPI (Yerevan). They studied fast backward (cumulative) nucleons for a wide range of nuclei. An approximate A-independence of the shape of the spectra and its weak dependence on a projectile (proton, pion, photon) were established. It was pointed out in the theoretical studies of these phenomena that the large fraction of the yield can be explained as due to interactions of the projectile with two nucleon SRCs.

Secondly inclusive (e,e) experiments at $x > 1$ at large Q^2 were performed. Theoretical analysis of these data confirmed the expectation of the universality of the SRCs and measured their A-dependence which was found to be similar to the one extracted from the backward nucleon production. Next, correlation experiments with proton and electron beams (BNL and Jlab) were performed which directly observed the decay of NN correlations after one of the nucleons of the SRC was removed from correlation using a high momentum transfer probe. Also these experiments established dominance of pn SRC correlations. Consistency of the results obtained using different beams and at different momentum transfers - proton beams at t= 5 GeV^{2}2 and electron beams at $Q^2 = 2\text{GeV}^2$ provided an important confirmation of the correct overall understanding of the mechanism of the reactions. The data also provided pretty strong upper limit on the admixture of the non-nucleonic degrees of freedom in nuclei.

The proposed experiment would allow to start moving investigations of SRCs in direction of higher precision and much more detailed information about the final state:

• A comparison of the rates of the $A(p, ppn)$ and $A(p, ppp)$ reactions would allow to perform a precision measurements of the difference of the momentum dependence of the pn and pp correlations, determining isospin structure of the the NN SRCs.

• The use of the inverse kinematics would allow to measure directly in what fraction of the events a removal of a fast nucleon is not associated with emission of a balancing nucleon and do it with a number of cross checks. This may pave the way to the observation of the triple

SRC (existence of such correlations is strongly indicated by the data on the fast backward nucleon production). It would also allow to put an upper limit (observe) on the presence of the non-nucleonic degrees of freedom in NN SRCs, for example Δ-isobars. Remember here that there are strong indications that SRC give the dominant contribution to the EMC effect which provides unambiguous evidence for existence of nonnucleonic degrees of freedom in nuclei.

• The proposed experiment would measure for the first time a (nearly) complete final state in the processes in which a projectile proton scatters off the pn or pp SRC pair. A relative proportion of the residual ground state (^{10}B in the case of pn pair removal) and continuum residual states (e.g. $^4He + {}^4He + pn$) would allow to study interplay between the mean field (shell model) and SRC components of the carbon wave function. For a quantitative description of this reaction it would be necessary to account for multiple rescattering effects for the incoming proton and the outgoing fast nucleons, and use realistic nuclear wave functions to calculate overlapping integrals. Such a theoretical study appears difficult yet doable.

In summary, the proposed experiment is highly innovative as it uses for the first time advantages of the inverse kinematics to perform comparative studies of pp and pn SRCs in several channels. It would allow for the first time to obtain information about the residual spectator system. I most strongly recommend the approval of the proposal.

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