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Hall C experiment E03-103 was designed for a precision measurement of the EMC effect in light nuclei, where reliable calculations can be performed. Yet still some “by-products” of theoretical calculations, i.e. nucleon swelling or pion enhancement, are in contradiction with other experimental results. JLab, SLAC and HERA, there is not a clear consensus. It has been broadly accepted that nuclear binding and Fermi motion should be included in any realistic models. The behavior of the nucleon in-medium has been one of the challenges of theoretical nuclear physics. Even after years of study, including additional measurements at CERN, distributions of its nucleons. This raised the logical question on the possible modification of nucleon structure in the nuclear medium. Describing the behavior of partons from 2-2 scattering into final state hadrons. The particle composition in heavy ion collisions should then be similar to p+p collisions, in contrast to the observed increased fraction of baryons in heavy ion collisions. However, there is evidence that an alternate method of hadron production, from color transparent higher-twist QCD processes where the final state hadron is produced directly in the hard subprocess, is important over a wide momentum range. The color transparent hadrons traverse the hot nuclear matter without interacting with it, in contrast to colored partons. Pions, which are abundantly produced in fragmentation, are observed to be suppressed in heavy ion collisions because the parent partons interact with the matter and lose some of their energy. Thus, the matter produced in heavy ion collisions could act as a filter, enhancing the fraction of observed hadrons which were produced in higher-twist subprocesses. Baryon and anti-baryon production, heavily suppressed in fragmentation, is naturally enhanced by this mechanism. We discuss the evidence for this from RHIC data including $x_F$ scaling of particle yields and correlations, and discuss how measurements in the near future can help understand the role of higher-twist effects in heavy ion collisions and also provide insight into hadron production in p+p collisions.

Forward particle production in d+Au collisions, AKIO OGAWA, Brookhaven National Laboratory — Parton distribution functions have been determined by perturbative QCD (pQCD) fits to experimental data. Due to QCD bremsstrahlung, gluon density quickly rises and dominate as the momentum fraction of partons bound within a nucleon (Bjorken $x$) becomes small. However, gluon density cannot grow forever and it is expected to saturate when the density is high enough that recombination effects can no longer be ignored. In pQCD picture, forward particle production at a hadron collider probes asymmetric parton collisions of high-$x$ quark and low-$x$ gluon. During FY08, RHIC had d+Au collisions, in addition to p+p collisions. The expectation that gluon saturation occurs at larger $x$ in a heavy nucleus may make it possible to search gluon saturation by RHIC energy, while the deuteron provides dilute partons as a probe of saturation. Both the STAR and the PHENIX experiments at RHIC had major detector upgrades in the forward region, making forward particle production at RHIC an excellent place to study low-$x$ gluons. A summary of new experimental results from FY08 d+Au collisions at RHIC will be presented.

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New measurement of the EMC effect in light nuclei, PATRICIA SOLVIGNON, Jefferson Lab — Twenty-six years ago, CERN physicists made the unexpected observation that the quark distribution in a nucleus is not just the sum of the quark distributions of its nucleons. This raised the logical question on the possible modification of nucleon structure in the nuclear medium. Describing the behavior of the nucleon in-medium has been one of the challenges of theoretical nuclear physics. Even after years of study, including additional measurements at CERN, SLAC and HERA, there is not a clear consensus. It has been broadly accepted that nuclear binding and Fermi motion should be included in any realistic models. Yet still some “by-products” of theoretical calculations, i.e. nucleon swelling or pion enhancement, are in contradiction with other experimental results. JLab Hall C experiment E03-103 was designed for a precision measurement of the EMC effect in light nuclei, where reliable calculations can be performed. The experiment collected the first data on the EMC effect in $^3$He at large $x$. It also improved the precision on the EMC ratio of medium to heavy nuclei. Our light nuclei results suggest a local density dependence in which the EMC effect would be sensitive to the detailed structure of the nuclei. In this talk, I will give a short review of the EMC effect with particular emphasis on new insights emerging from the recent JLab results.

Strange sea contribution to the ground state charge and magnetization of the nucleon, FATIHA BENMOHKHTAR1, Carnegie Mellon — The contributions of strange quarks to nucleon properties have been studied in several observables: to the momentum from deep inelastic neutrino scattering, to the spin with polarized deep inelastic electron scattering and to the mass with pion-nucleon scattering. In order to extract the contribution of strange quarks to the ground state charge and magnetization distributions of the nucleon, several Parity Violating (PV) electron scattering experiments have been carried out. These experiments involve measurement of the helicity dependent cross section of elastically scattered polarized electrons from an unpolarized target. During this talk, I will be focusing on the G0 experiment at the Thomas Jefferson National Accelerator Facility. G0 recently measured the parity violating asymmetry in the cross section for polarized electrons scattered at backward angles off liquid hydrogen and deuterium. Measurements were made at two momentum transfers: 0.23 and 0.62 (GeV/c)$^2$. Combined with earlier forward angle measurements on a hydrogen target, also from the G0 experiment, the contribution of strange quarks to the proton’s charge and magnetization distributions can be determined. These measurements also allow the extraction of the isovector axial form factor as seen in electron scattering. Final results of the complete separation of the strange electric, strange magnetic and the isovector axial form factors at these two kinematic points are presented. A variety of recent theoretical predictions of these form factors are discussed.

For the G0 Collaboration.
The increasingly common use of the double-polarization technique to measure the nucleon electromagnetic form factors, in the last 15 years, has resulted in a dramatic improvement of the quality of all four nucleon electromagnetic form factors, $G_{Ep}, G_{Mp}, G_{En}$ and $G_{Mn}$. It has also completely changed our understanding of the proton structure, having resulted in a distinctly different $Q^2$-dependence for $G_{Ep}$ and $G_{Mp}$, contradicting the prevailing wisdom of the 1990’s based on cross section measurements and the Rosenbluth separation method, namely that $G_{Ep}$ and $G_{Mp}$ obey a “scaling” relation $\mu G_{Ep} \sim G_{Mp}$. A direct consequence of the faster decrease of $G_{Ep}$ revealed by the JLab polarization experiments was the disappearance of the early scaling $F_2/F_1 \sim 1/Q^2$ predicted by perturbative QCD. Electromagnetic form factors encode the information on the structure of a strongly interacting many-body system of quarks and gluons, such as the nucleon. Much theoretical efforts have been made to understand the nucleon form factors. This reflects the fact that a direct calculation of nucleon form factors from the underlying theory, Quantum Chromodynamics, is complicated as it requires, in the few GeV momentum transfer region, non-perturbative methods. Therefore, in practice it involves approximations which often have a limited range of applicability. The unexpected results of the nucleon electromagnetic form factors using double-polarization high-precision experiments, have challenged our theoretical understanding of the structure of the nucleon. They have triggered several new theoretical developments, which will be discussed.

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