Measurements at HERMES of quark propagation and hadronization in nuclei

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Semi-inclusive deep-inelastic lepton-nucleus collisions provide a unique opportunity to investigate quark propagation in nuclei as well as the space time evolution of the hadronization process. In the simpliest scenario, the nucleus which has the size of a few fermi, acts as an ensemble of targets with which the quark struck in the scattering process or the hadron subseqently formed may interact. The resulting hadron distributions and multiplicities can be directly related to nuclear effects in quark propagation and hadronization. An understanding of the quark propagation through the nuclear environment involving competing processes like gluon radiation, quark energy loss through multiple scattering, and the hadronization of quarks is crucial for the interpretation of data on ultra-relativistic heavy-ion collisions. Interesting recent developments include the calculation[1] of medium modification of parton fragmentation functions by multiple scattering and gluon bremsstrahlung by means of a systematic expansion of higher twist corrections to the fragmentation process. Specific predictions emerge for HERMES data on hadron production.
The influence of the nuclear medium on the production of charged hadrons in semi-inclusive deep inelastic scattering has been studied by the HERMES experiment at DESY using 27.5 GeV positrons. Identification of $\pi's, K's$, and $p's$ is accomplished by means of a novel dual-radiator ring- imaging Cerenkov counter. Measurements of hadron multiplicity have been made for targets of deuterium, N_2, and ^{84}Kr. For the first time, the multiplicity ratios of $\pi's, K's$, and $p's$ for the nuclear targets relative to the deuteron, i.e. the "attenuation ratios", have been derived as a function of both virtual photon energy and fractional hadron energy. The kinematic dependences of the multiplicity ratios provide rigorous tests of available models of the hadron propagation and hadronization. The attenuations are found to differ with hadron type and in the case of kaon and proton also with charge. Hadron formation times and parton energy loss inferred from these data will be discussed, and the reduction of hadron multiplicities in nuclei will be compared with recent theoretical predictions. In addition, data on the enhancement of hadron production at high hadron transverse momentum (Cronin effect) will be presented and compared with results from hadron-nucleus and nucleus-nucleus collisions.

References

[1] X. Guo and X. N. Wang, Phys, Rev. Lett. **85** (2000) 3591; E. Wang and X. N. Wang, hep-ph/0202105.