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Hadronization within the Nuclear Environment

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Details of the hadronization process remain difficult to probe. Experimentally one can only detect the fully formed hadron. Studies of parton fragmentation from high energy collisions are explained by semi-empirical models, but are typically insensitive to details of the formation process. By studying the fragmentation process within the nuclear medium, one can hope to explore the time-development of the hadronic state, that is, the dynamics of confinement. Recent high-energy experiments at RHIC have provided new measurements of fragmentation within both cold and hot partonic matter. Since the properties of the hot matter are deduced from the produced hadrons, a more detailed understanding of the hadronization process may allow one to learn more precise information about the state formed in the heavy-ion collision. Measurements from $d - Au$ collisions are forthcoming which test the modifcation of hadronization in cold nuclear matter, and at the same time, the B-factories are determining the basic fragmentation functions to an unparalled precision. Semi-inclusive deep inelastic scattering of leptons from nuclei provides a unique window on the hadronization process in cold nuclear matter since the momentum of the initially struck parton is experimentally determined; in addition, initial state hadronic effects are largely suppressed. The influence of the nuclear medium on the production of hadrons has been recently studied in the Hermes experiment at DESY in semi-inclusive deep-inelastic scattering of 27.6 GeV positrons off deuterium, helium, neon, nitrogen and krypton targets. Differential multiplicities for the heavier nuclei relative to deuterium have been determined for π^+, π^0, π^-, K^+, K^-, p and $\bar{p}$, as a function of the virtual photon energy ν, the fraction z of the energy transfered to the hadron, the hadron transverse momentum squared, p_T^2, and the four-momentum squared of the virtual photon, $-Q^2$. New measurements of two-hadron attenuation will also be presented. Strong nuclear effects are seen, which depend also on hadron identity and nuclear size. Results will be compared to predictions of theoretical models which seek to explain hadron formation within the nuclear medium, and compared with recent results from RHIC.

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