Perturbative QCD and multiple scattering in nuclear matter

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Factorization theorems in perturbative QCD traditionally describe only a single scattering of partons in high energy hadron or nucleus collisions. This is not sufficient if the mean free path of a parton is smaller than the size of the nuclear matter. A rigorous way to treat multiple scattering within a factorized pQCD framework as so-called higher twist corrections has been laid out by J. Qiu and G. Sterman. In the past R.J. Fries has successfully applied this formalism to proton nucleus collisions, e.g. he was the first to carry out a resummation of higher twist contributions [1]. Renewed interest in this more rigorous approach comes from heavy ion physics where "pQCD inspired" calculations of jet energy loss have turned out to carry a large dependence on model assumptions. During the period under consideration R.J. Fries has started work with A. Majumder to further develop the higher twist formalism. Before applications in heavy ion collisions can be considered processes in well-defined environments are studied:

(a) Transverse momentum broadening from multiple scattering for heavy quarks in deep inelastic scattering and p+A collisions. This work has the goal to resum nuclear enhanced higher twist corrections at leading order in the coupling (i.e. w/o radiation). This is a generalization of previous work of R.J. Fries [1]. A. Majumder and collaborators have recently added the insight that the results can be written as a diffusion in transverse momentum space.

(b) Resummation of leading nuclear enhanced higher twist corrections at next-to-leading order (NLO) in the coupling. This is a generalization of project (a) to allow gluon radiation. At the same time it is also a generalization of previous work of Wang and Guo at NLO which has only twist-4 corrections but no resummation of arbitrary twist. The calculations are carried out for deep-inelastic scattering. Both energy loss and transverse momentum broadening will be studied.

[1] Rainer J. Fries, Phys. Rev. D **68**, 074013 (2003).