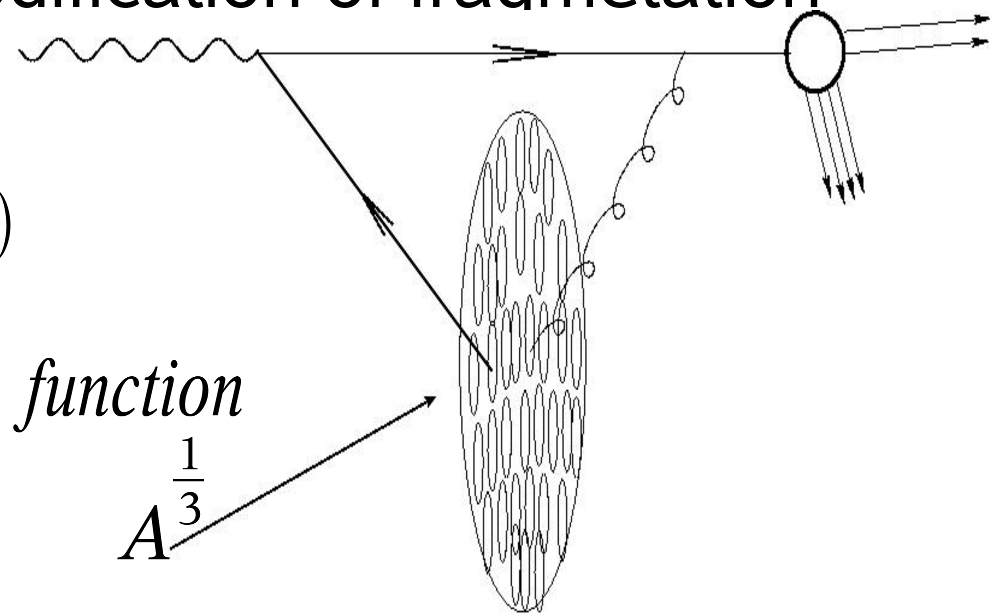
Jet quenching in the higher twist formalism

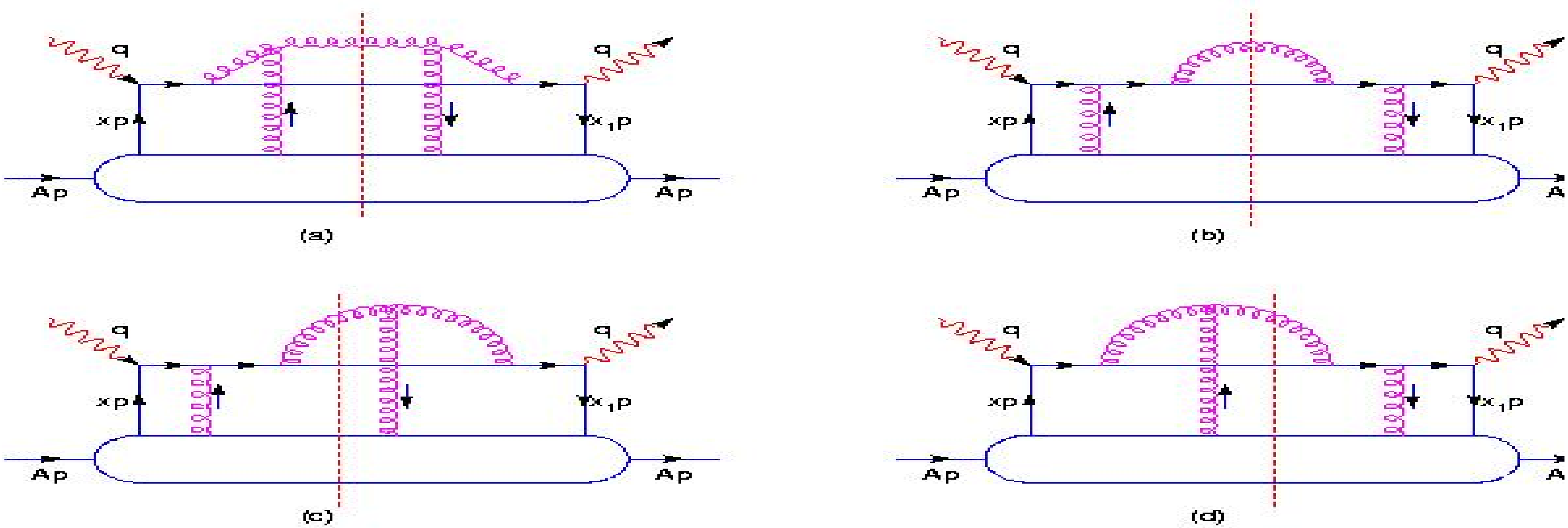
Based on the higher twist modification of fragmetation function in DIS



$$\frac{dW^{\mu\nu}}{dz_1} = \int dx\, f_q^A(x)\, H^{\mu\nu}\, \tilde{D}^{h_1}(z_1)$$

$$\tilde{D} = medium\ modified\ fragmentation\ function$$

Luo, Qiu and Sterman PRD 50, 1951 (1994).



In the collinear limit, one can factorize the hard part from the soft matrix elements $W^{\mu\nu} \sim \int H^{\mu\nu} dy_1 dy_2 dy_3$

$$\langle P | \psi(y_1) A(y_2) A(y_3) \psi(0) | P \rangle$$

Expand H in a Taylor series in the transverse gluon momentum

$$H = H(Q, k_T = 0) + \left[\frac{d^2 H(Q)}{dk_T^2} \right]_{k_T=0} k_T^2 + \ldots$$

$$\tilde{D}(z_{1,}\mu^2) = D(z_{1,}\mu^2) + \frac{\alpha_s}{2\pi} \int_0^{\mu^2} \frac{dl_\perp^2}{l_\perp^2} \int \frac{dy}{y} \left(\frac{1+y^2}{1-y} f(x, y, Q^2, l_\perp) + V.C. \right) D(z_1/y, \mu^2)$$

$$f = \frac{C_A 2\pi\alpha}{l_T^2 + k_T^2} \frac{\int dy\, dy_1\, dy_2 \langle A | \bar{\psi}(y) F(y_1) F(y_2) \psi(0) | A \rangle e^{i\, factors}}{N_c f^A(x)}$$

Assume a Gaussian density distribution for nucleons in a medium sized nucleus

$$T_{qg} \sim \int dx_1 dx_2 d^2 x_T C \rho(x_1) \rho(x_2) A^{1/3} (F(x_B) x G^N(x)) (1 - e^{-x_L^2/x_A^2})$$

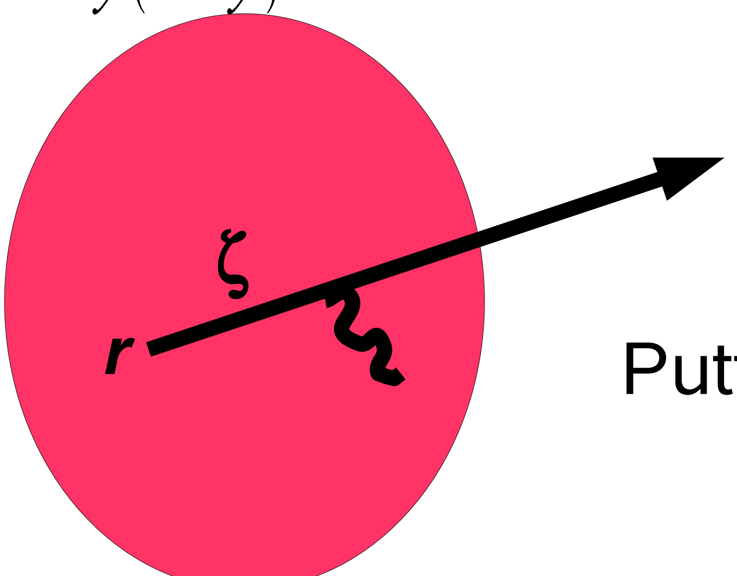
In a Heavy-ion environment we have

$$\frac{d\Delta\sigma}{dy\,d^2p_T} = \int d^2b\,d^2r\,t_A(r)\,t_B(r-b)\,dx_a\,dx_b\,G(x_a)\,G(x_b)$$

$$\frac{d\hat{\sigma}}{d\hat{t}}\,\frac{\alpha}{2\pi}\,\frac{\int dl_T^2}{l_T^2}\,\frac{dy}{y}\,\frac{1+y^2}{1-y}\,\frac{C_A 2\pi\alpha}{l_T^2 N_c}\int d\zeta\,(2-2\cos(p_L\zeta))$$

$$C\,\frac{\zeta_0}{\zeta}\,\rho_0\left[\frac{t_A(r+\zeta)}{t_A(0)}+\frac{t_B(r-b+\zeta)}{t_B(0)}\right]\frac{D(z/y)}{\pi z}$$

$$p_L = \frac{l_T^2}{2Ey(1-y)}$$



Main quantity is

$$\int dy_1^-\,dy_2^-\,\langle Matter|F^{+\mu}F_\mu^+|Matter\rangle$$

Putting in the factors, can convert to

$$\hat{q} = 3-4\;GeV^2/fm$$

Energy Loss in the static large L limit

$$\langle \Delta y \rangle = \int dy \frac{d\, l_T^2}{l_T^2}(1+(1-y)^2)\frac{C_A 2\pi \alpha^2 C}{N_c l_T^2}\int_0^L d\zeta\, C \rho_0 [2 - 2\cos(p_L \zeta)]$$

$$\langle \Delta y \rangle = \frac{\pi^2 L^2 C_A \alpha^2 C}{N_c E}\left[\log\left(\frac{z_{max}^2 (1-z_{min})}{z_{min}^2 (1-z_{max})}\right) + z_{min} - z_{max}\right]$$

z_{min} and z_{max} come from the kinematic bound where we enforce the decay products to always go forward

$$z_{min} = \frac{1}{2} - \frac{\sqrt{1-4\Lambda^2/Q^2}}{2}$$

$$z_{max} = \frac{1}{2} + \frac{\sqrt{1-4\Lambda^2/Q^2}}{2}$$

$$Q^2 \leq 2\Lambda E$$
$$Q^2 > 4\Lambda^2$$

Λ is a non-perturbative scale beyond which we will not evolve further