Unified picture of jet fragmentation from early to late times

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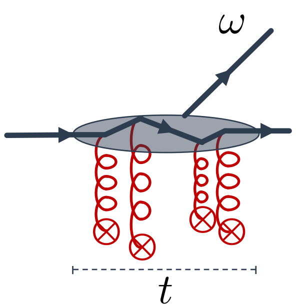
Medium-induced emission by elastic scatterings: [BDMPS-Z formalism]

$$\frac{\mathrm{d}I(t)}{\mathrm{d}\omega} \sim$$



Analytic solution (in limiting cases):

1. Opacity expansion: dilute medium, or hard scattering. [GLV, Wiedemann]
2. Harmonic approximation: dense medium, and soft scatterings. [BDMPS-Z]

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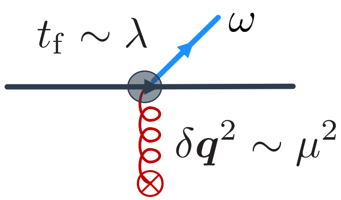
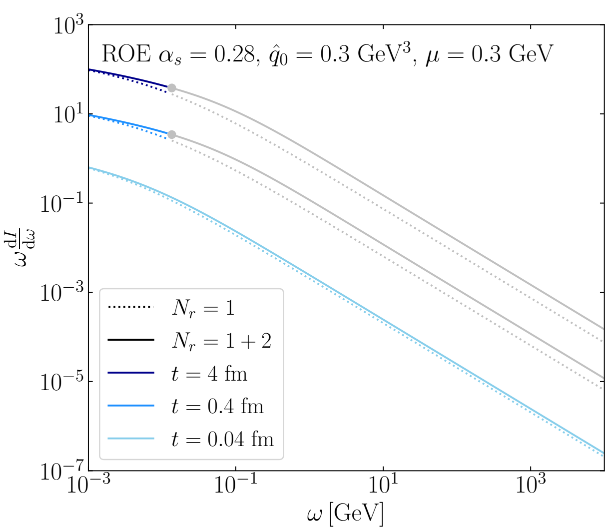
New expansion schemes:

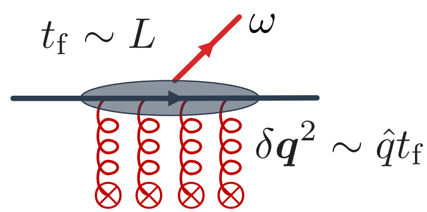
Short, soft scatterings



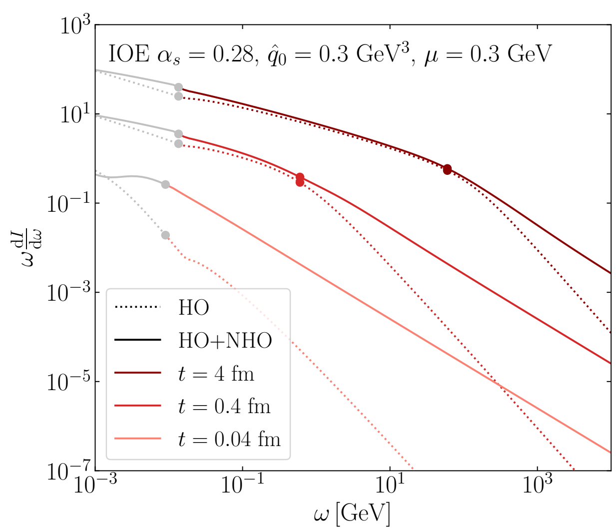
$$\omega \ll \omega_{\text{BH}} = \frac{\mu^2 \lambda}{2}$$



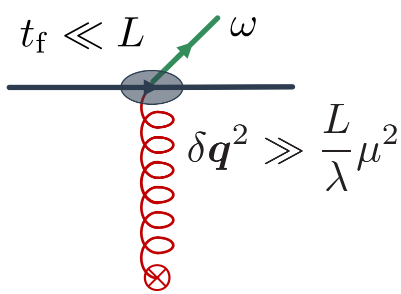
Coherent, soft scatterings



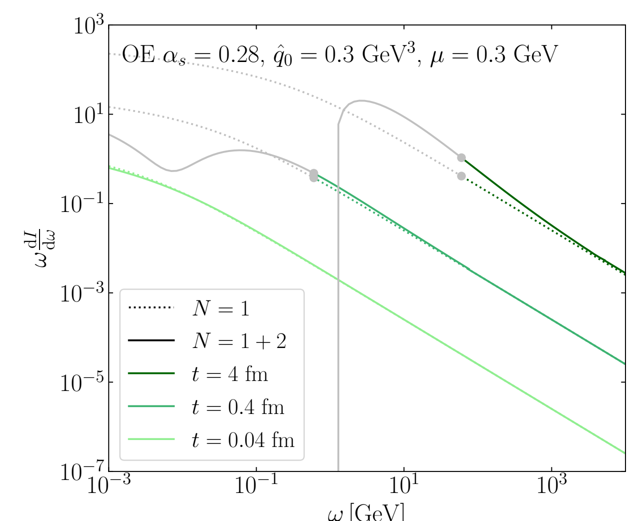
$$\omega_{\text{BH}} \ll \omega \ll \omega_c = \frac{\hat{q} t^2}{2}$$



Rare, hard scatterings

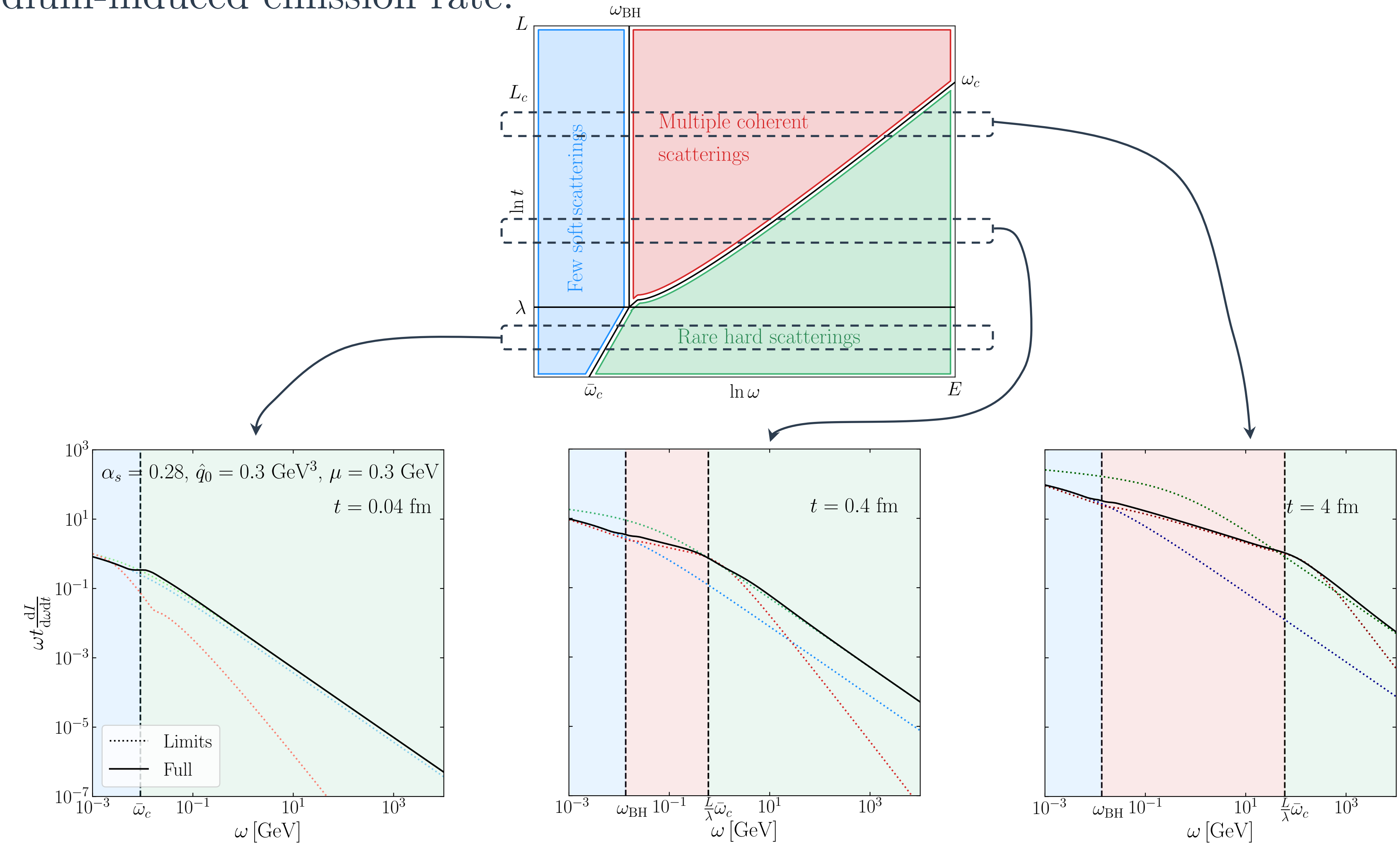


$$\omega \gg \omega_c$$

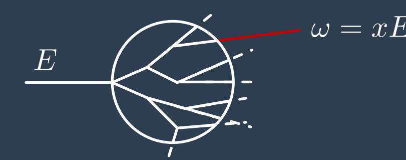


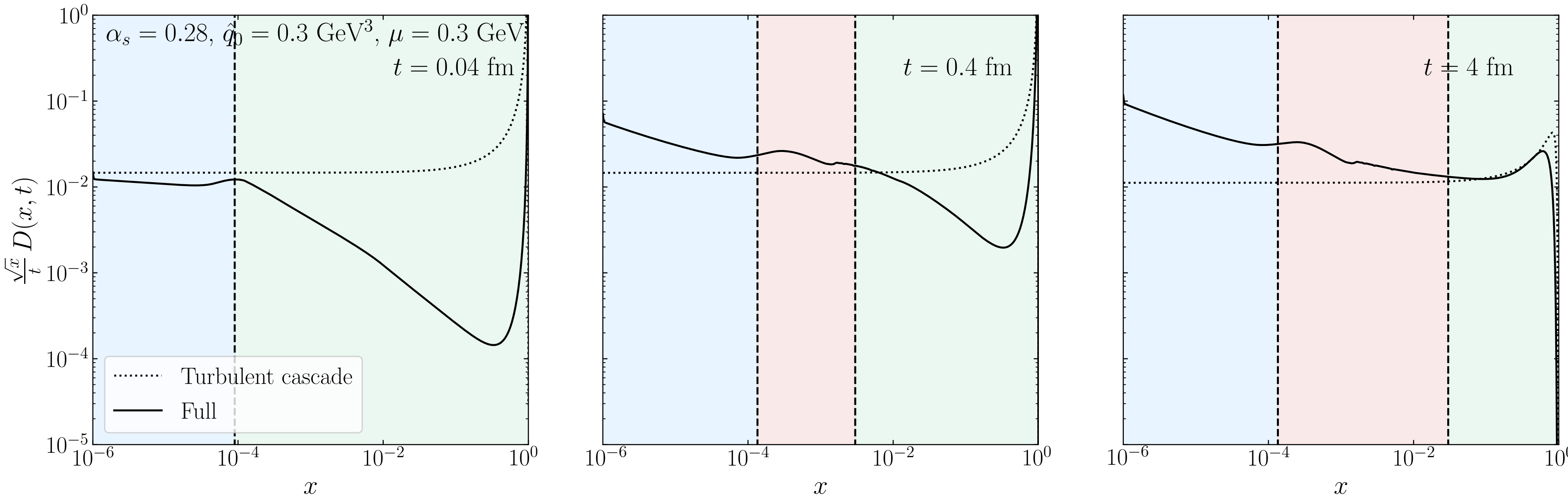
Covering the full phase space: $\frac{\mathrm{d}I}{\mathrm{d}\omega\mathrm{d}t}$

Medium-induced emission rate:



Fragmentation function: $D(x,t) = \omega \frac{\mathrm{d}N}{\mathrm{d}\omega}$

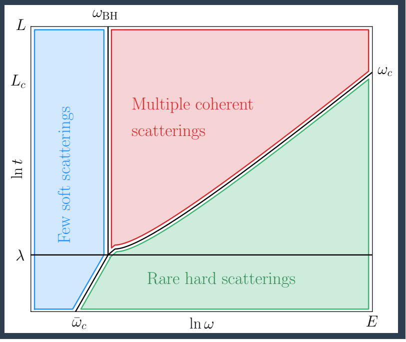




Update on energy-loss:

- Early time: no BDMPS-Z emissions.
- Late time, BDMPS-Z is restricted: $\omega_{\mathrm{BH}} < xE < \omega_c$.
- Single hard emission correction: $xE > \omega_c$.
- Turbulent cascade changes at: $xE < \omega_{\mathrm{BH}}$.

The accuracy of medium jets



Resummation of emissions ($t \gg \lambda$):

$$\ln\Delta(t) = \int \mathrm{d}t \int \mathrm{d}\omega \frac{\mathrm{d}I}{\mathrm{d}\omega\mathrm{d}t} =$$

$$\alpha_s \frac{t}{\lambda}\left(f_1 \ln^2 \frac{\omega_{\rm BH}}{\omega_{\rm min}} + f_2 \ln \frac{\omega_{\rm BH}}{\omega_{\rm min}} + f_3\right) + \alpha_s\left(g_1\sqrt{\frac{\omega_c}{\omega_{\rm BH}}} + g_2 \ln\frac{t}{\lambda} + g_3\right) + \alpha_s\left(h_1 \ln\frac{t}{\lambda} + h_2\right)$$

vacuum N^{n}LL analog with $\alpha_s \mapsto \alpha_s \frac{t}{\lambda}$

leading Power subleading Length-log

Length-log

Leading power approximation: soft limit

$$D^{(\rm LP)}(y = 1 - x \sim 0, t|E) = \frac{\sqrt{2}}{y}\bar{\alpha}\sqrt{\frac{\omega_c}{yE}} \exp\left[-2\pi\left(\bar{\alpha}\sqrt{\frac{\omega_c}{yE}}\right)^2\right]$$

Length-log correction: soft limit + time dependent phase space

$$D^{(\rm NLP)}(y = 1 - x \sim 0, t|E) = D^{(\rm LP)}(y, t|E)\cdot \exp\left(2^{3/2}\bar{\alpha}\ln\frac{t}{\lambda}\right)$$