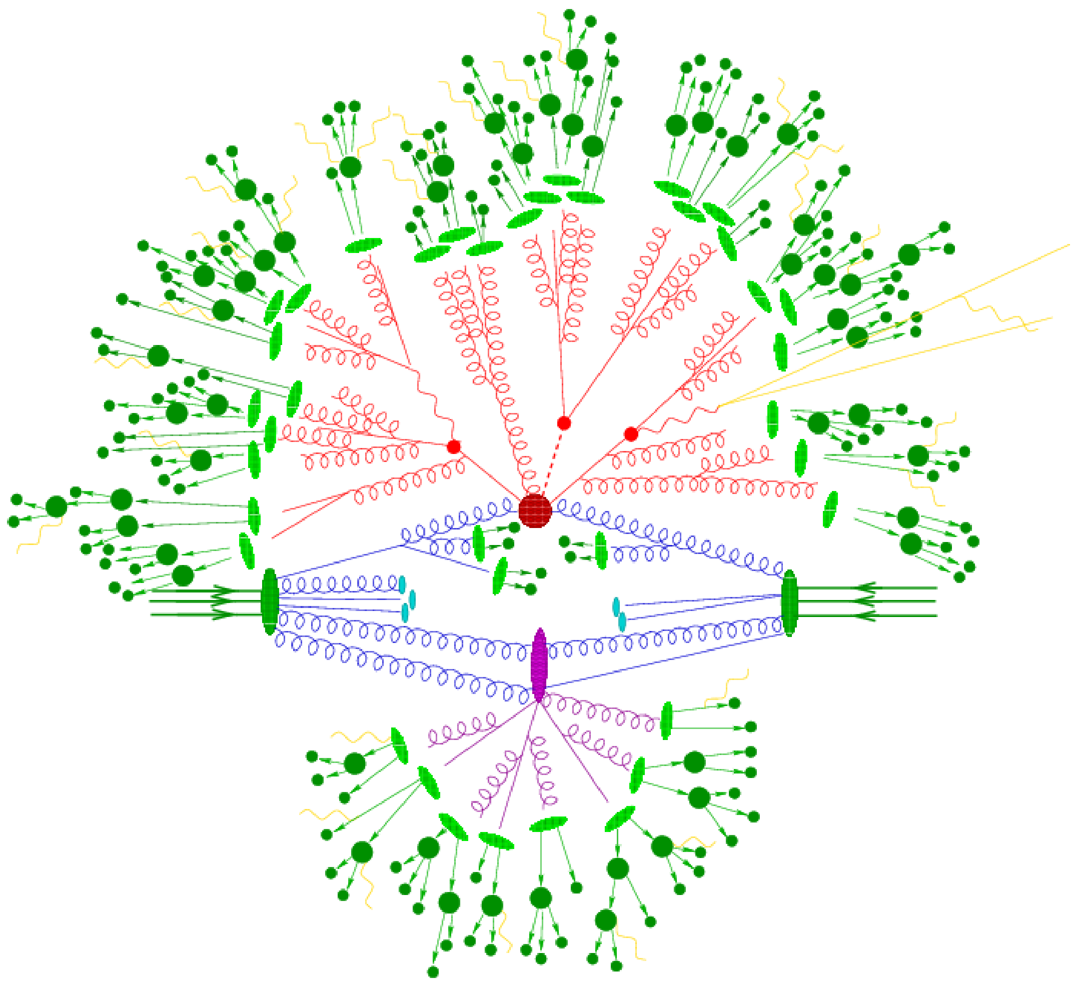
PARTON SHOWER EVOLUTION AT THE AMPLITUDE LEVEL

Fernando Torre González

Supervised by Jeff Forshaw and Simon Plätzer

Parton showers: the current state of the art

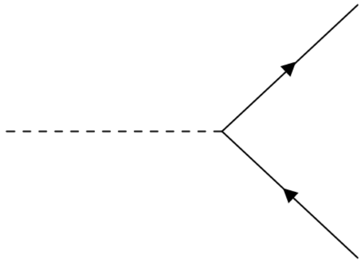


Parton showers model the cascade of QCD radiation that occurs from coloured high-energy particles

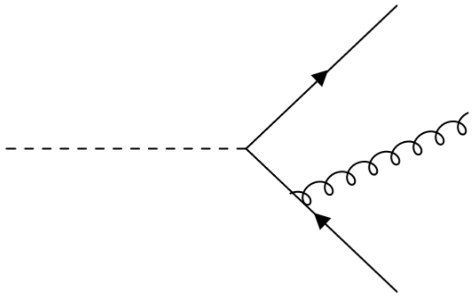
- Angular ordered shower: up to NLL accuracy of global, two-jet observables but it fails beyond the two-jet limit or for non-global observables.
- Dipole shower: accurate for global and non-global observables, only up to LL and LC

Comprehensive introduction to parton showers: 1411.4085

Real emissions and virtual exchanges factorise in the soft kinematic limit

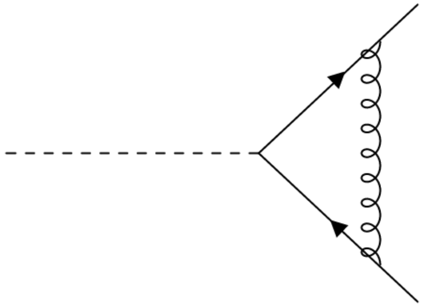


$$|H\rangle$$



$$\mathbf{D}^{\mu}\,|H\rangle$$

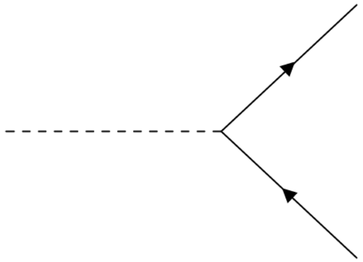
$$\mathbf{D}_i^{\mu} = \sum_j \mathbf{T}_j E_i \frac{p_j^{\mu}}{p_j \cdot q_i}$$



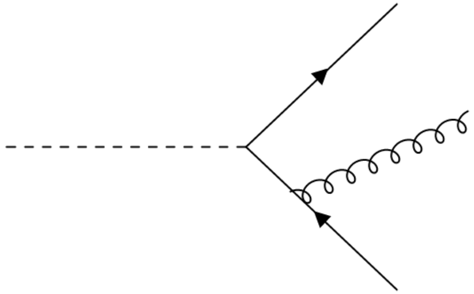
$$\mathbf{\Gamma}\,|H\rangle$$

$$\mathbf{\Gamma} = \frac{\alpha_s}{\pi}\sum_{i<j}(-\mathbf{T}_i \cdot \mathbf{T}_j)\left\{\int \frac{\mathrm{d}\Omega_k}{4\pi}\omega_{ij}(\hat{k}) - i\pi\tilde{\delta}_{ij}\right\}$$

Real emissions and virtual exchanges factorise in the soft kinematic limit

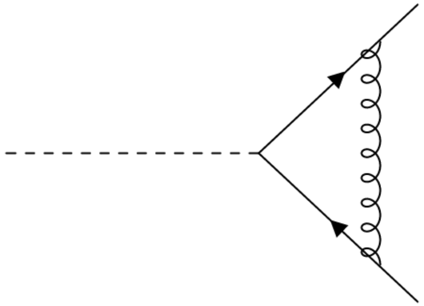


$$|H\rangle$$



$$\mathbf{D}^{\mu}\,|H\rangle$$

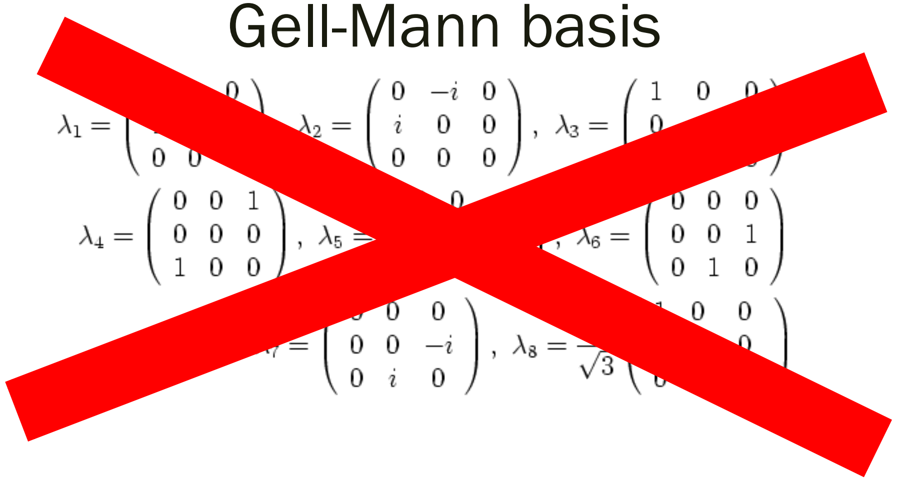
$$\mathbf{D}_i^{\mu} = \sum_j \mathbf{T}_j E_i \frac{p_j^{\mu}}{p_j \cdot q_i}$$



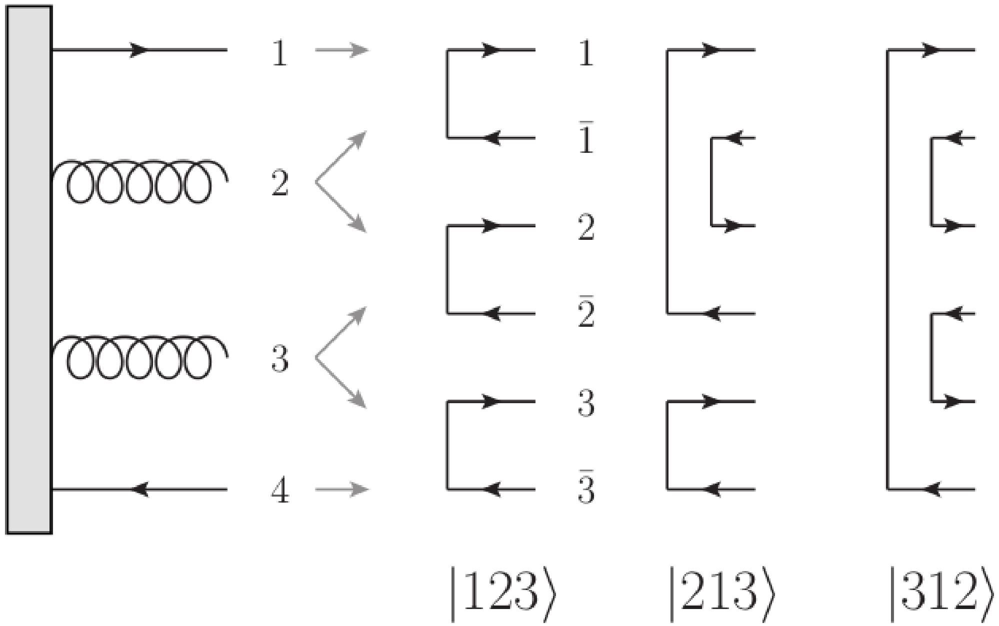
$$\mathbf{\Gamma}\,|H\rangle$$

$$\mathbf{\Gamma} = \frac{\alpha_s}{\pi}\sum_{i<j}(-\mathbf{T}_i \cdot \mathbf{T}_j)\left\{\int \frac{\mathrm{d}\Omega_k}{4\pi}\omega_{ij}(\hat{k}) - i\pi\tilde{\delta}_{ij}\right\}$$

Gell-Mann basis

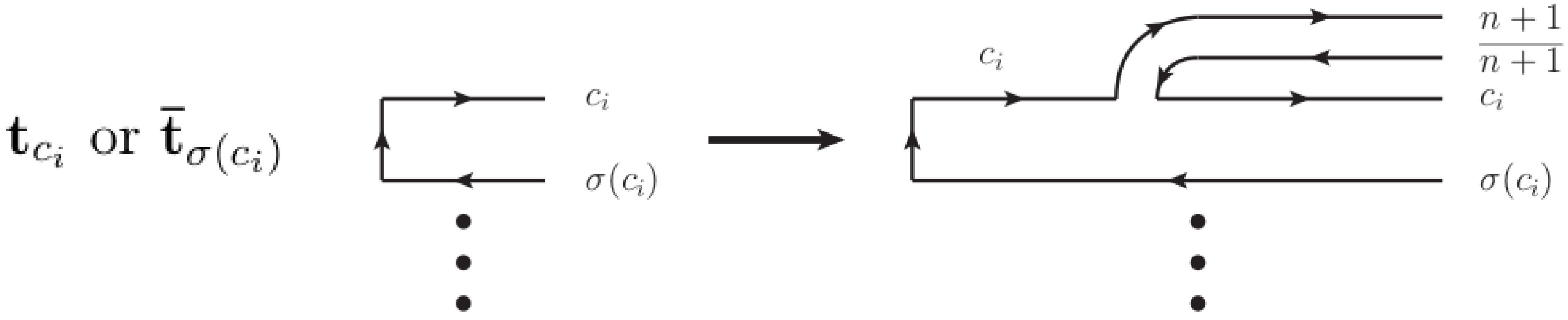


Colour Flow Basis

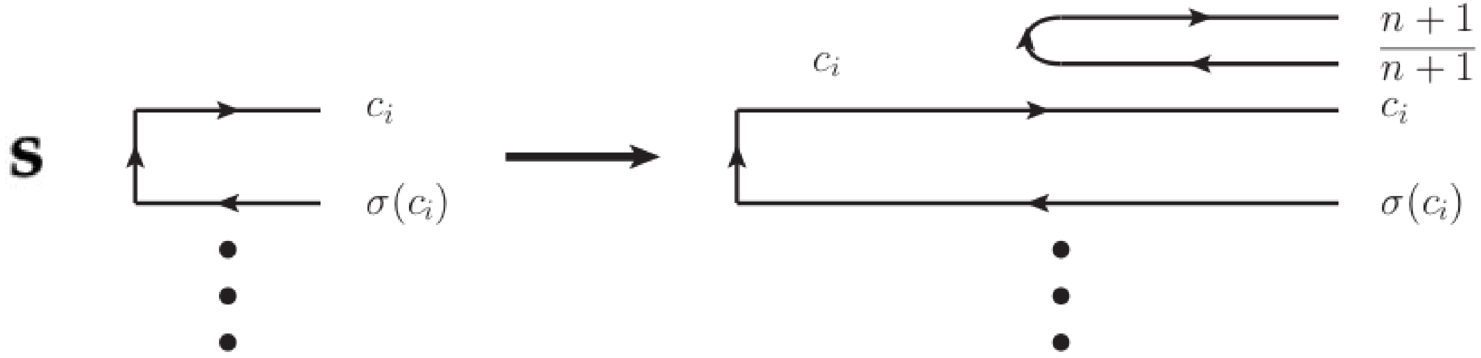


Colour evolution: real emissions

$$\mathbf{T}_i = \lambda_i \mathbf{t}_{c_i} + \bar{\lambda}_i \bar{\mathbf{t}}_{\bar{c}_i} - \frac{1}{N_c}\left(\lambda_i - \bar{\lambda}_i\right)\mathbf{s}$$

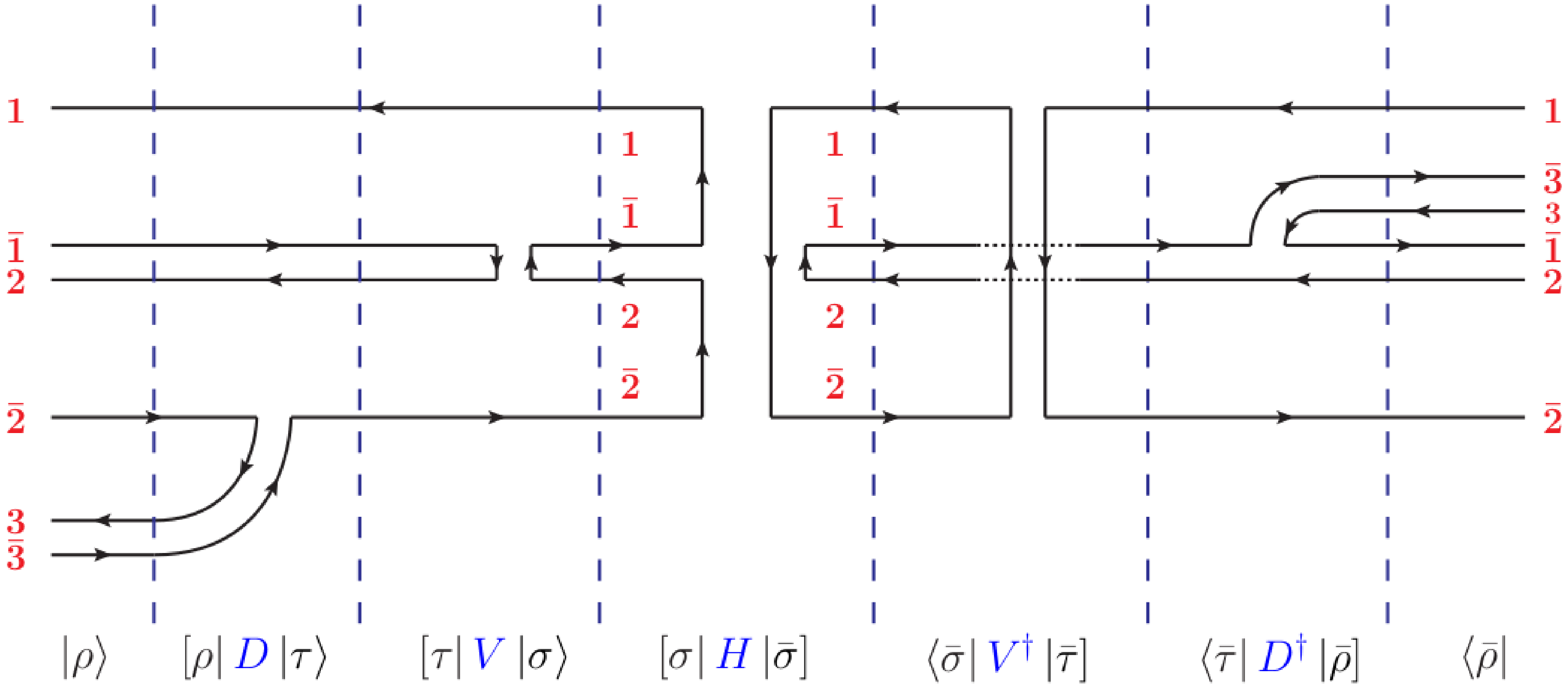


(A)

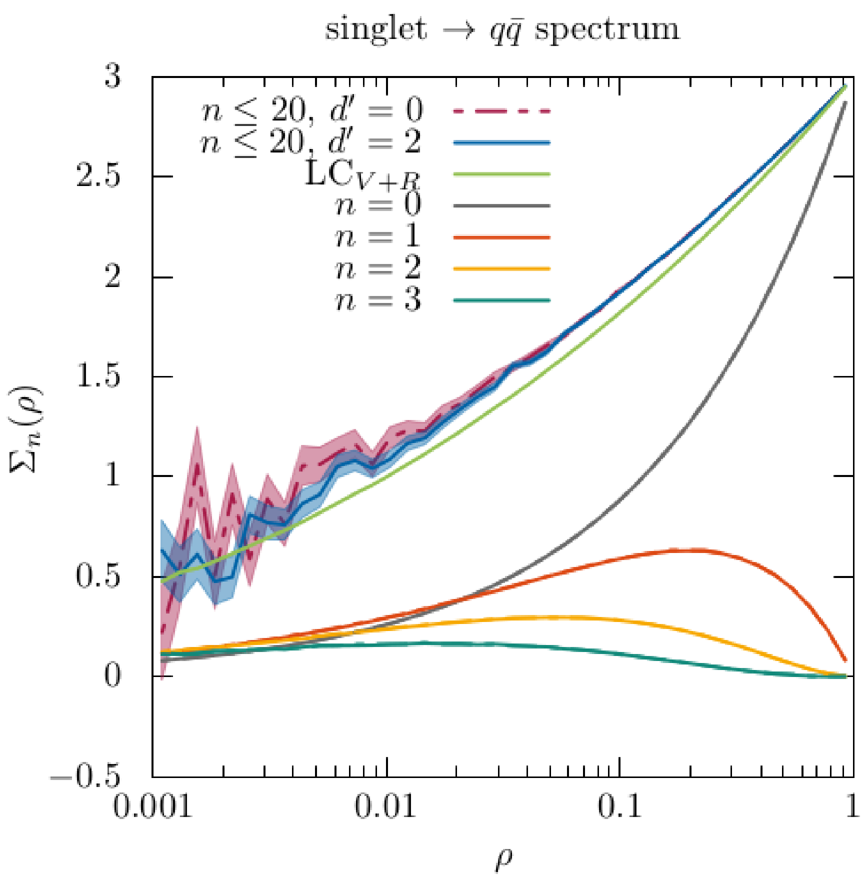


(B)

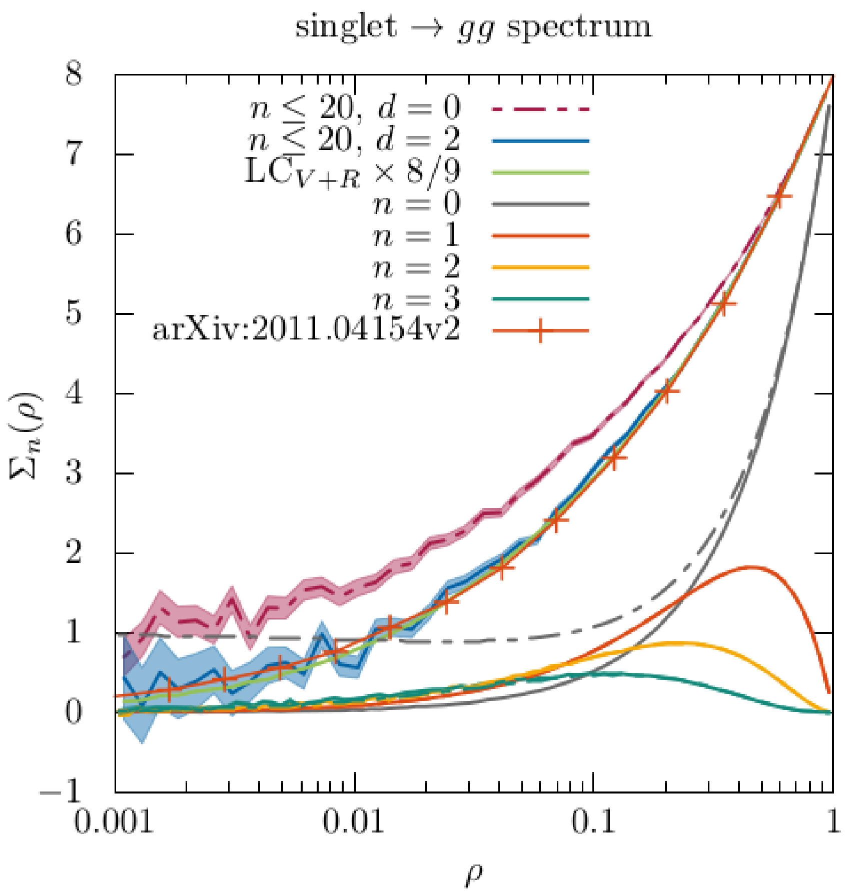
An example of colour evolution



M. De Angelis, J. R. Forshaw, and S. Plätzer, “Resummation and simulation of soft gluon effects beyond leading color,” Physical Review Letters, vol. 126, March 2021.



(A) Breakdown of the jet veto cross section by multiplicity and colour order, for the process singlet $\to q\bar{q}$.



(B) Breakdown of the jet veto cross section by multiplicity and colour order, for the process singlet $\to gg$.

Figures from Matthew de Angelis' doctoral thesis at UoM