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Calculation of the soft anomalous dimensions with time-like and light-like Wilson lines

Soft singularities of scattering amplitudes are important for both theoretical and practical reasons. It is well known that these singularities are captured by correlators of Wilson lines which follow the classical trajectory of energetic partons participating in the process and intersect at the hard interaction vertex. Such correlators feature ultraviolet singularities, which allow us to compute the soft anomalous dimension, provided the infrared is regularized. However, while correlators of time-like Wilson lines which intersect each other are multiplicatively renormalizable, strictly light-like Wilson lines feature also collinear singularities and lose multiplicative renormalizability. This feature complicates their regularization and the separation between infrared and ultraviolet singularities. Indeed, the soft anomalous dimensions of massless scattering amplitudes is rather different from that of massive ones, and the relation between them is subtle.
In this talk, I will start from a regularization scheme for time-like Wilson lines, and analyse the limit where some of the Wilson lines become light-like. The method we use is the combination of differential equations and expansion by regions. This provides insight on the non-analytic contributions which distinguish between the complete result and the strict light-like limit (referred to as the 'hard region'). Using a two-loop example I will show that all multiple poles in epsilon present in the strict limit cancel in the sum of regions, leaving behind a single pole, representing the contribution to the soft anomalous dimension. I will then turn to three loops, where I present a calculation of the hard region with one time-like and three light-like Wilson lines.

Primary authors: Prof. GARDI, Einan (University of Edinburgh); ZHU, Zehao

Presenter: ZHU, Zehao

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