Subtraction of $e^+e^- \to u\bar{u}d\bar{d}$ with distributed soft counterterms

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April 4, 2019

1 Counterterms

1.1 C(1,2)

$$P_{q\bar{q}} = T_R\left[-g^{\mu\nu} + 4z(1-z)\frac{n_\perp^\mu n_\perp^\nu}{n_\perp^2}\right] \tag{1}$$

1.2 C(1,2,3)

$$t_{12,3} \equiv 2\frac{z_1 s_{23} - z_2 s_{13}}{z_1+z_2} + \frac{z_1 - z_2}{z_1+z_2}s_{12}, \tag{2}$$

$$P_{q'\bar{q}'q} = \frac{1}{2}C_F T_R\left[-\frac{t_{12,3}^2}{s_{12}^2} + \frac{s_{123}}{s_{12}}\left(\frac{4z_3 + (z_1-z_2)^2}{z_1+z_2} + (1-2\epsilon)(z_1+z_2)\right) - (1-2\epsilon)\right] \tag{3}$$

1.3 S(1,2)

$$S_{q\bar{q}} = \frac{1}{s_{12}^2}[k) \neq 1,2][12]^2 \sum_{(j,k)\neq 1,2}\left[\frac{s_{1j}s_{2k} + s_{1k}s_{2j} - s_{12}s_{jk}}{s_{12j}s_{12k}} - \frac{s_{1j}s_{2j}}{s_{12j}^2} - \frac{s_{1k}s_{2k}}{s_{12k}^2}\right] j\cdot k, \tag{4}$$

1.4 S(C(1,2))

1.5 C(C(1,2),3)

1.6 C(S(1,2),3)

$$S_{q\bar{q}} = \frac{T_R}{s_{12}^2}\sum_{(j,k)\neq 1,2}[]^2 3^2\left[\frac{s_{13}z_2 + s_{23}z_1 - s_{12}z_3}{s_{123}(z_1+z_2)} - \frac{s_{13}s_{23}}{s_{123}^2} - \frac{z_1 z_2}{(z_1+z_2)^2}\right] \tag{5}$$

1.7 C(S(C(1,2)),3)

References

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