The planar double box integral for top pair production with a closed top loop to all orders in the dimensional regularisation parameter

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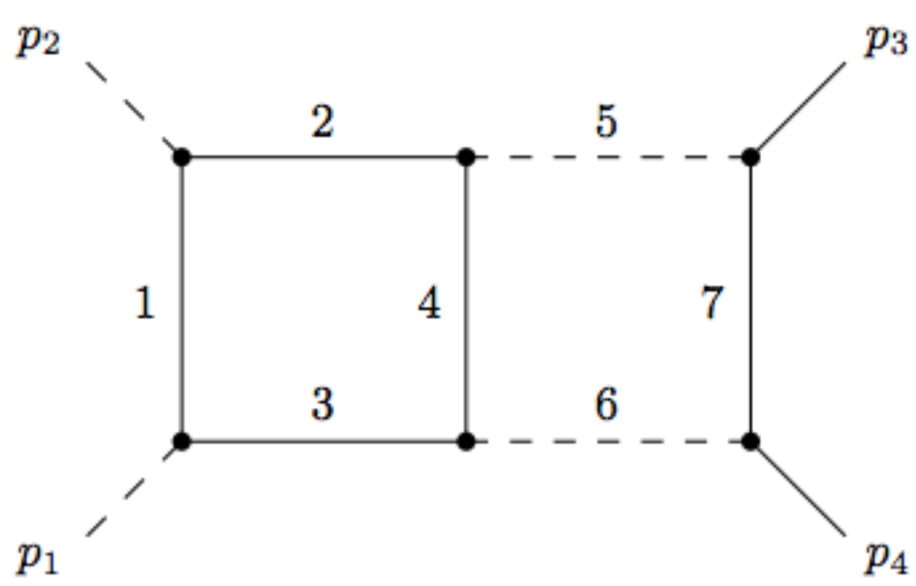
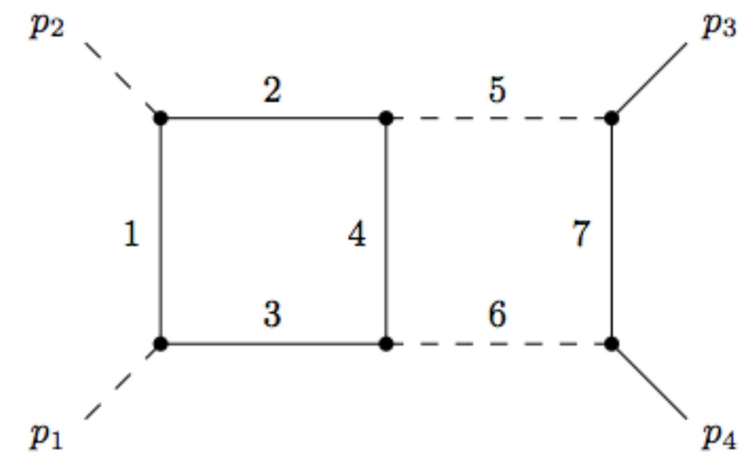


Based on arXiv: 1804.11144 by Luise Adams, Ekta Chaubey and Stefan Weinzierl.

Introduction



- The planar double box enters the next-to-next-to-leading order (NNLO) contribution for process $pp \to t\bar{t}$.
- Depends on 2 scales and contains the sunrise graph as a sub-topology.
- Naturally a case of elliptic generalisations of multiple polylogarithms.
- Presence of not one but three elliptic curves.
- System of differential equations brought to a form linear in ϵ , where ϵ^0 part is strictly lower triangular.
- Transformation of the basis of master integrals rational in x,y, the periods of the three elliptic curves and their y-derivatives.

Differential Equations (D.E.) system linear in ϵ

- Changing the basis, $\vec{J} = U\vec{I}$ D.E. transforms into

$$d\vec{J} = A^{'}\vec{J}, \quad A^{'} = UAU^{-1} + UdU^{-1}\,.$$

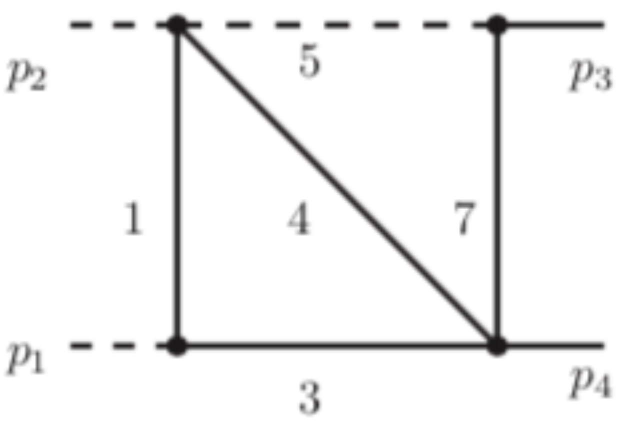
- There exists a transformation U, s.t. A^0 is strictly lower triangular

$$d\vec{J} = (A^{(0)}(x,y) + \epsilon A^{(1)}(x,y))\vec{J}\,.$$

- Transformation matrix rational in

$$\epsilon, x, y, \psi_1^{(a)}, \psi_1^{(b)}, \psi_1^{(c)}, \partial_y\psi_1^{(a)}, \partial_y\psi_1^{(b)}, \partial_y\psi_1^{(c)}.$$

An example



- The 3 master integrals can be taken as

$$J_{24} = \epsilon^3 \frac{(1+x^2)^2}{x(1-x^2)} \frac{\pi}{\psi_1^{(b)}} I_{1112001}$$

$$J_{25} = \epsilon^3 (1-2\epsilon) \frac{(1+x^2)^2}{x(1-x^2)} I_{1111001} + R_{25,24} \frac{\psi_1^{(b)}}{\pi} J_{24},$$

$$J_{26} = \frac{6}{\epsilon} \frac{(\psi_1^{(b)})^2}{2\pi i W_y^{(b)}} \frac{d}{dy} J_{24} + R_{26,24} (\frac{\psi_1^{(b)}}{\pi})^2 J_{24} - \frac{\epsilon^2}{24}(y^2 - 30y - 27) \frac{\psi_1^{(b)}}{\pi} D^- I_{1001001} \quad .$$

- This pattern applies to all the elliptic sectors.
- A^0 vanishes for x=0 or y=1.
- For y=1, entries of A^1 reduce to differential one-forms, for x=0 they reduce to modular forms.

Thank you!