

Incremental Metapost Graphics for T_EXPower: Using feynmf/feynmp and emp

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June 12, 2000

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Caveat Emptor: the version of **emp** currently on CTAN does not yet have the **emp_x** environment required for these examples. Get the most recent version from

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These examples of incremental graphics for T_EXpower are collected from various talks and lectures that I had prepared originally with **seminar**. Some of them are probably overusing T_EXpower's features, ...

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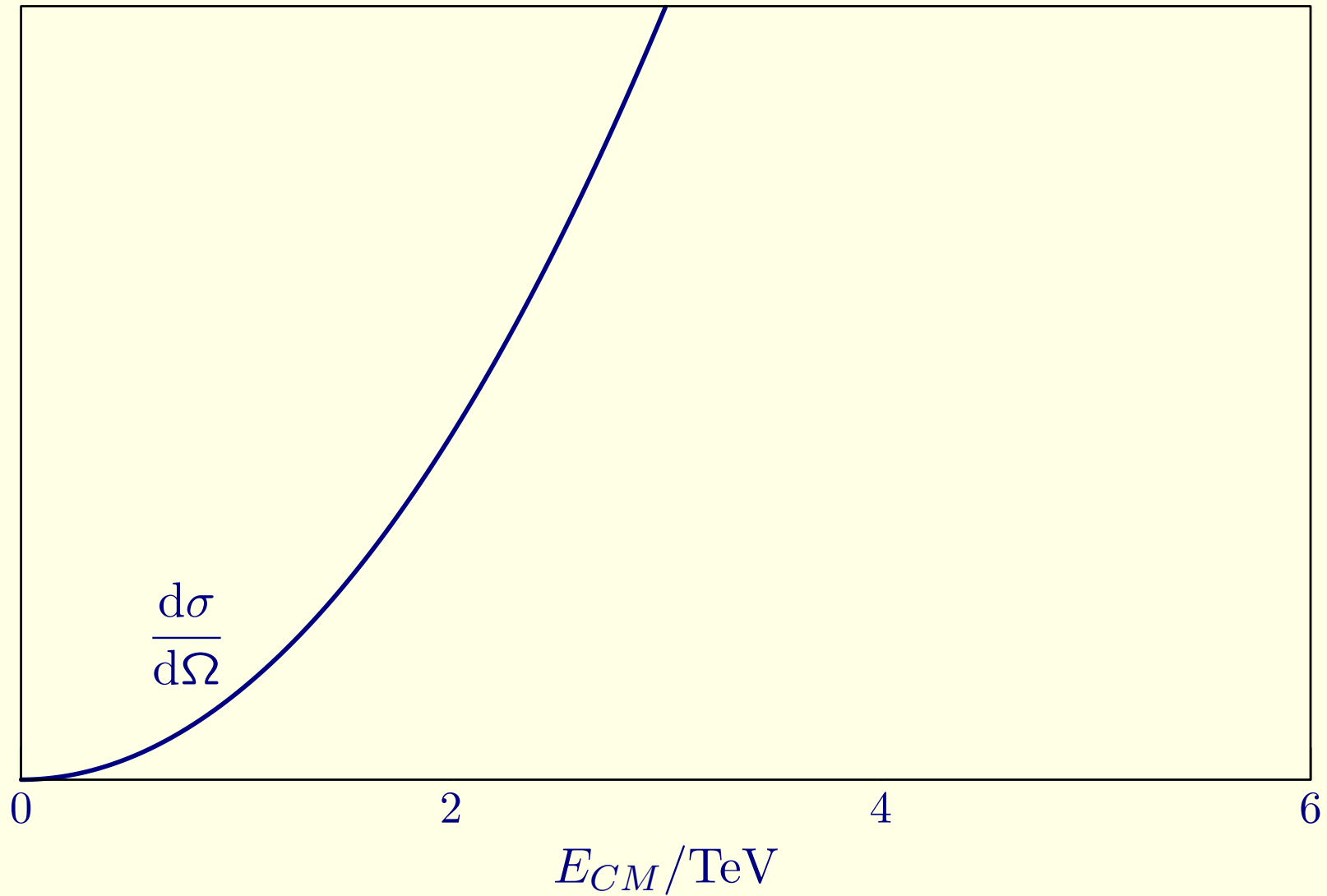
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NB: all links point to the final version (step) of each page!

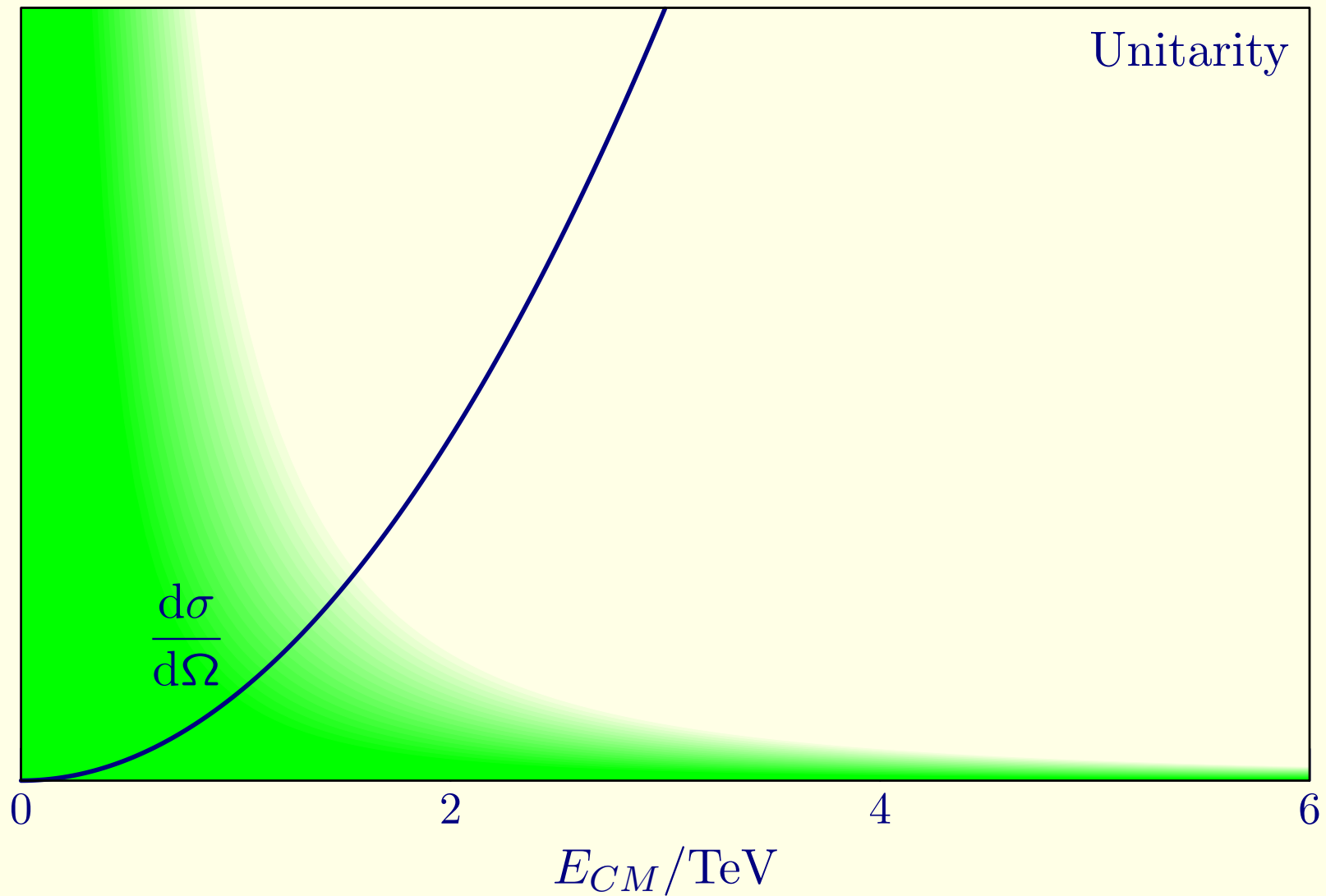
1 Blending Graphics With the Background



Differential cross section

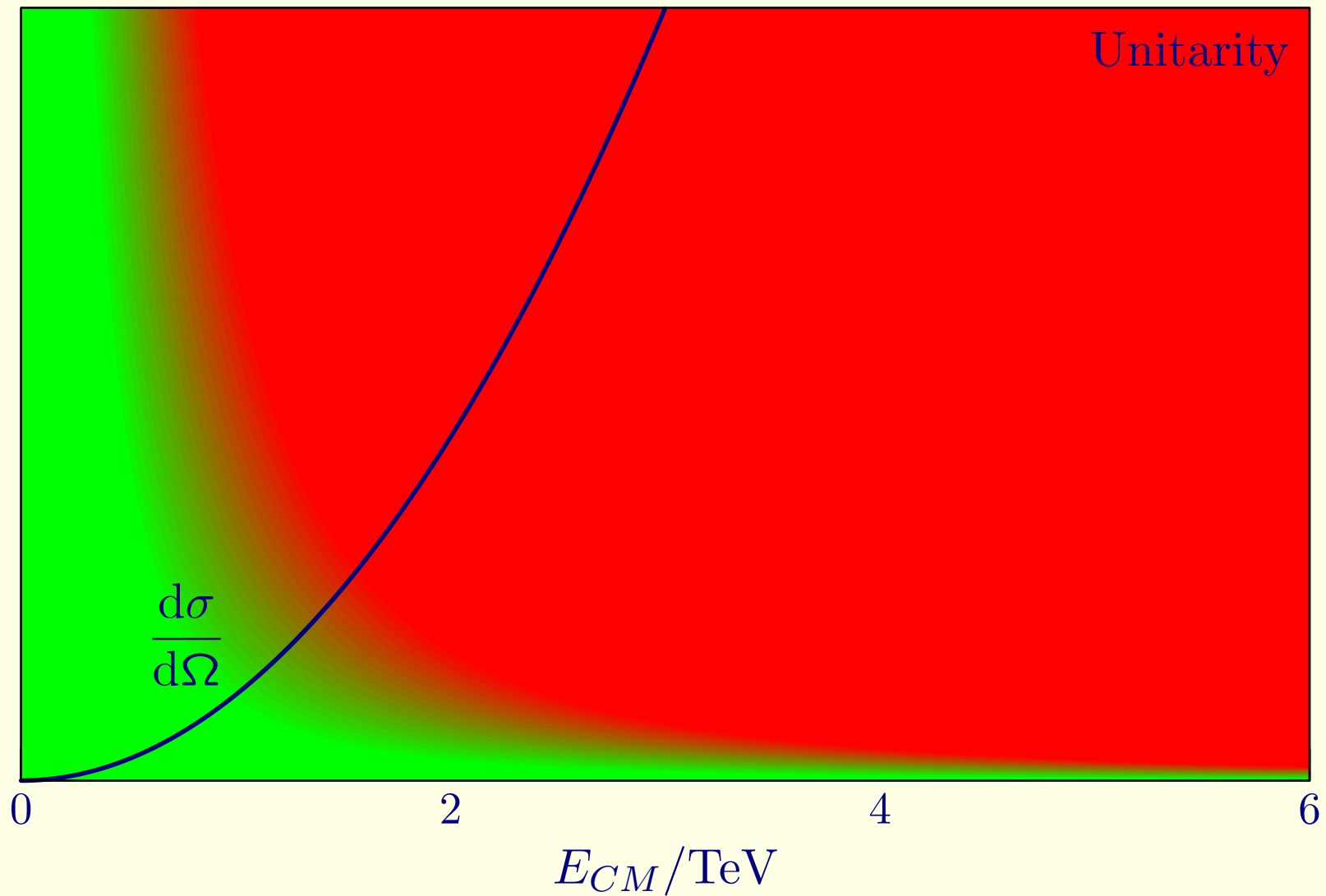
for $e^- \nu_e \rightarrow e^- \nu_e$.

1 Blending Graphics With the Background



Differential cross section and S -wave tree level unitarity bound
for $e^- \nu_e \rightarrow e^- \nu_e$.

1 Blending Graphics With the Background



Differential cross section and S -wave tree level unitarity bound
for $e^- \nu_e \rightarrow e^- \nu_e$.

2 Incremental Feynman Diagrams Synchronized With Equations

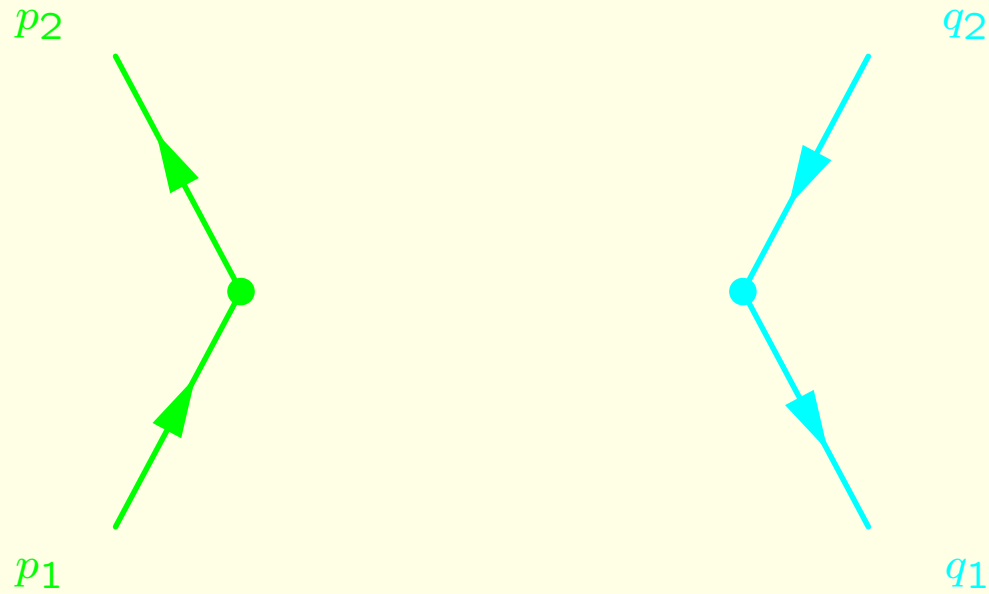
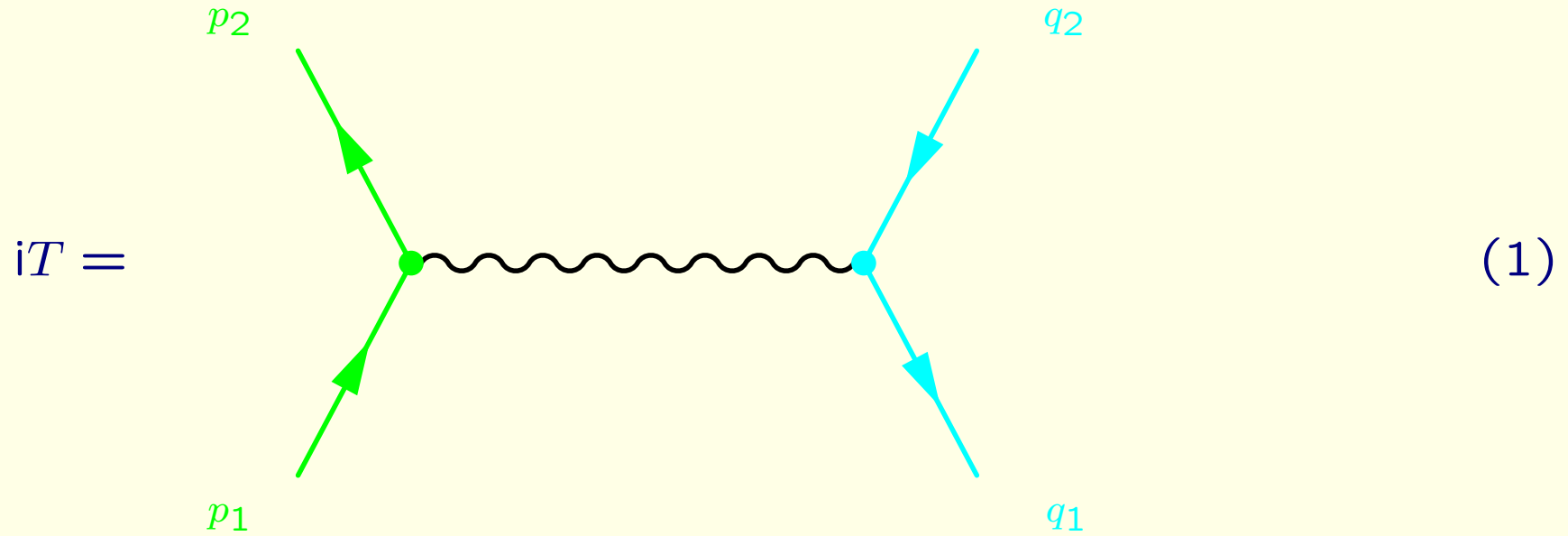
$$iT = \text{Diagram (1)} \quad (1)$$


Diagram (1) illustrates a vertex interaction. A central black dot represents the vertex. Two green lines with arrows pointing towards the vertex represent incoming particles with momenta p_1 and p_2 . Two cyan lines with arrows pointing away from the vertex represent outgoing particles with momenta q_1 and q_2 .

$$iT = \text{Diagram (2)} \quad (2)$$


Diagram (2) illustrates a vertex interaction. A central black dot represents the vertex. Two cyan lines with arrows pointing towards the vertex represent incoming particles with momenta q_1 and q_2 . Two green lines with arrows pointing away from the vertex represent outgoing particles with momenta p_1 and p_2 .

2 Incremental Feynman Diagrams Synchronized With Equations

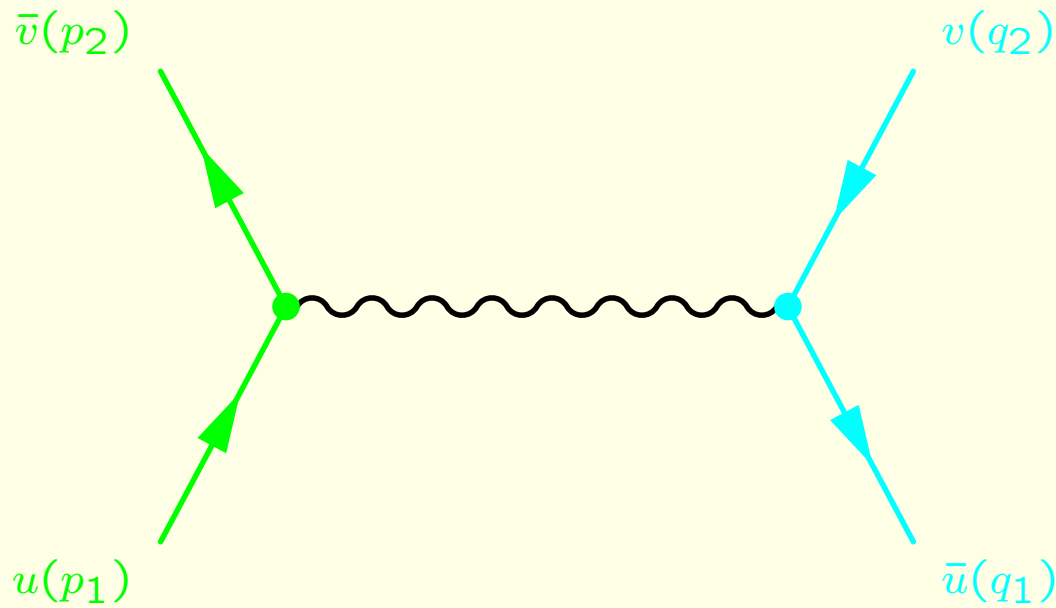


$iT =$

(2)

2 Incremental Feynman Diagrams Synchronized With Equations

$iT =$



The diagram shows a central wavy line representing a boson exchange between two vertices. The left vertex is a green dot where two green fermion lines meet. One green line, labeled $u(p_1)$, enters from the bottom-left. The other green line, labeled $\bar{v}(p_2)$, exits towards the top-left. The right vertex is a cyan dot where two cyan fermion lines meet. One cyan line, labeled $\bar{u}(q_1)$, enters from the bottom-right. The other cyan line, labeled $v(q_2)$, exits towards the top-right.

(1)

$iT = \bar{v}(p_2)$ $u(p_1)$ $\bar{u}(q_1)$ $v(q_2)$

(2)

2 Incremental Feynman Diagrams Synchronized With Equations

$iT =$

(1)

$$iT = \bar{v}(p_2)(-ie\gamma^\rho)u(p_1)$$

$$\bar{u}(q_1)(-ie\gamma^\sigma)v(q_2)$$

(2)

2 Incremental Feynman Diagrams Synchronized With Equations

The diagram shows a central wavy line representing a scalar boson exchange between two vertices. The left vertex is a green dot where two green fermion lines meet. One green line, labeled $u(p_1)$, enters from the bottom-left. The other green line, labeled $\bar{v}(p_2)$, exits from the top-left. The vertex is labeled $-ie\gamma_\rho$. The right vertex is a cyan dot where two cyan fermion lines meet. One cyan line, labeled $\bar{u}(q_1)$, enters from the bottom-right. The other cyan line, labeled $v(q_2)$, exits from the top-right. The vertex is labeled $-ie\gamma_\sigma$. The wavy line between the vertices is labeled with the propagator $\frac{-ig_{\rho\sigma}}{(p_1 + p_2)^2 + i\epsilon}$. To the left of the diagram is the text $iT =$. To the right of the diagram is the label (1) .

$$iT = \text{Diagram} \quad (1)$$

$$iT = \bar{v}(p_2)(-ie\gamma^\rho)u(p_1) \frac{-ig_{\rho\sigma}}{(p_1 + p_2)^2 + i\epsilon} \bar{u}(q_1)(-ie\gamma^\sigma)v(q_2) \quad (2)$$

2 Incremental Feynman Diagrams Synchronized With Equations

$iT =$

$$\frac{-ig_{\rho\sigma}}{(p_1 + p_2)^2 + i\epsilon}$$

(1)

$$\begin{aligned}
 iT &= \bar{v}(p_2)(-ie\gamma^\rho)u(p_1) \frac{-ig_{\rho\sigma}}{(p_1 + p_2)^2 + i\epsilon} \bar{u}(q_1)(-ie\gamma^\sigma)v(q_2) \\
 &= ie^2 \frac{1}{s} [\bar{v}(p_2)\gamma_\rho u(p_1)] [\bar{u}(q_1)\gamma^\rho v(q_2)] \quad (2)
 \end{aligned}$$

3 Incremental Metapost Boxes

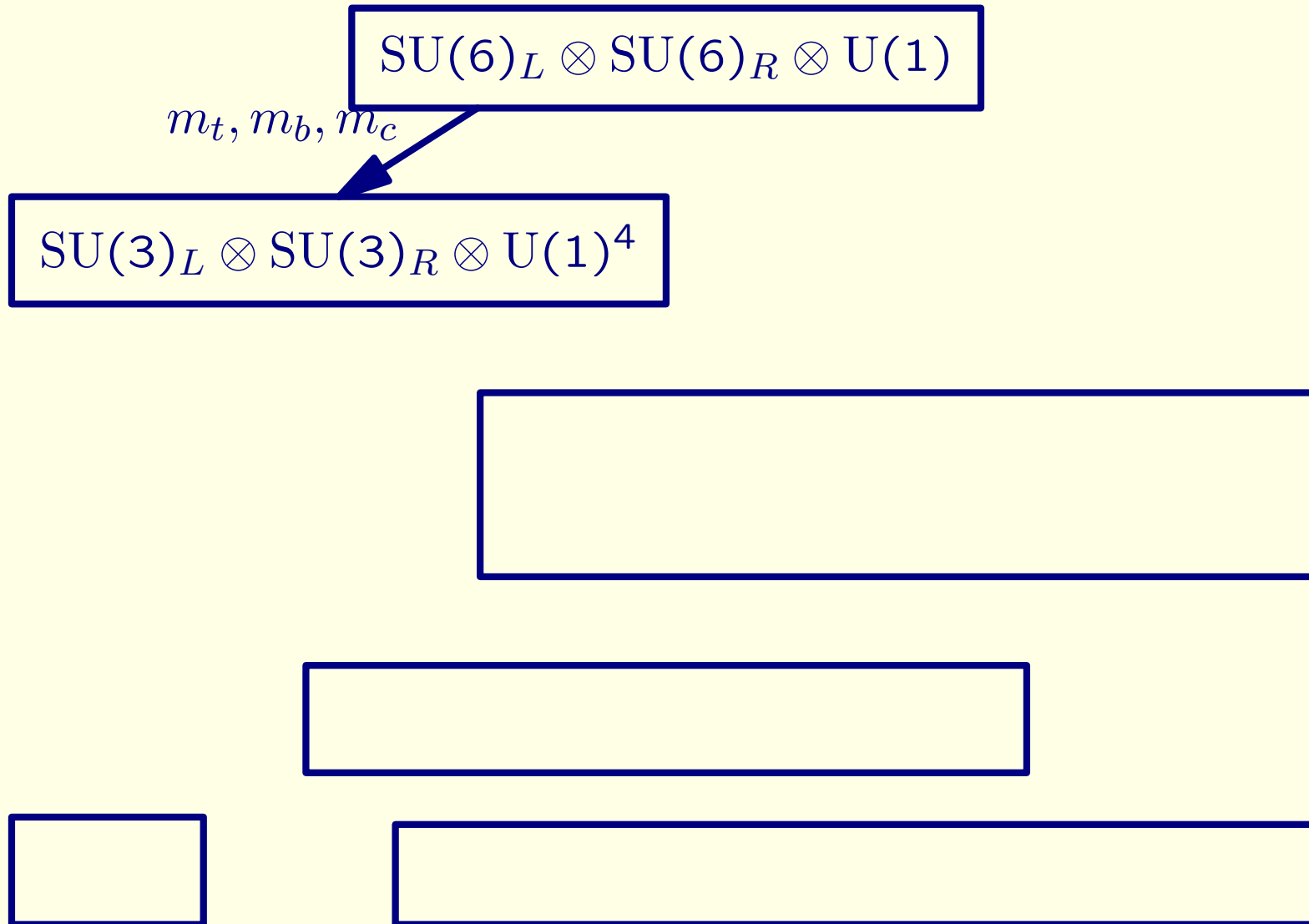
Chiral symmetries in the standard model

$$SU(6)_L \otimes SU(6)_R \otimes U(1)$$



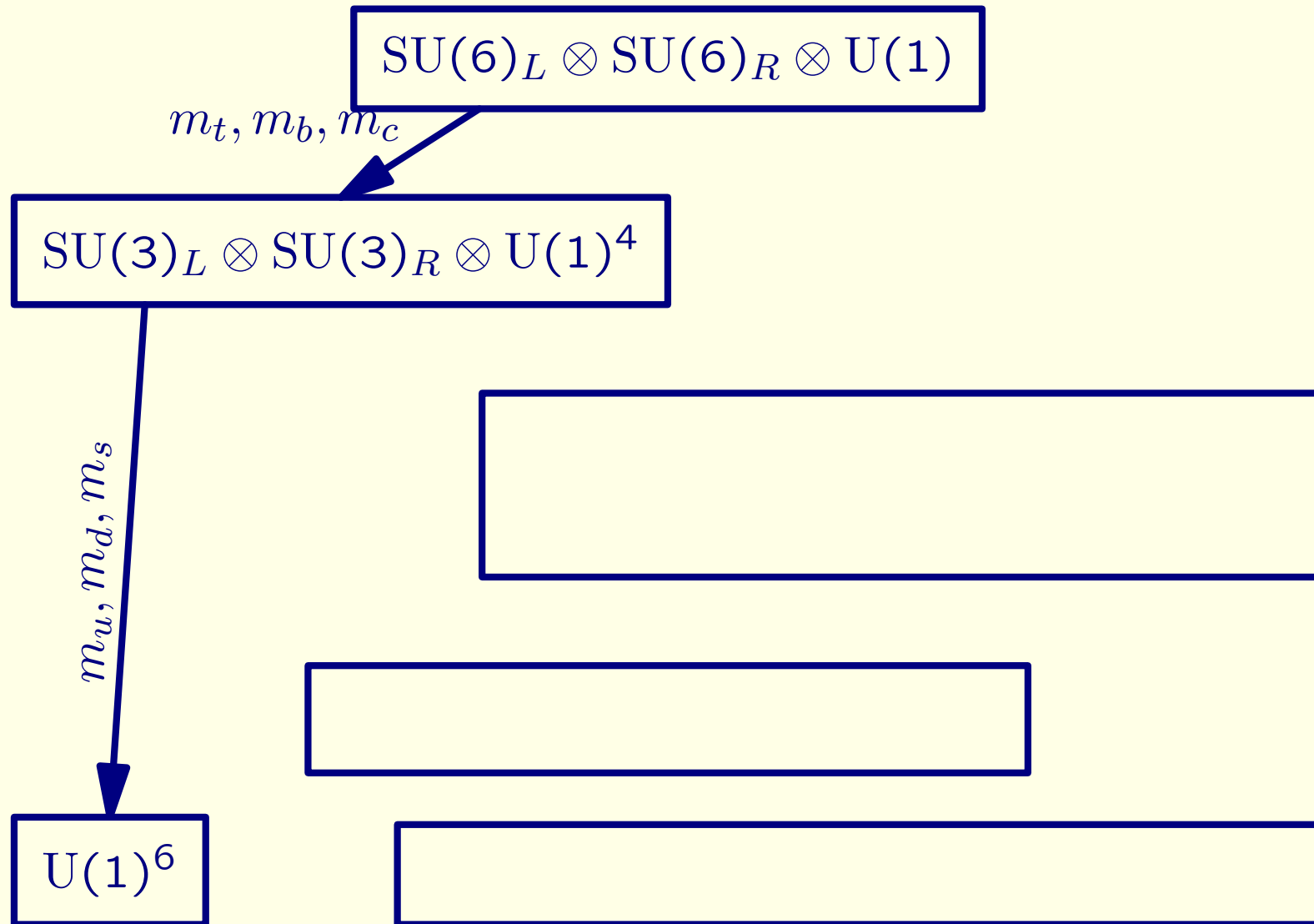
3 Incremental Metapost Boxes

Chiral symmetries in the standard model broken by quark masses



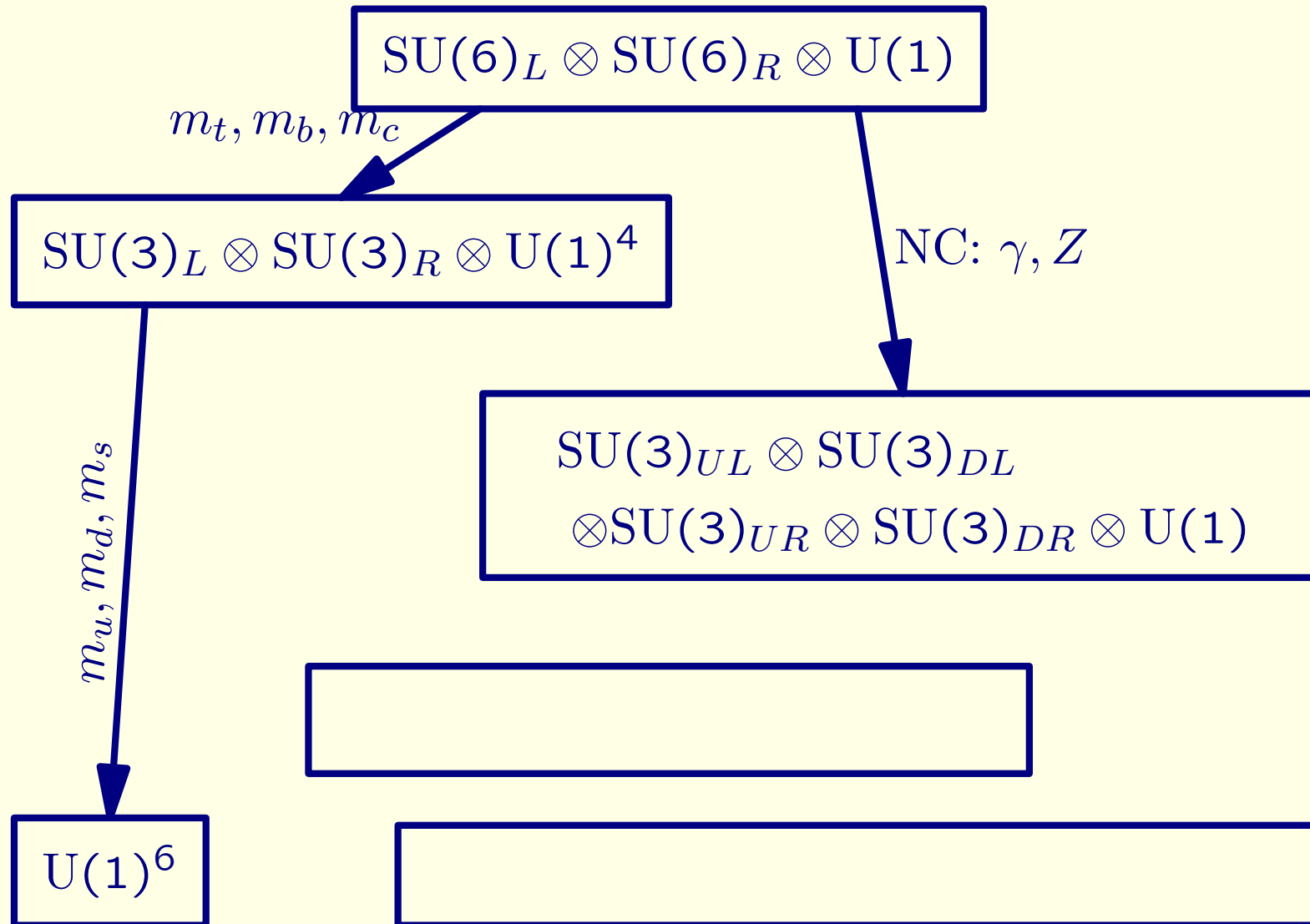
3 Incremental Metapost Boxes

Chiral symmetries in the standard model broken by quark masses



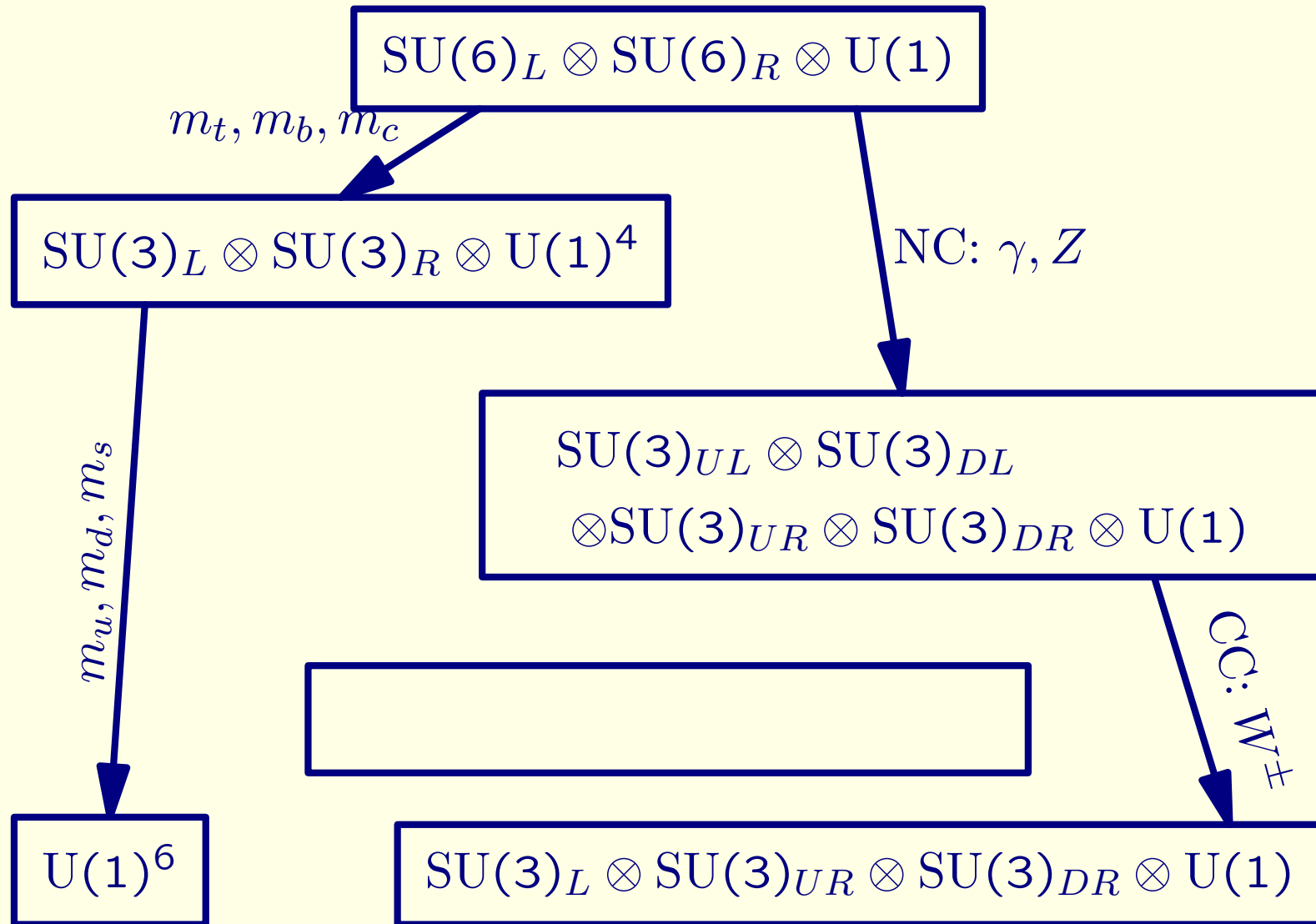
3 Incremental Metapost Boxes

Chiral symmetries in the standard model broken by quark masses and electroweak interactions:



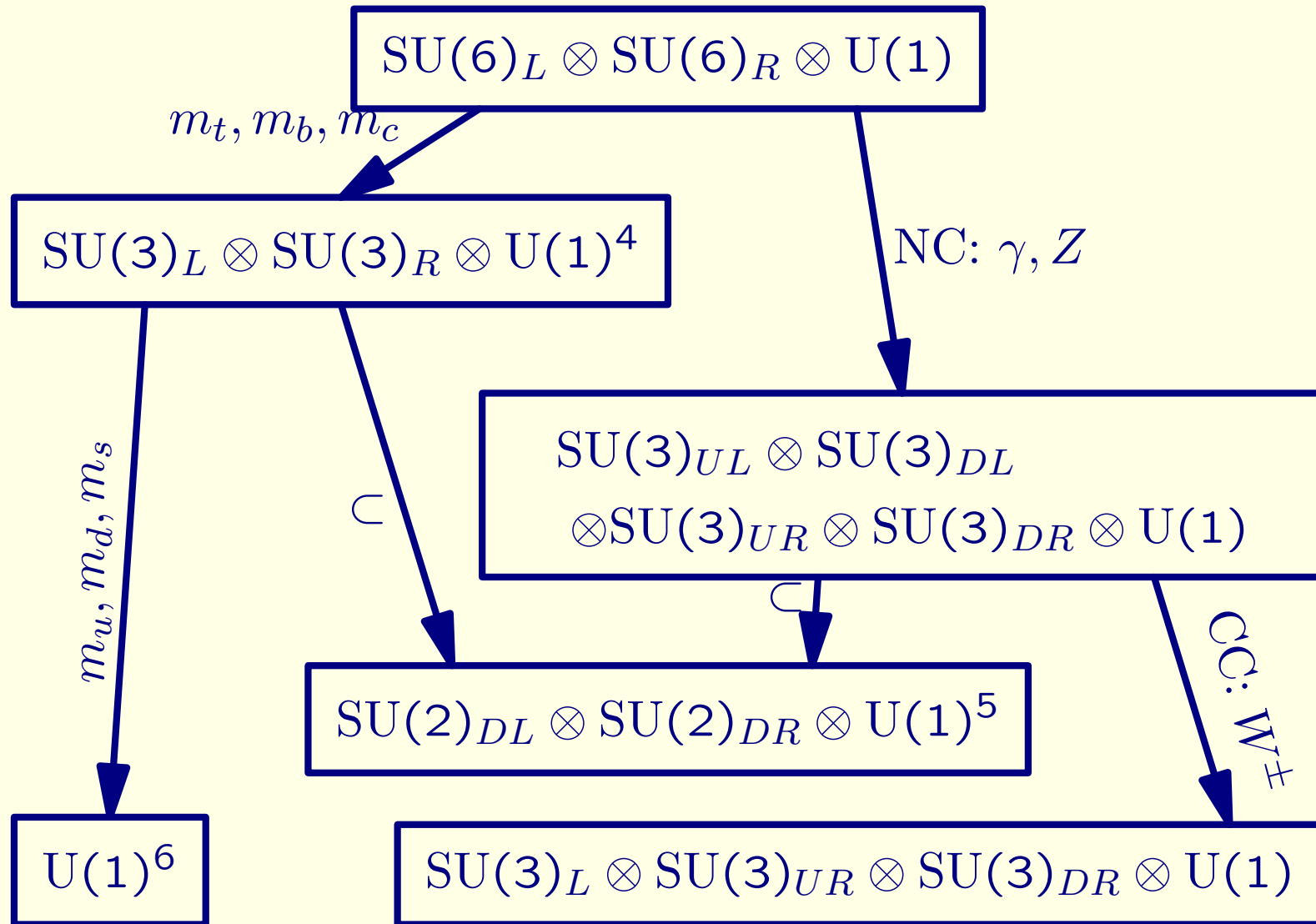
3 Incremental Metapost Boxes

Chiral symmetries in the standard model broken by quark masses and electroweak interactions:



3 Incremental Metapost Boxes

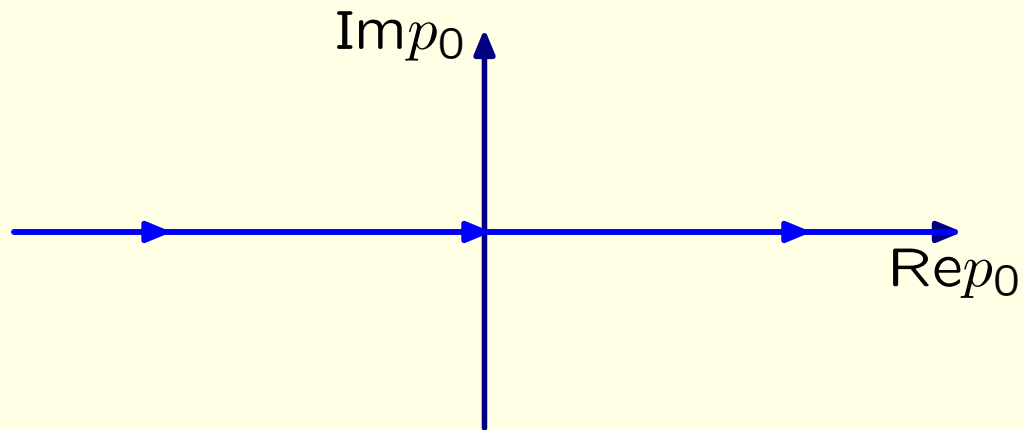
Chiral symmetries in the standard model broken by quark masses and electroweak interactions:



4 Incremental Graphics Synchronized With Text

$$\int_{-\infty}^{+\infty} dp_0 \frac{e^{-ipx}}{p^2 - m^2} \quad (3)$$

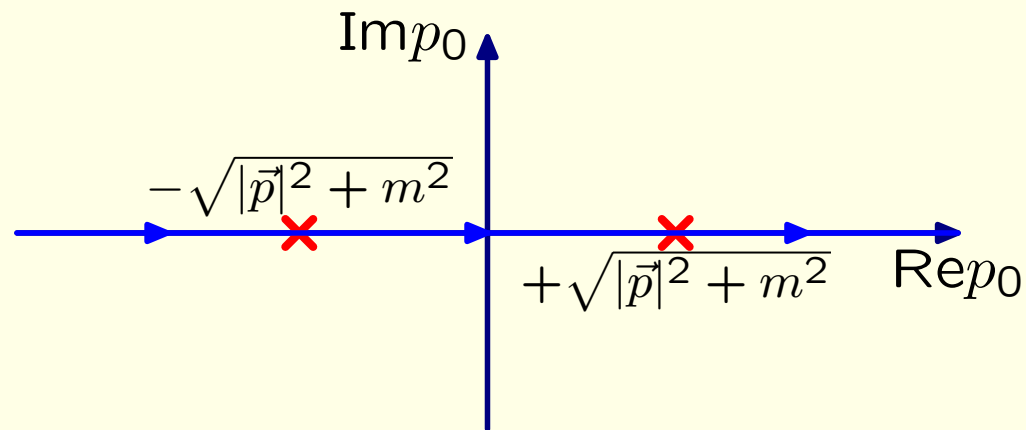
The integral over the energy of the intermediate states in the complex p_0 -plane



4 Incremental Graphics Synchronized With Text

$$\int_{-\infty}^{+\infty} dp_0 \frac{e^{-ipx}}{p^2 - m^2} \quad (3)$$

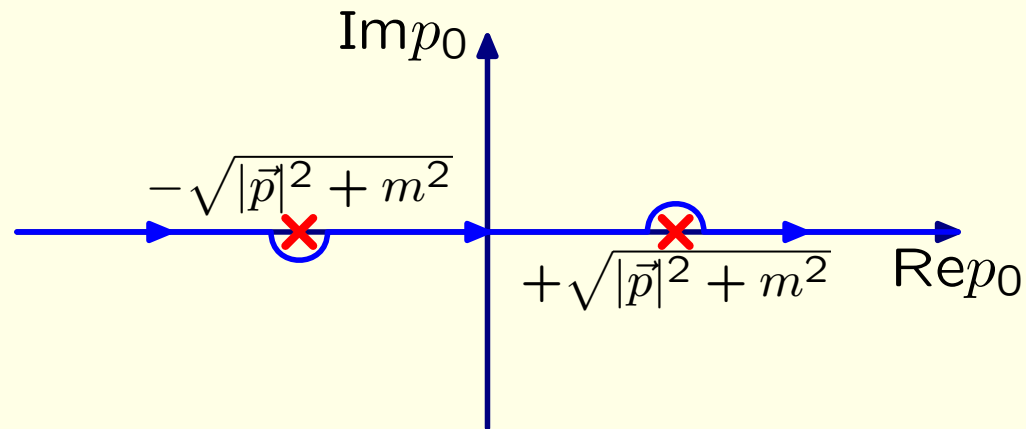
The integral over the energy of the intermediate states in the complex p_0 -plane encounters two **poles** at $p_0 = \pm \sqrt{|\vec{p}|^2 + m^2}$.



4 Incremental Graphics Synchronized With Text

$$\int_{-\infty}^{+\infty} dp_0 \frac{e^{-ipx}}{p^2 - m^2} \quad (3)$$

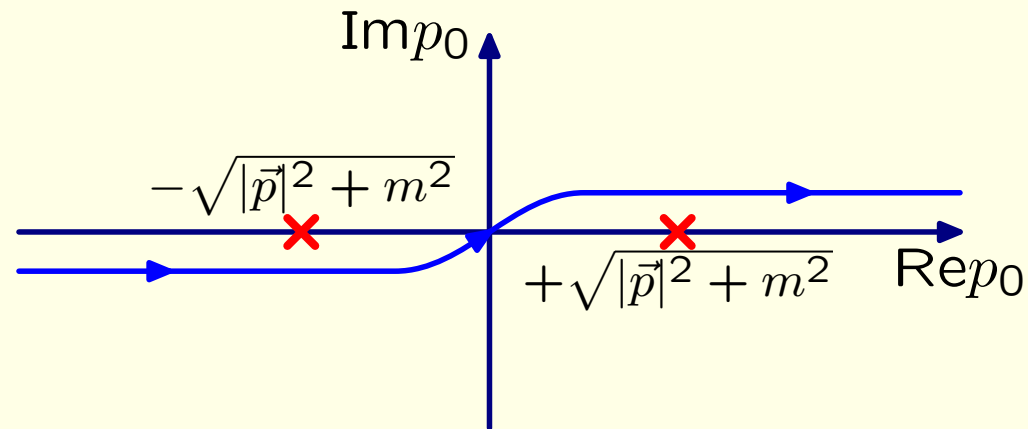
The integral over the energy of the intermediate states in the complex p_0 -plane encounters two **poles** at $p_0 = \pm\sqrt{|\vec{p}|^2 + m^2}$. These poles are circled corresponding to Feynman's boundary conditions.



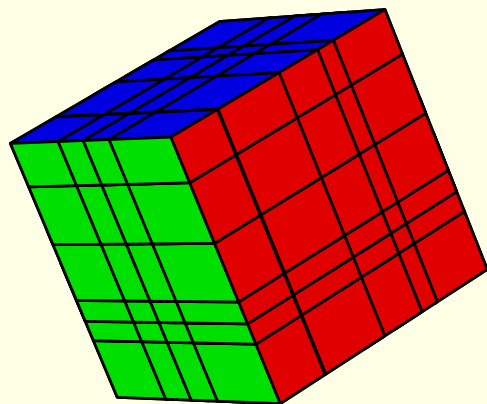
4 Incremental Graphics Synchronized With Text

$$\lim_{\epsilon \rightarrow 0} \int_{-\infty}^{+\infty} dp_0 \frac{e^{-ipx}}{p^2 - m^2 + i\epsilon} \quad (3)$$

The integral over the energy of the intermediate states in the complex p_0 -plane encounters two **poles** at $p_0 = \pm \sqrt{|\vec{p}|^2 + m^2}$. These poles are circled corresponding to Feynman's boundary conditions. This pole prescription can be expressed most concisely as a “ $+i\epsilon$ -prescription”.

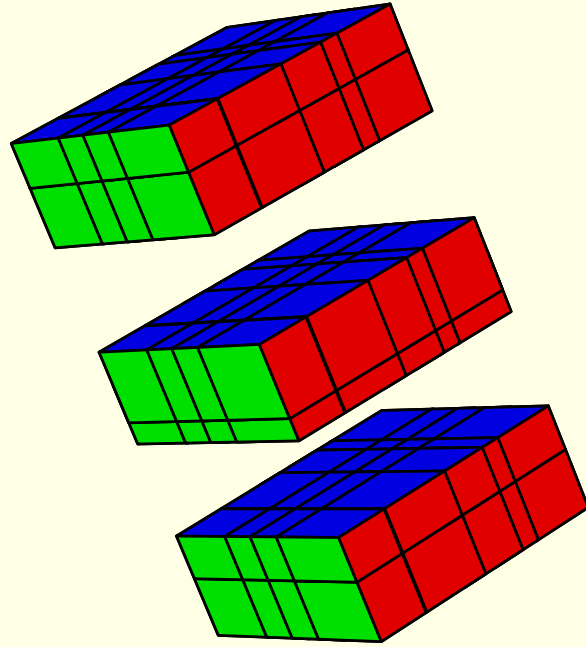


5 3D Metapost Synchronized With Equations



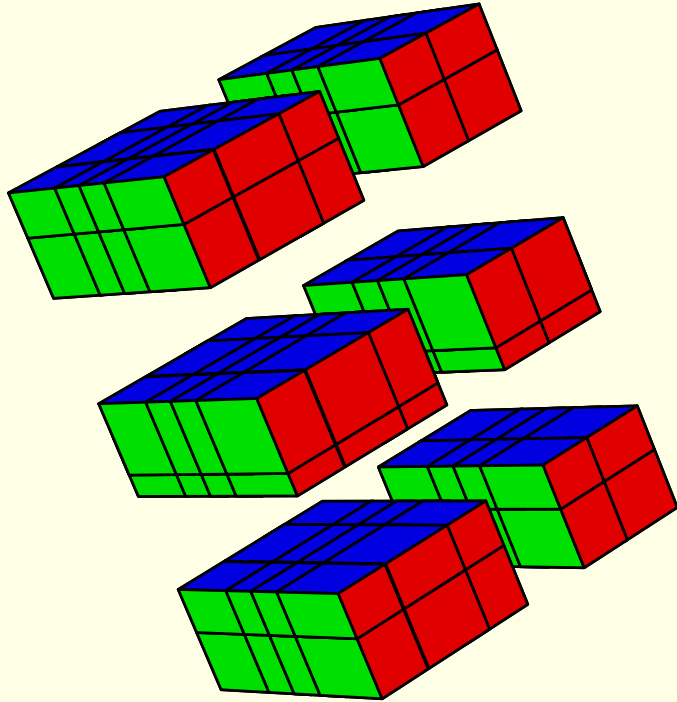
$$D = D_1 \otimes D_2 \otimes D_3$$

5 3D Metapost Synchronized With Equations



$$\begin{aligned} D &= D_1 \otimes D_2 \otimes D_3 \\ &= (D_1^{(1)} \oplus D_1^{(2)} \oplus D_1^{(3)}) \otimes D_2 \otimes D_3 \end{aligned}$$

5 3D Metapost Synchronized With Equations

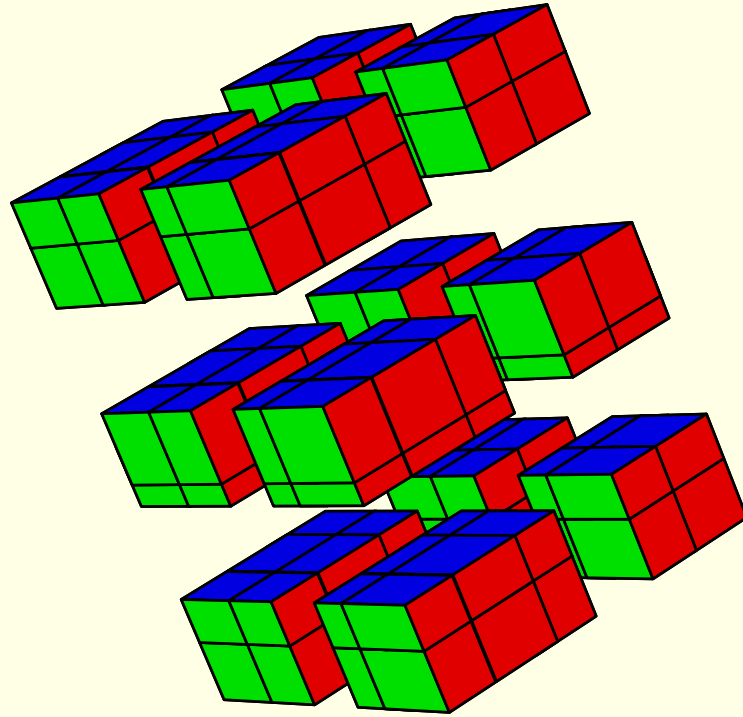


$$D = D_1 \otimes D_2 \otimes D_3$$

$$= (D_1^{(1)} \oplus D_1^{(2)} \oplus D_1^{(3)}) \otimes D_2 \otimes D_3$$

$$= (D_1^{(1)} \oplus D_1^{(2)} \oplus D_1^{(3)}) \otimes (D_2^{(1)} \oplus D_2^{(2)}) \otimes D_3$$

5 3D Metapost Synchronized With Equations



$$D = D_1 \otimes D_2 \otimes D_3$$

$$= (D_1^{(1)} \oplus D_1^{(2)} \oplus D_1^{(3)}) \otimes D_2 \otimes D_3$$

$$= (D_1^{(1)} \oplus D_1^{(2)} \oplus D_1^{(3)}) \otimes (D_2^{(1)} \oplus D_2^{(2)}) \otimes D_3$$

$$= (D_1^{(1)} \oplus D_1^{(2)} \oplus D_1^{(3)}) \otimes (D_2^{(1)} \oplus D_2^{(2)}) \otimes (D_3^{(1)} \oplus D_3^{(2)})$$