



FeynGame

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Other contributors:

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SUISSE
FRANCE

CMS

LHCb

ATLAS

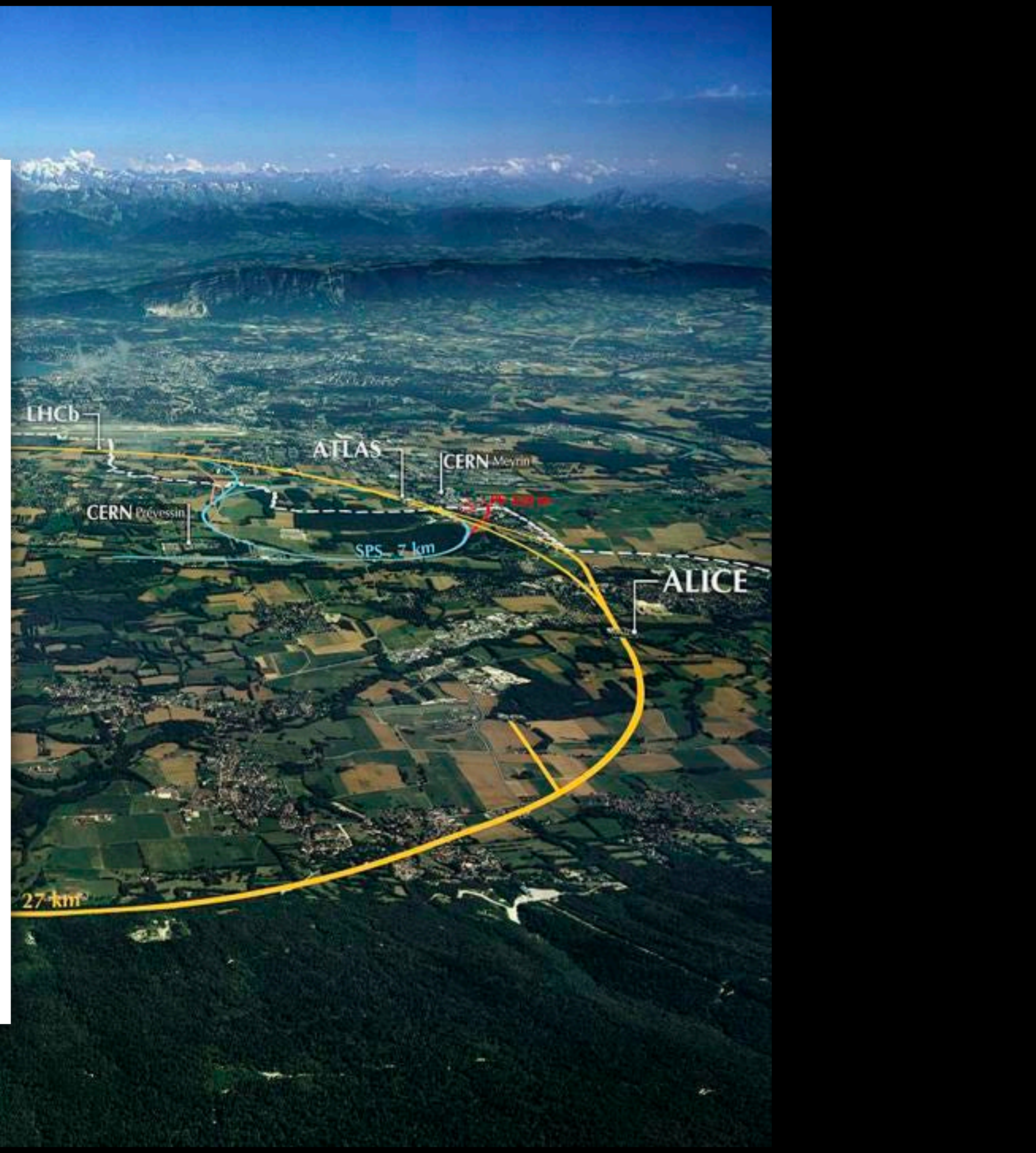
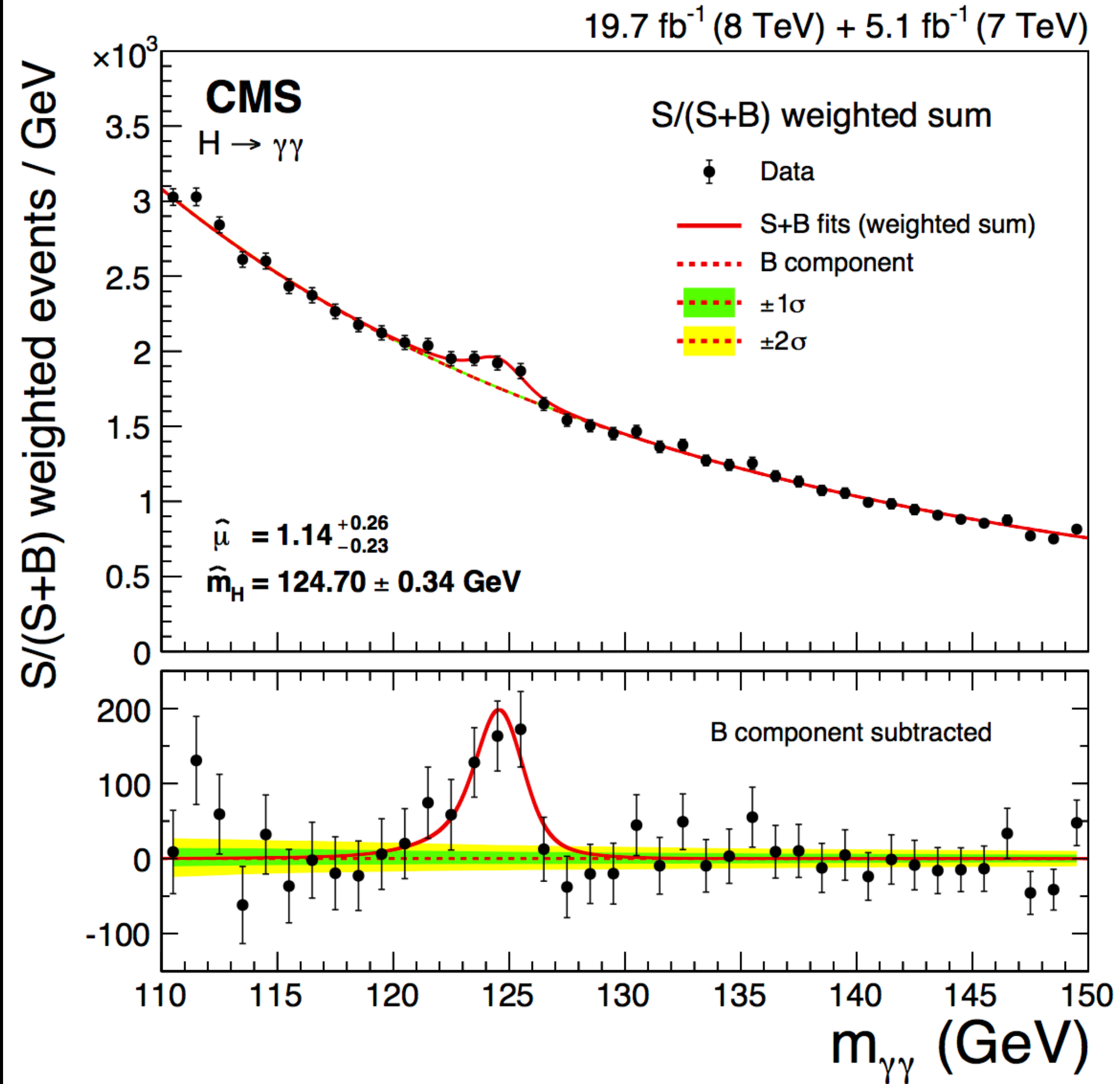
CERN Meyrin

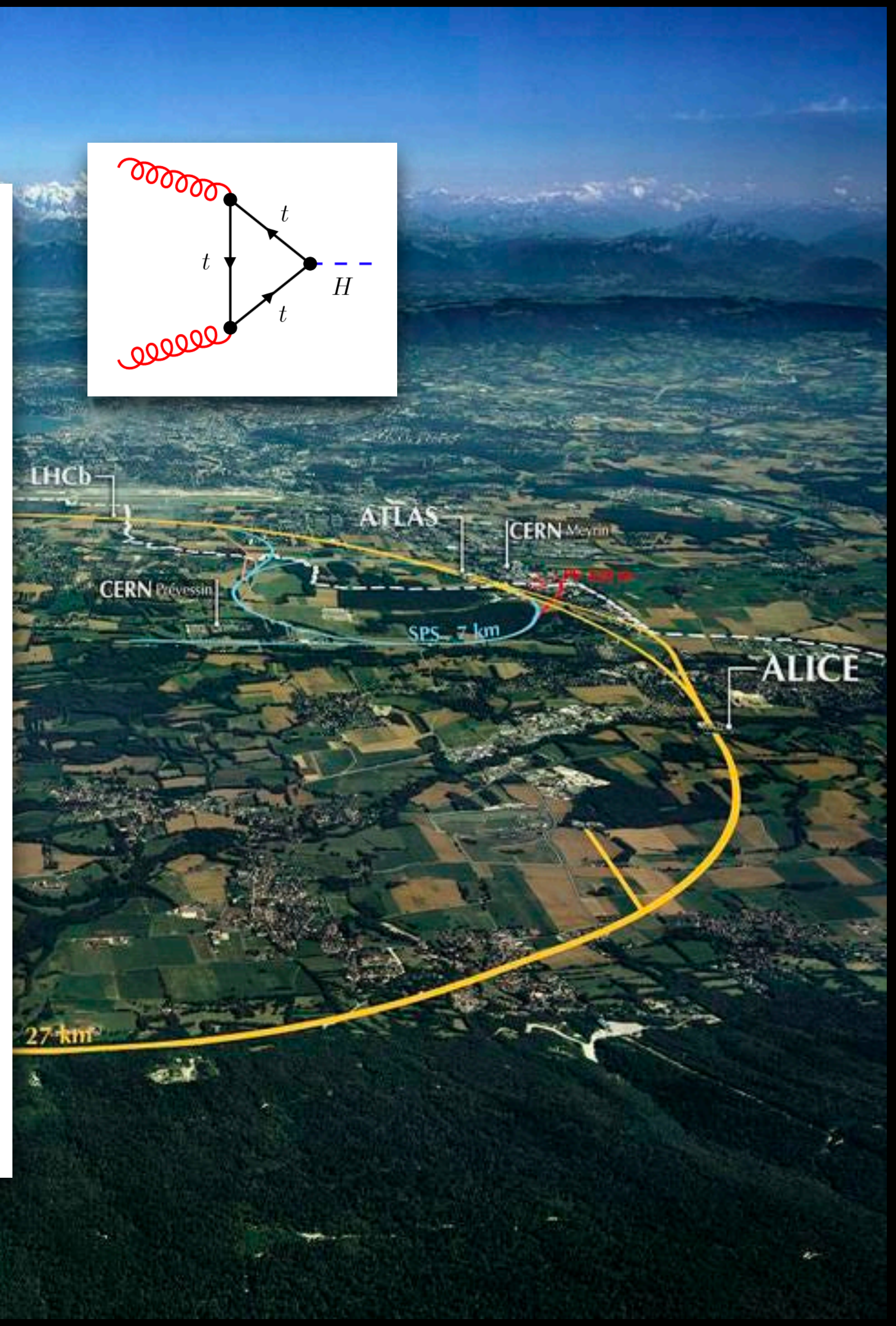
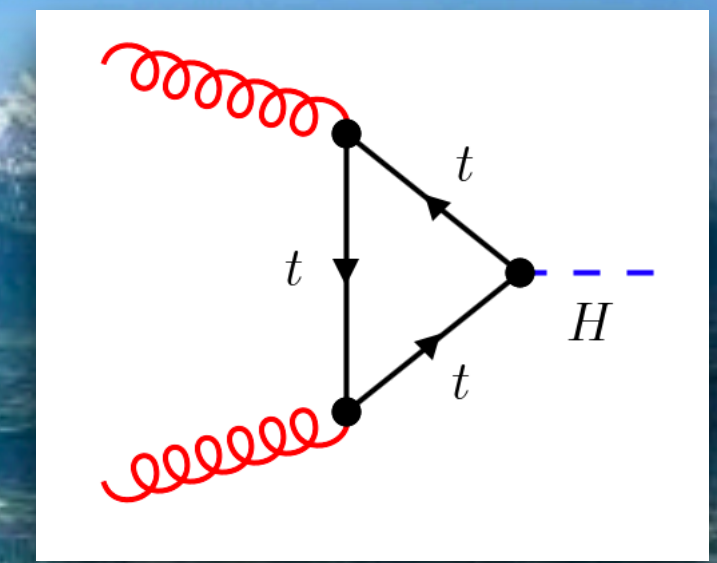
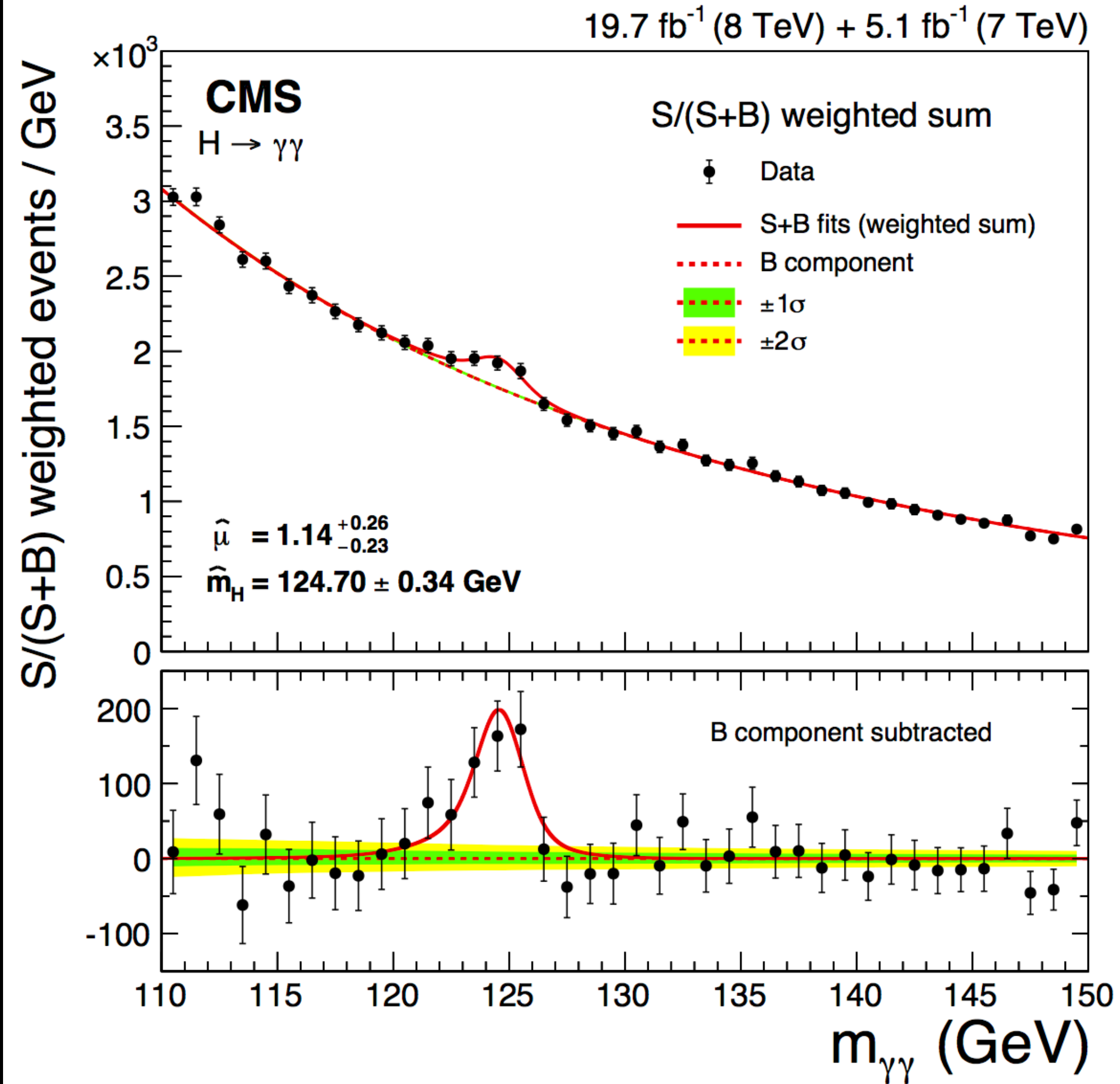
CERN Prévessin

SPS 7 km

ALICE

LHC 27 km





Space-Time Approach to Quantum Electrodynamics

R. P. FEYNMAN

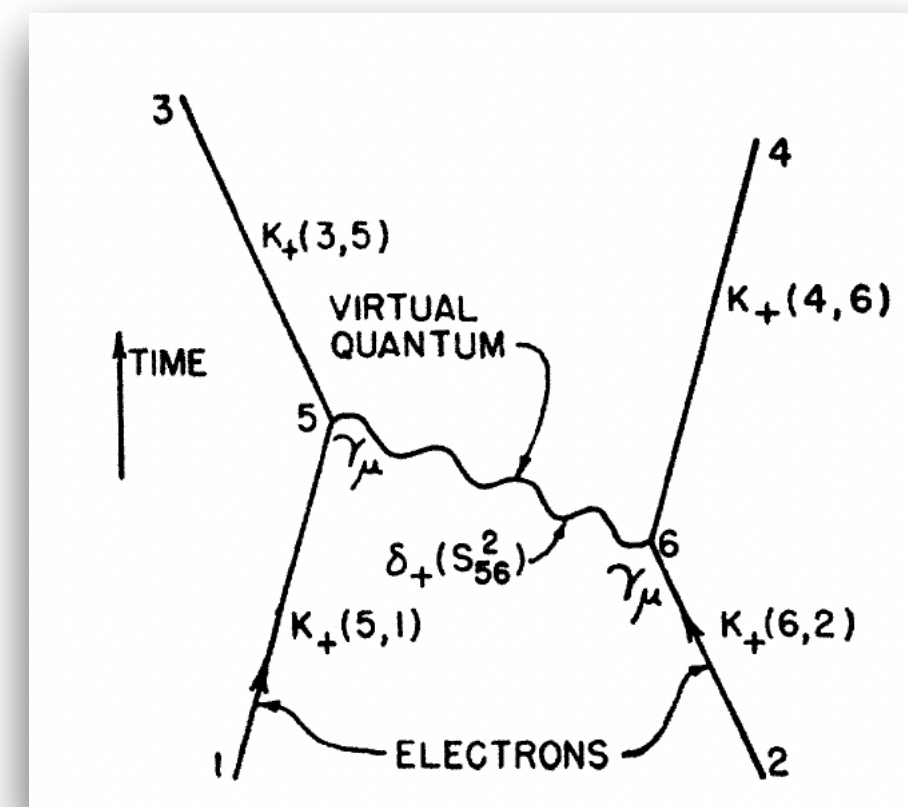
Department of Physics, Cornell University, Ithaca, New York

(Received May 9, 1949)

In this paper two things are done. (1) It is shown that a considerable simplification can be attained in writing down matrix elements for complex processes in electrodynamics. Further, a physical point of view is available which permits them to be written down directly for any specific problem. Being simply a

and presumably consistent, method is therefore available for the calculation of all processes involving electrons and photons.

The simplification in writing the expressions results from an emphasis on the over-all space-time view resulting from a study of the solution of the equations of electrodynamics. The relation





electrostatics



electrostatics



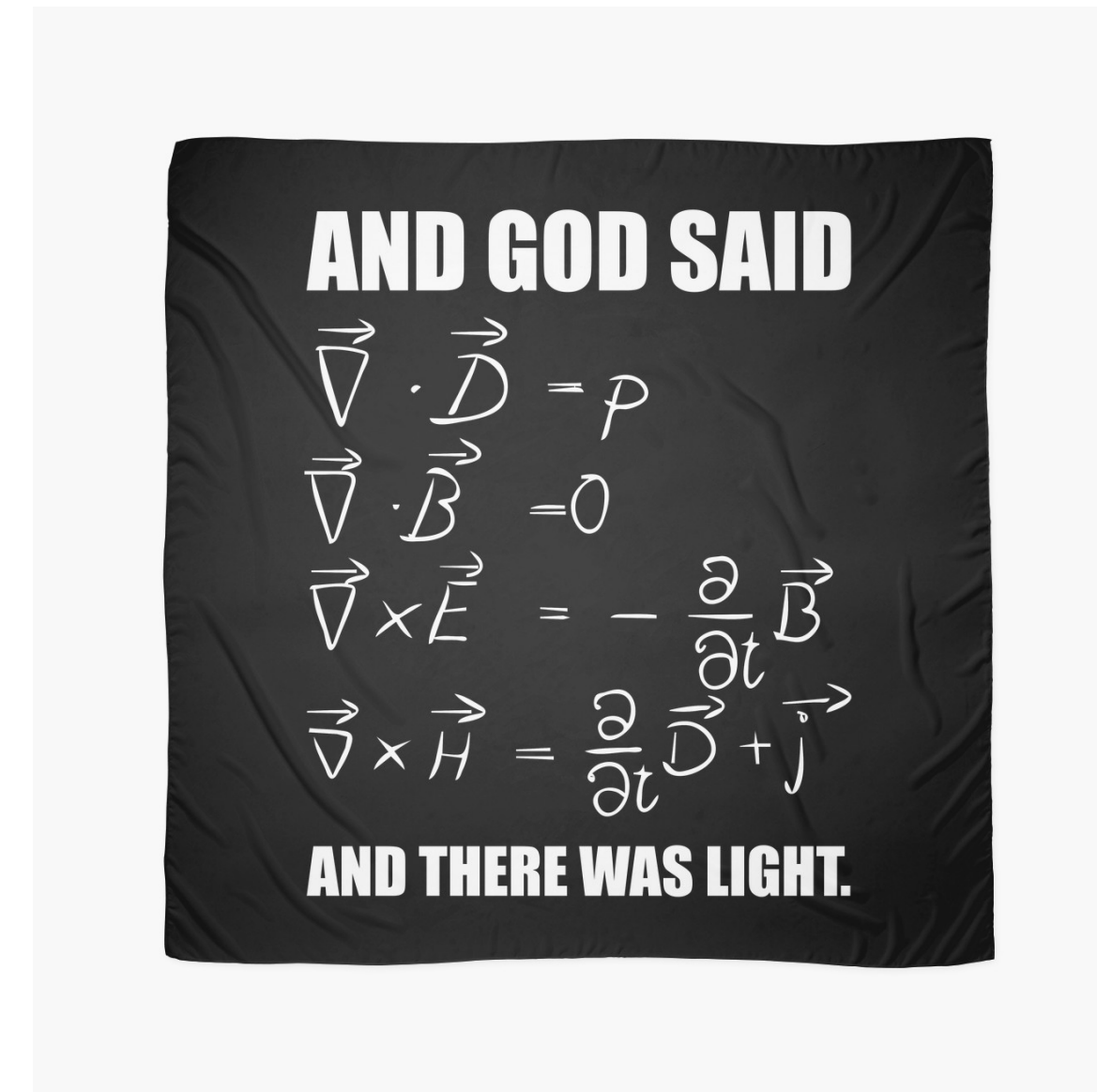
magnetism



electrostatics



magnetism



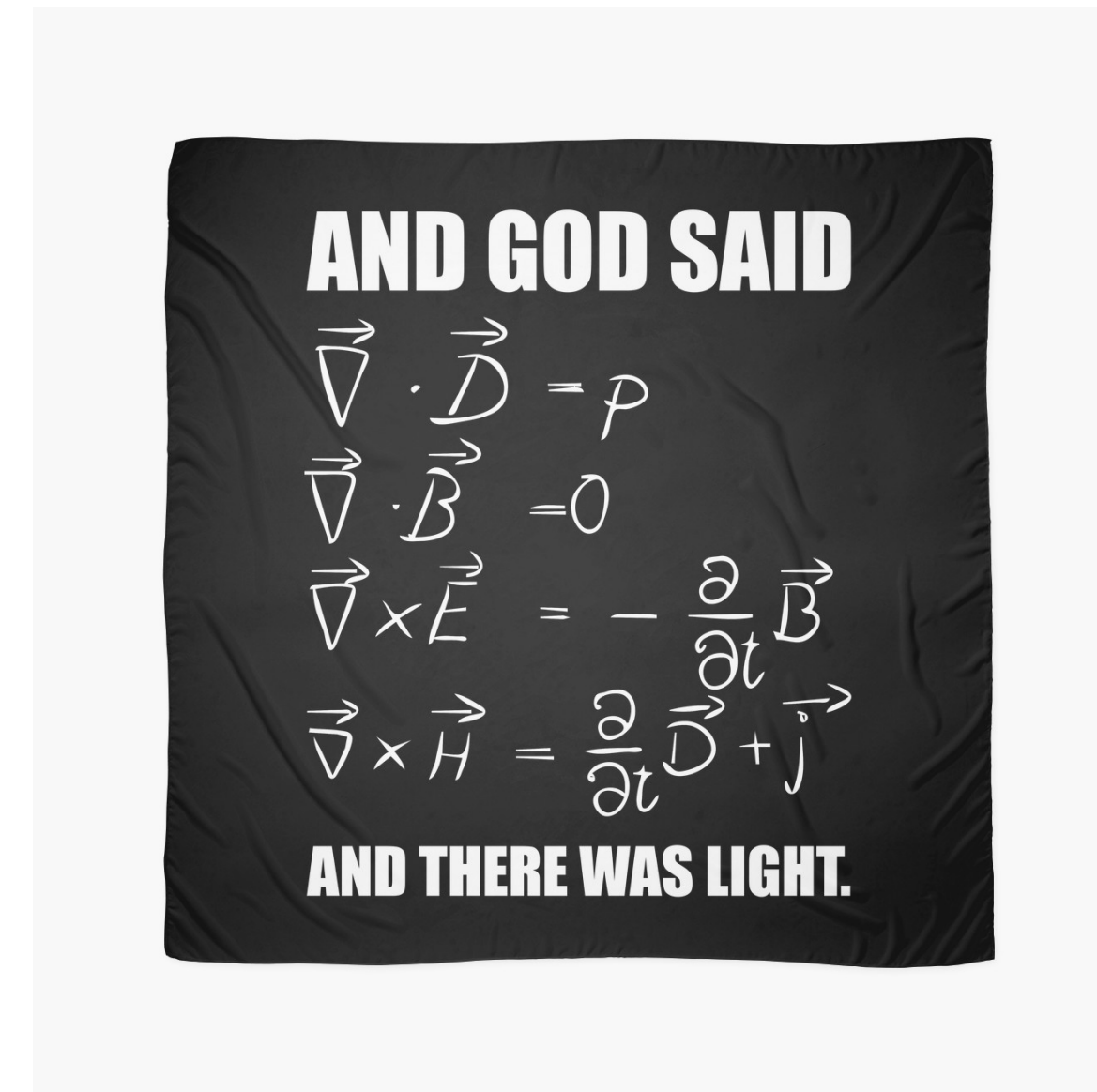
James Clerk Maxwell



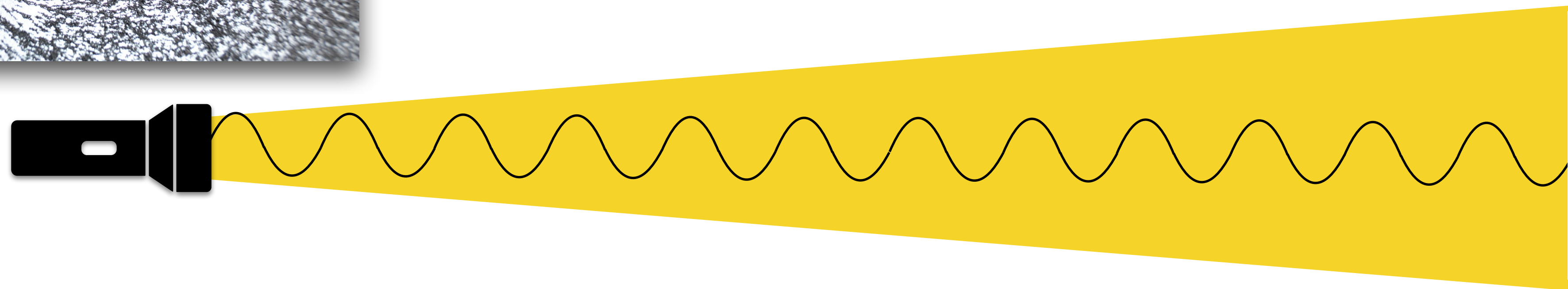
electrostatics



magnetism



James Clerk Maxwell



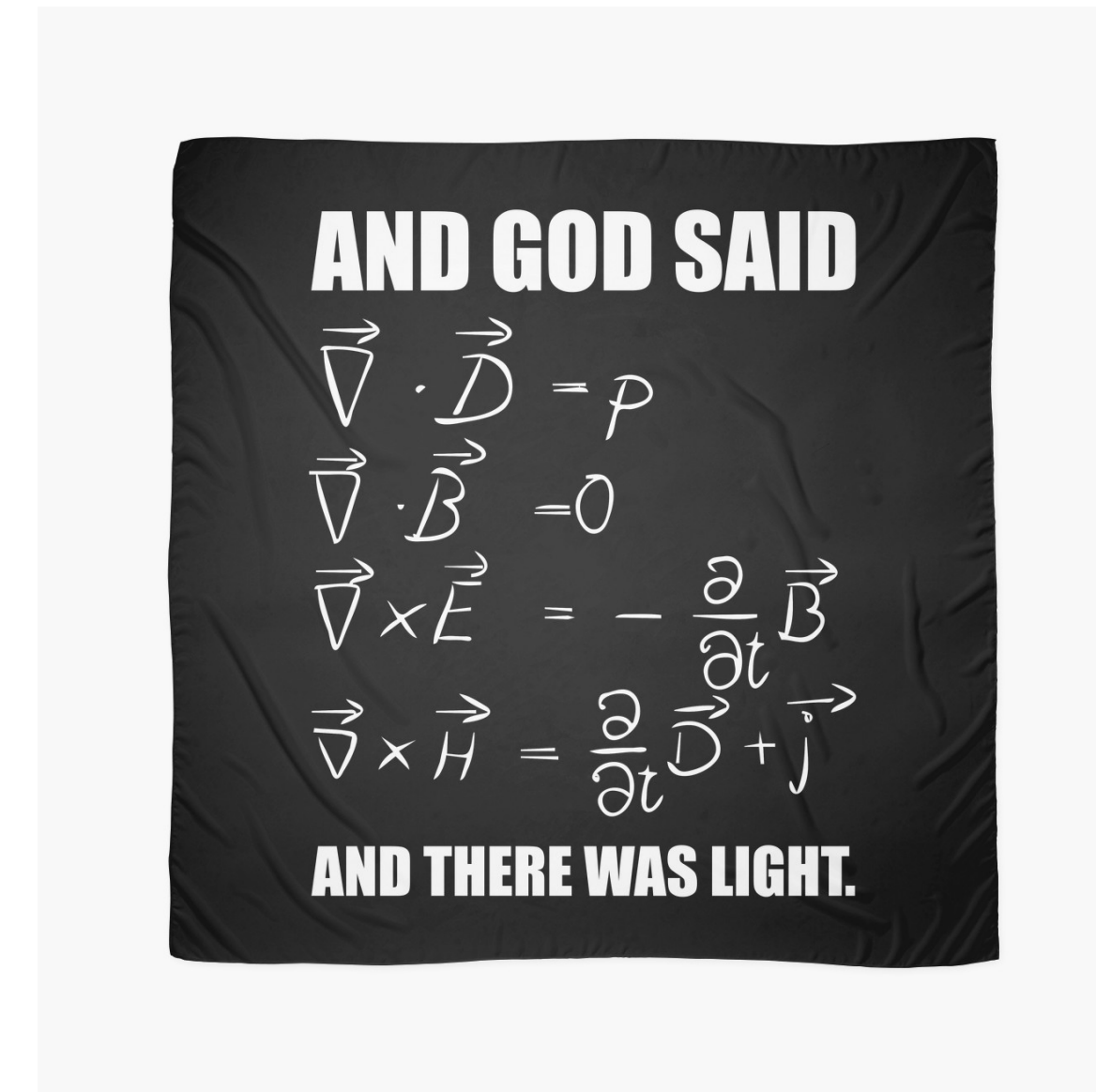
electrodynamics



electrostatics



magnetism



James Clerk Maxwell

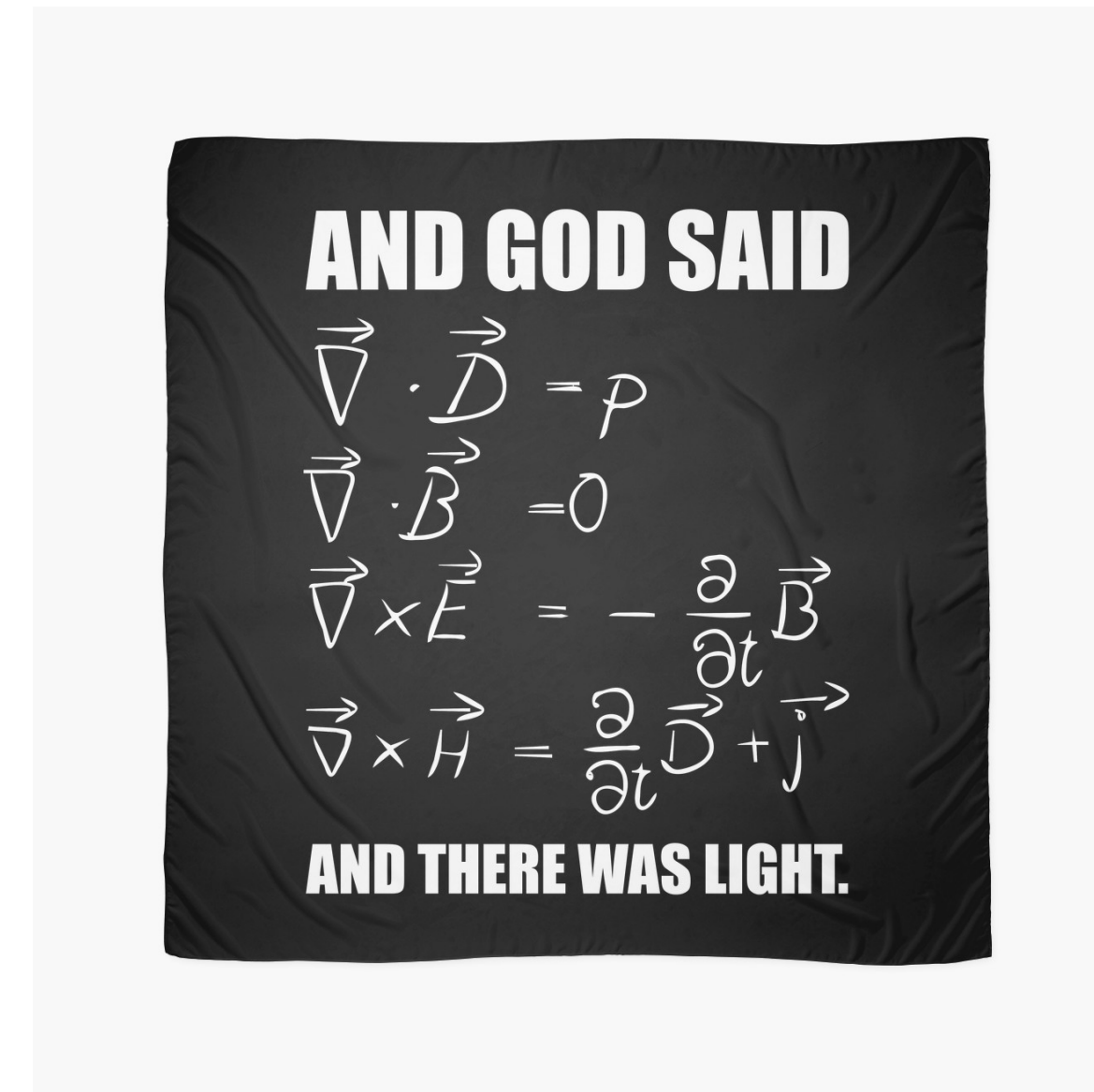
electrodynamics



electrostatics



magnetism



James Clerk Maxwell



quantum electrodynamics

● e^-

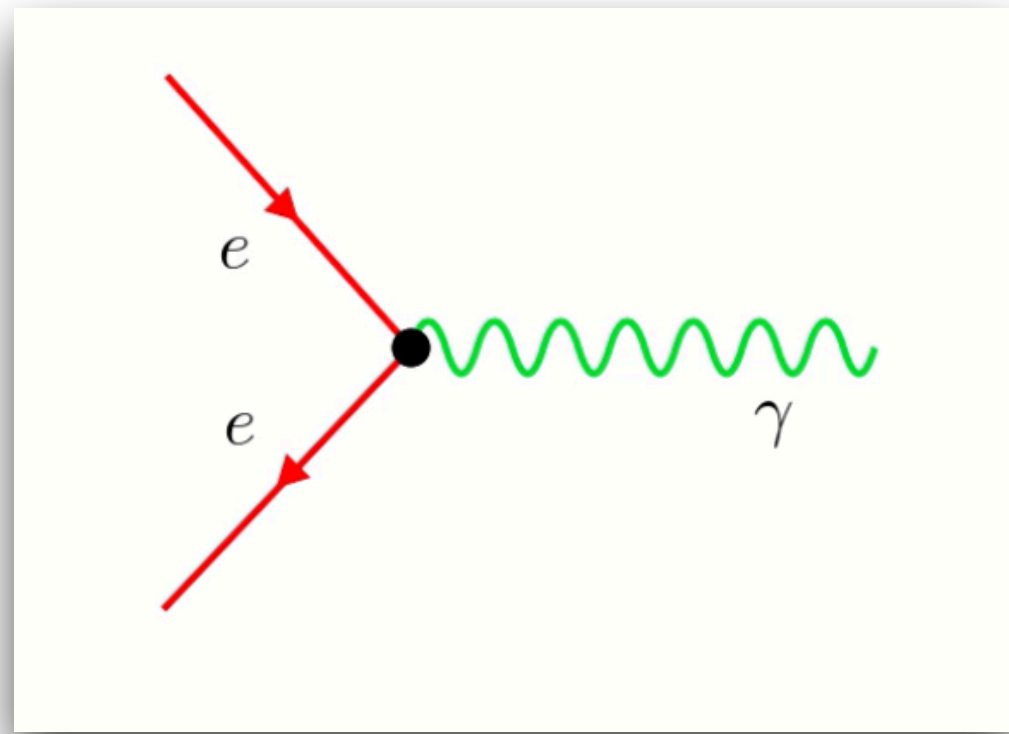
● e^-

● e^-

● e^-

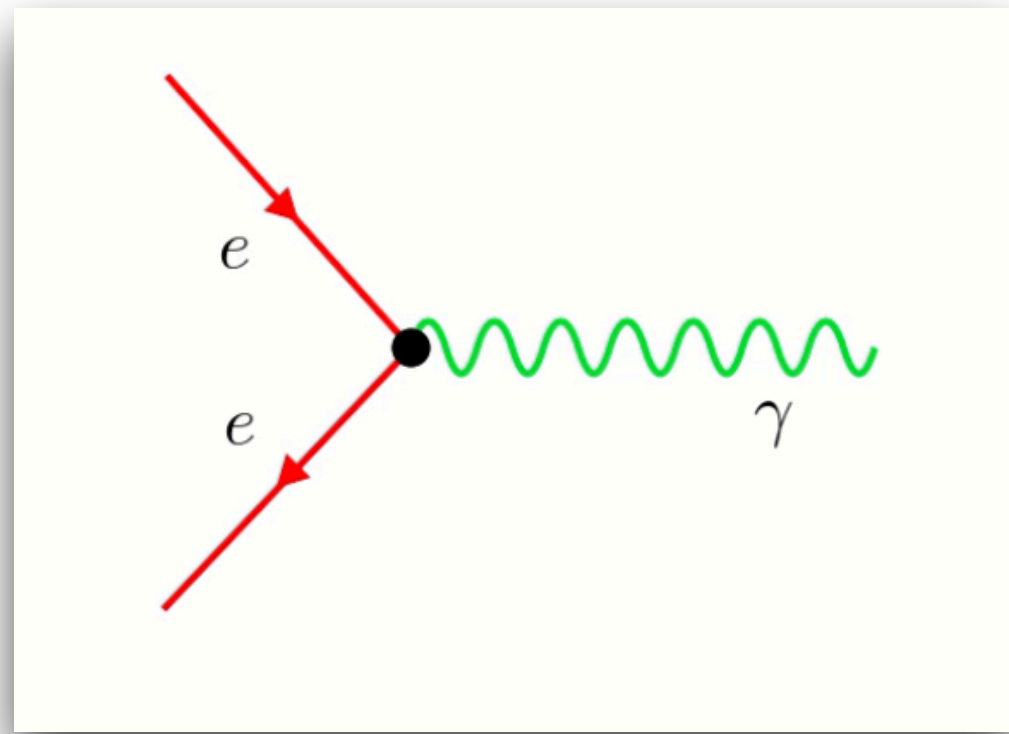
● e^-

● e^-



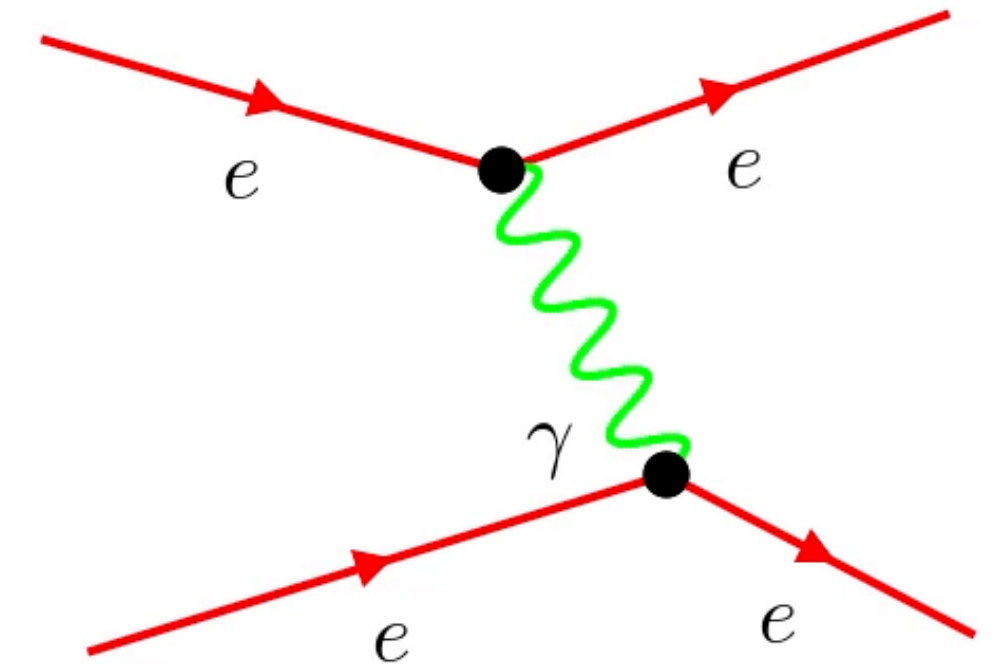
● e^-

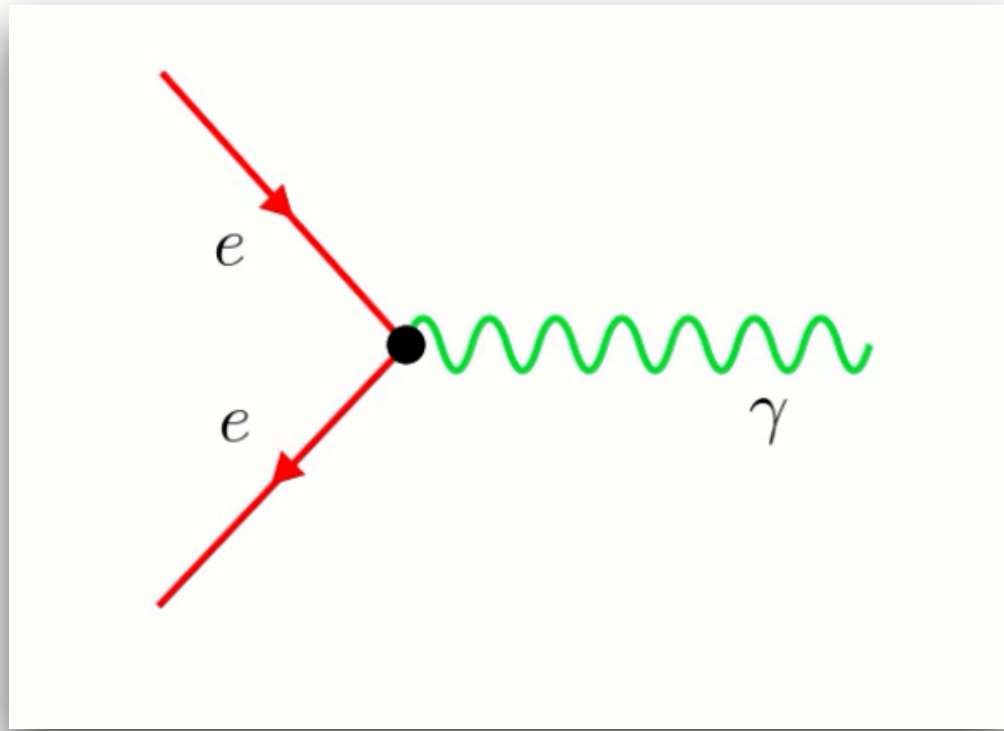
● e^-



e^-

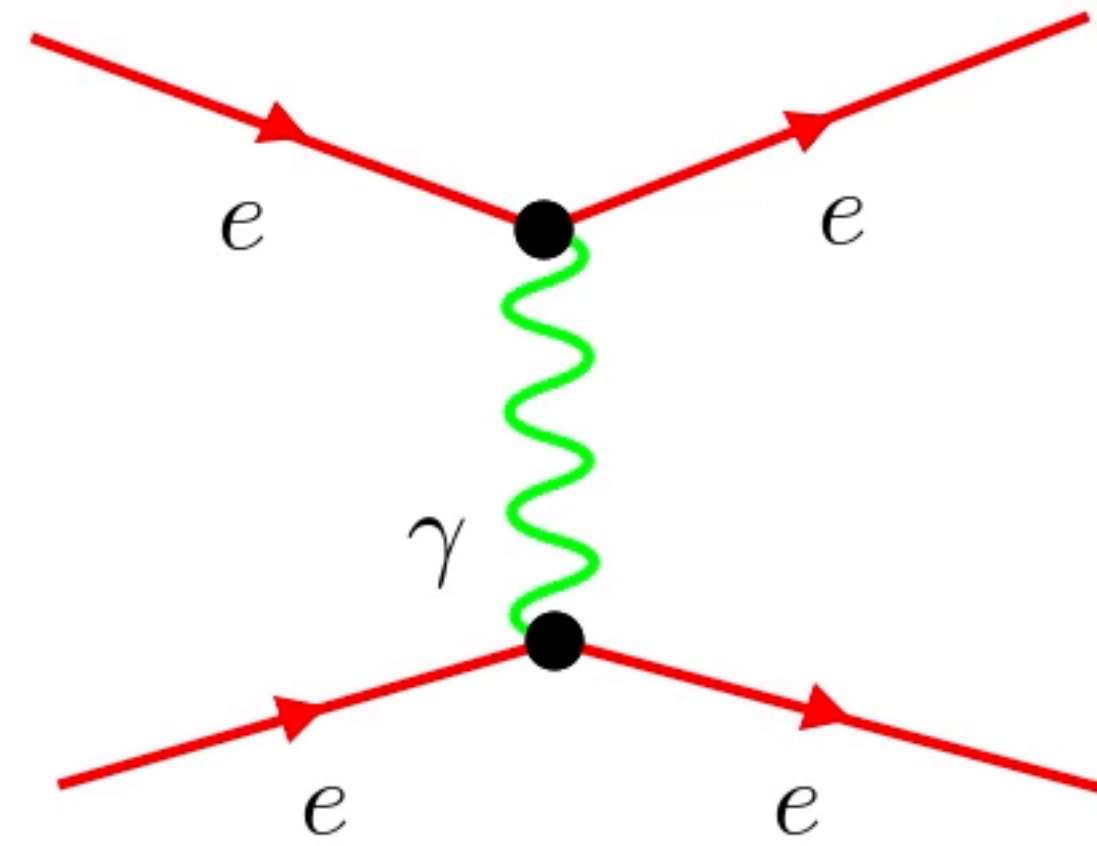
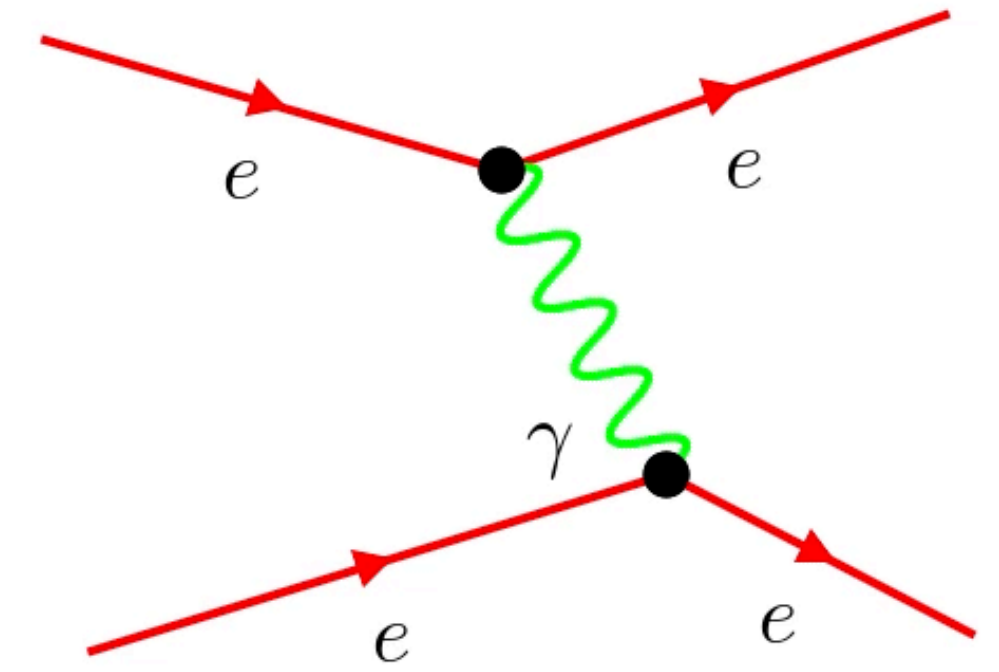
e^-

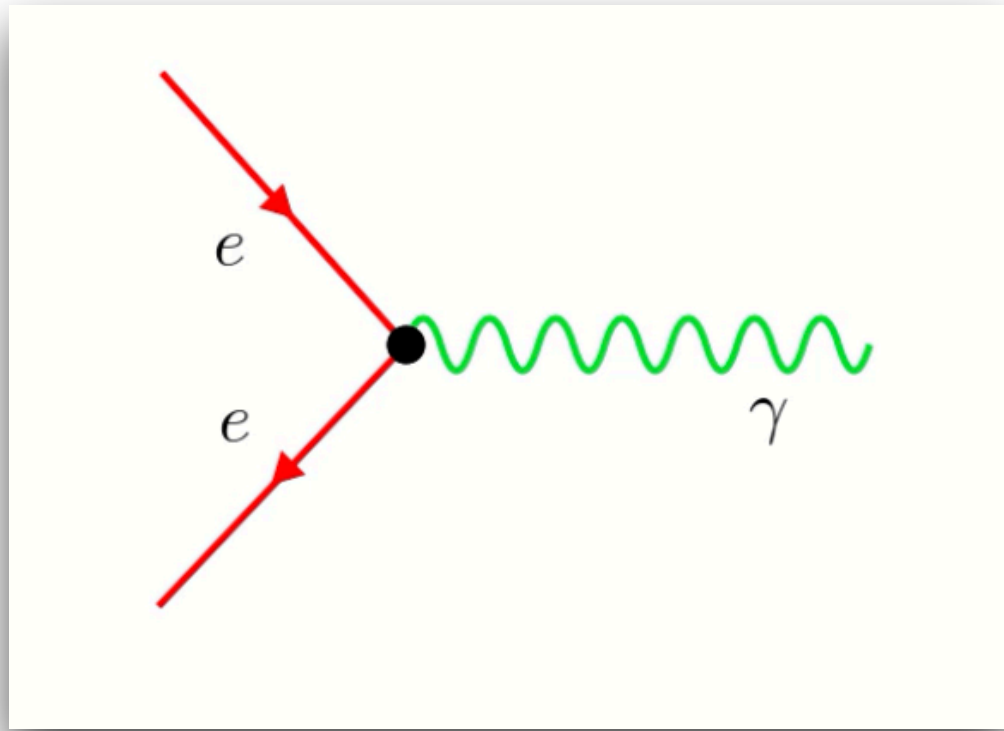




e^-

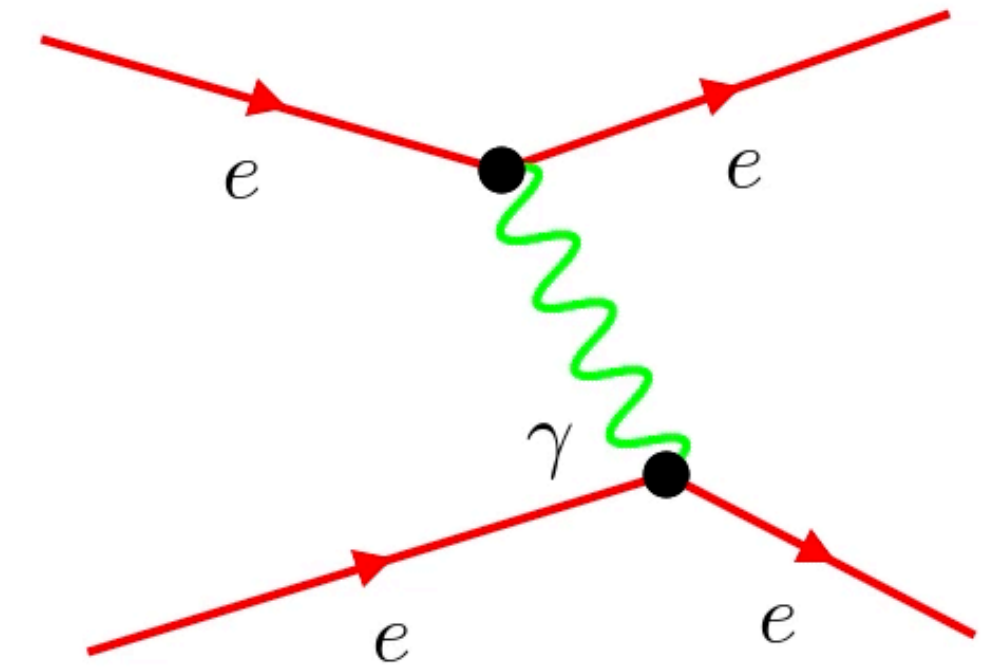
e^-



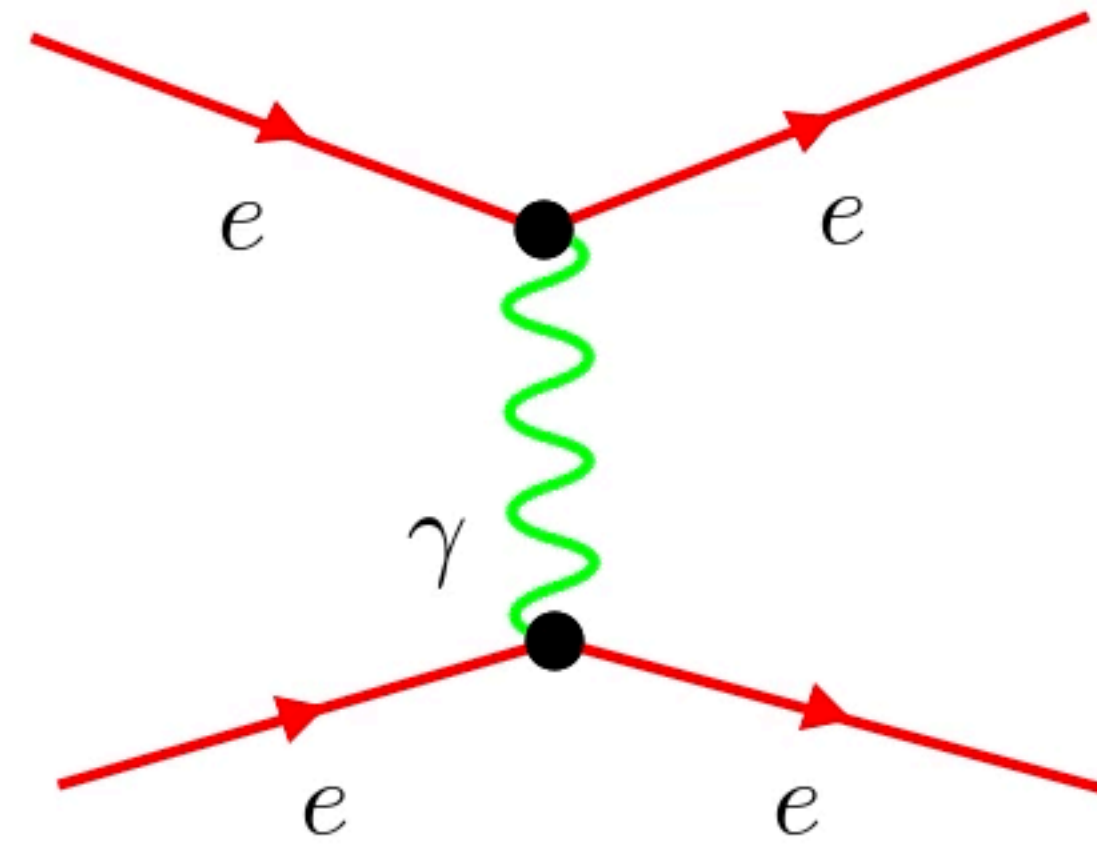


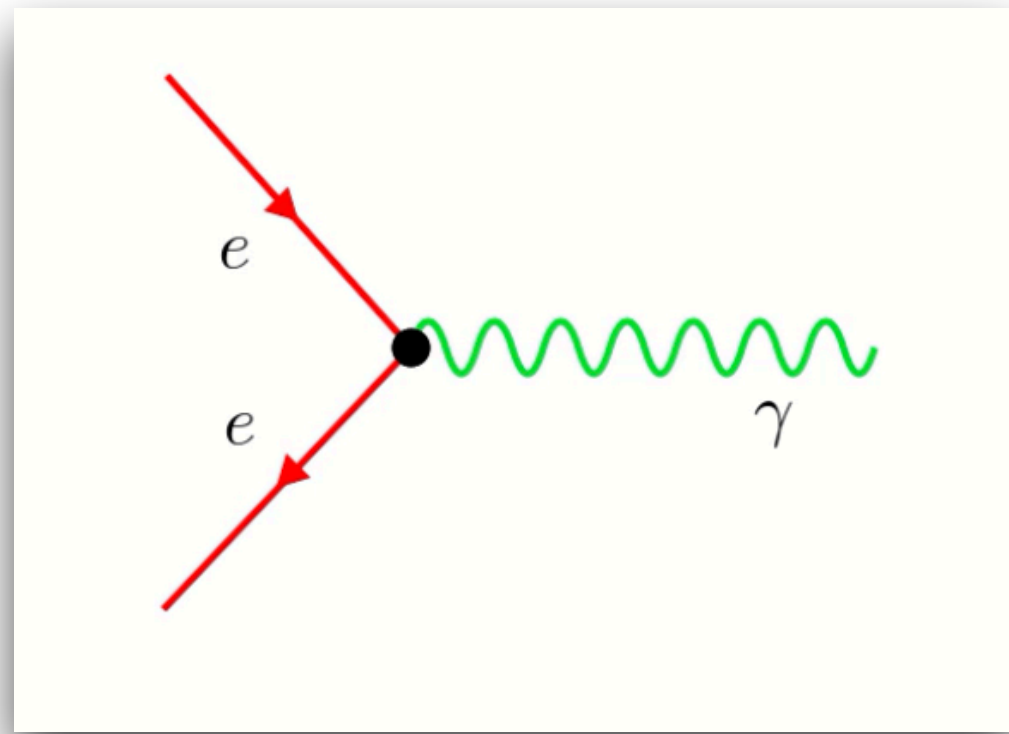
● e^-

● e^-



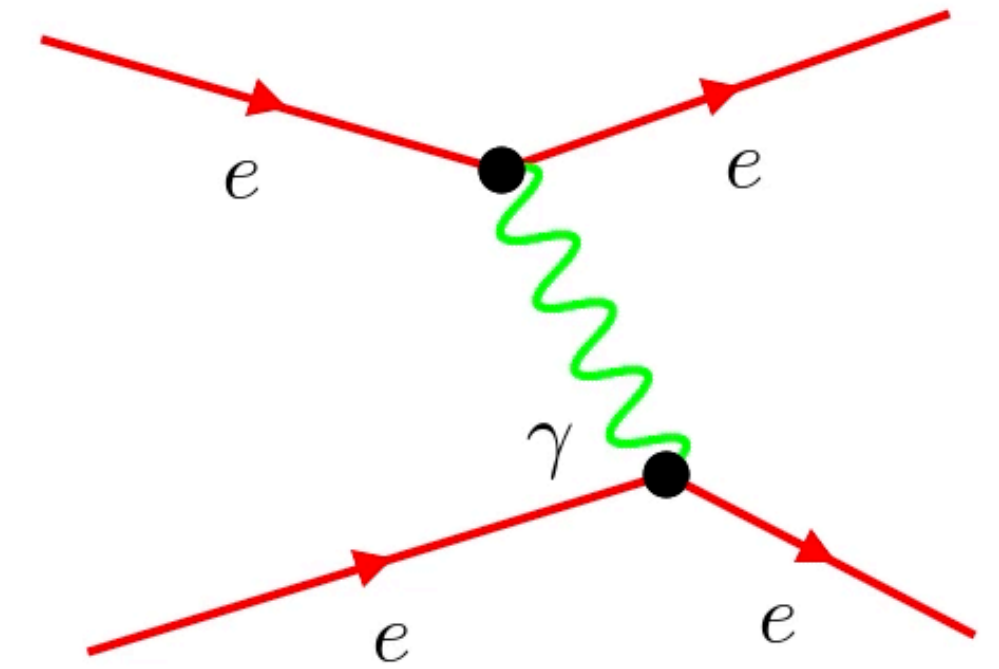
$$e^+e^- \rightarrow e^+e^-$$



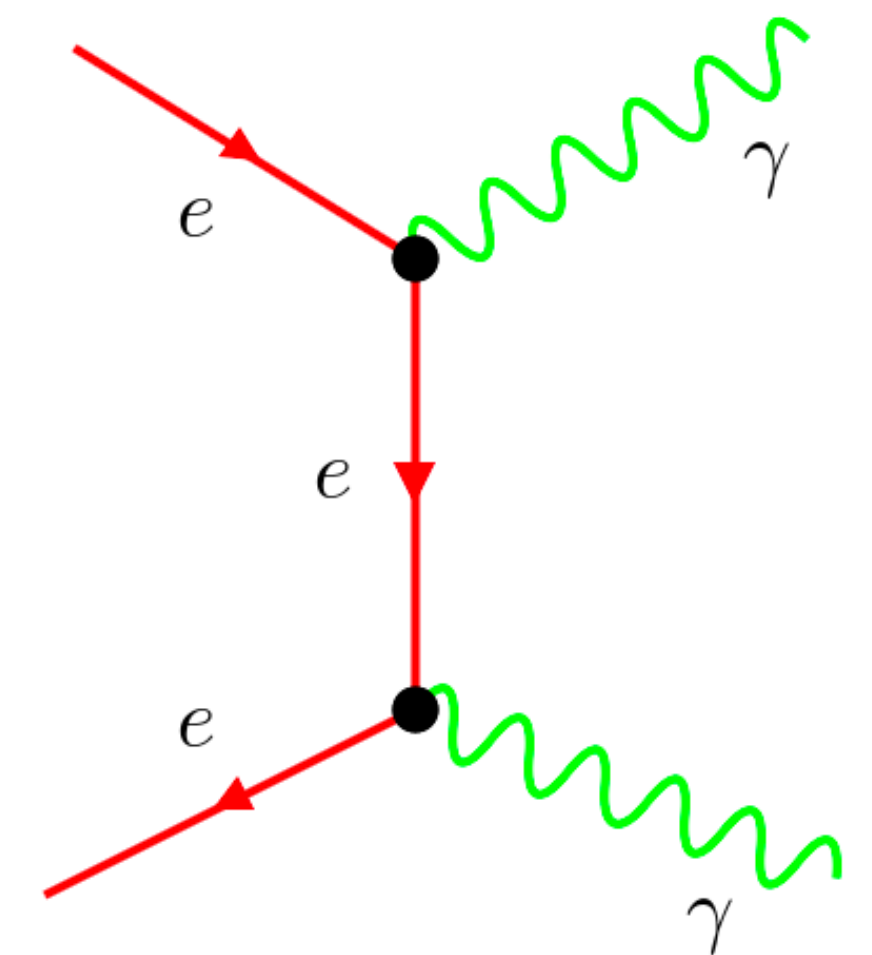
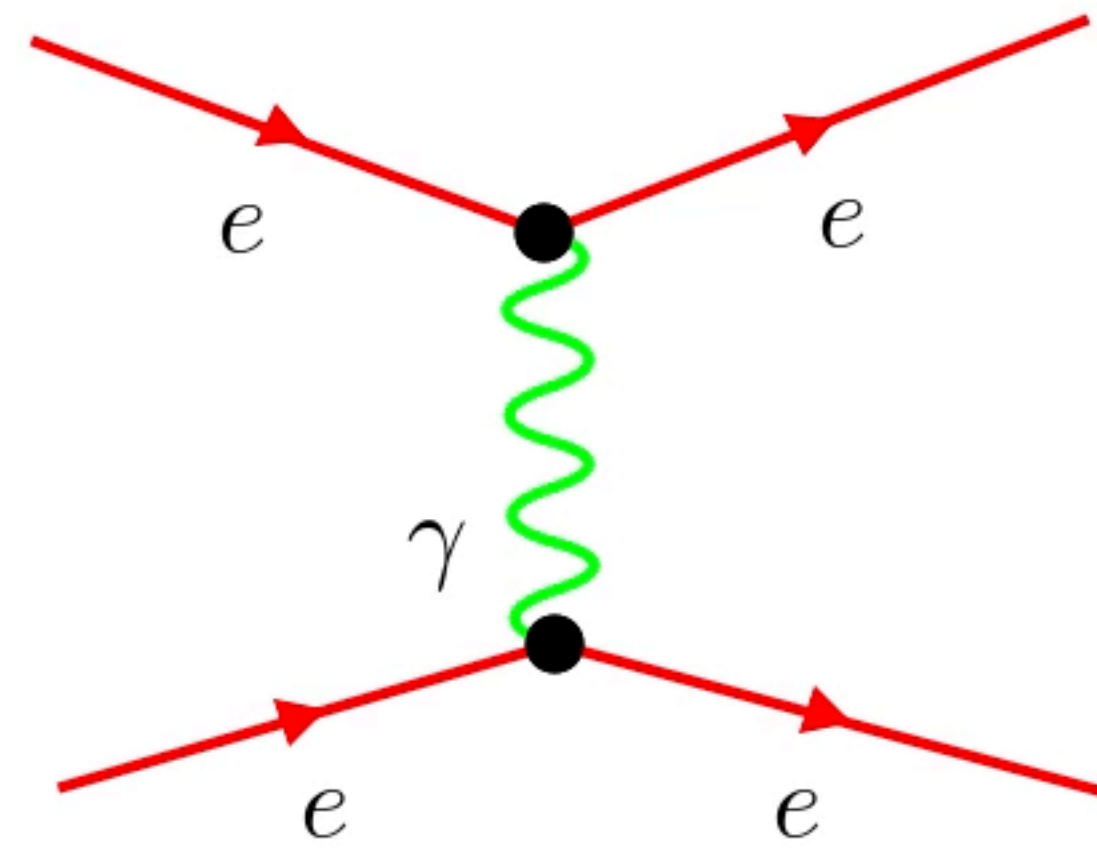


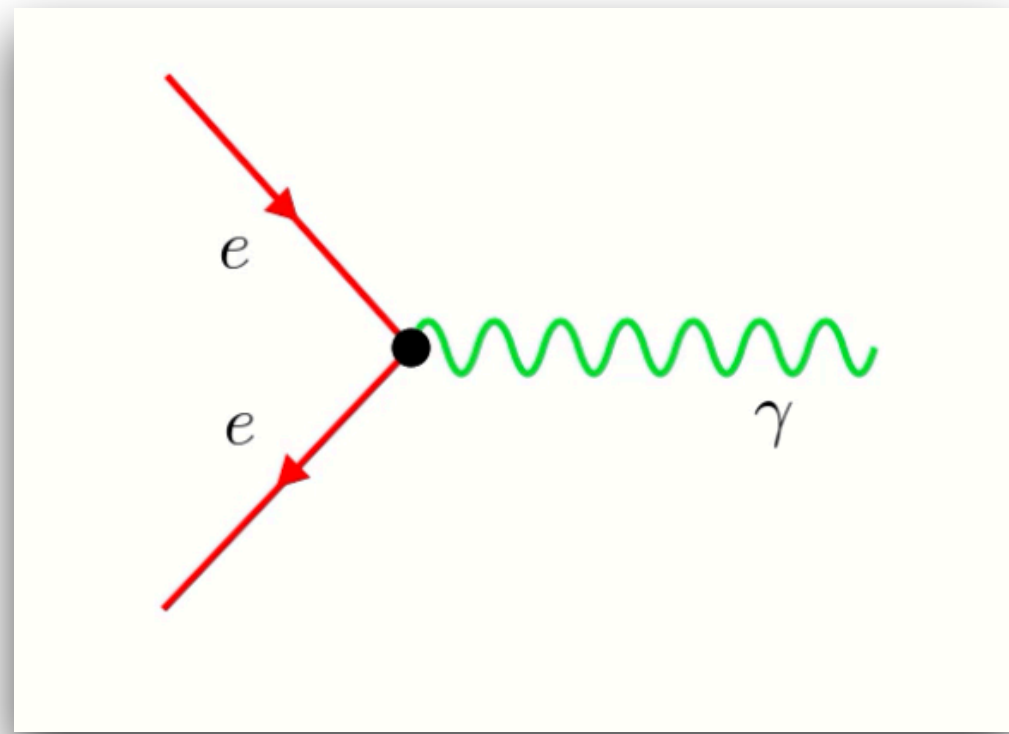
● e^-

● e^-



$$e^+e^- \rightarrow e^+e^-$$

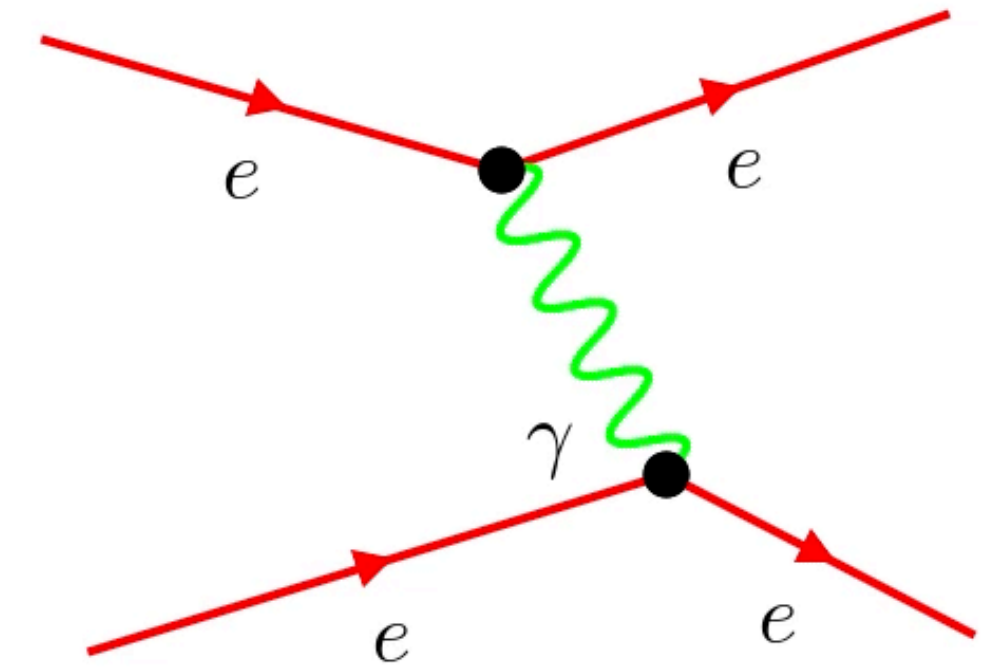




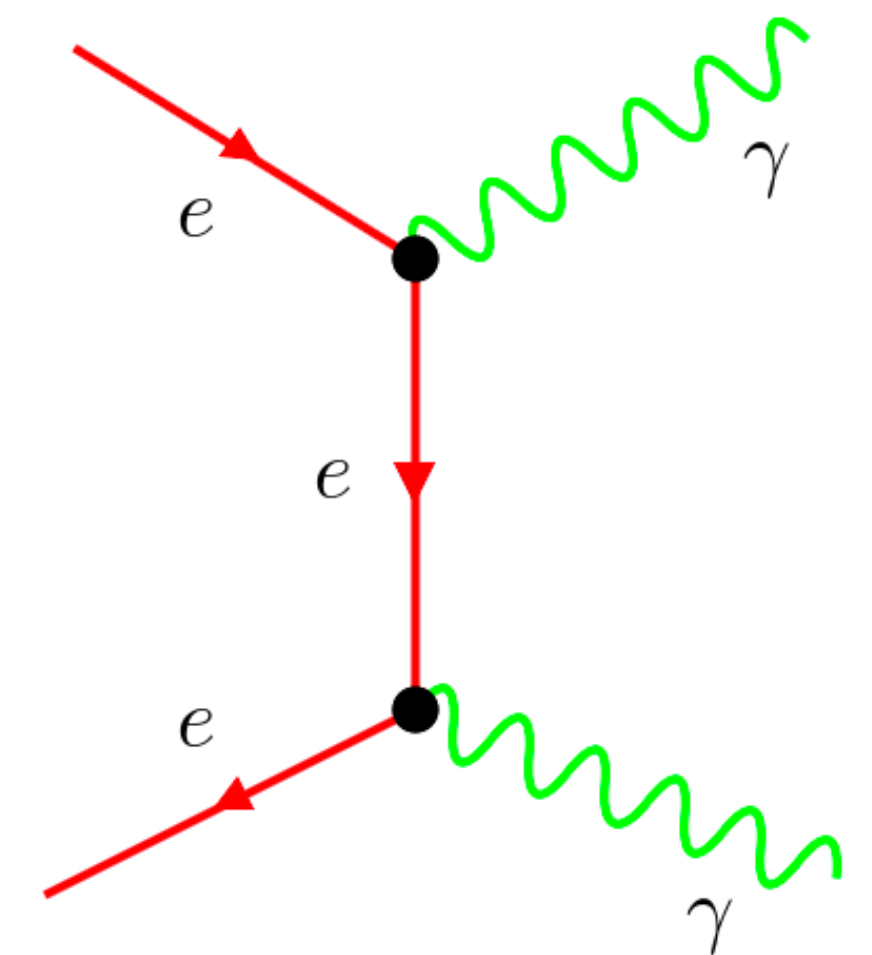
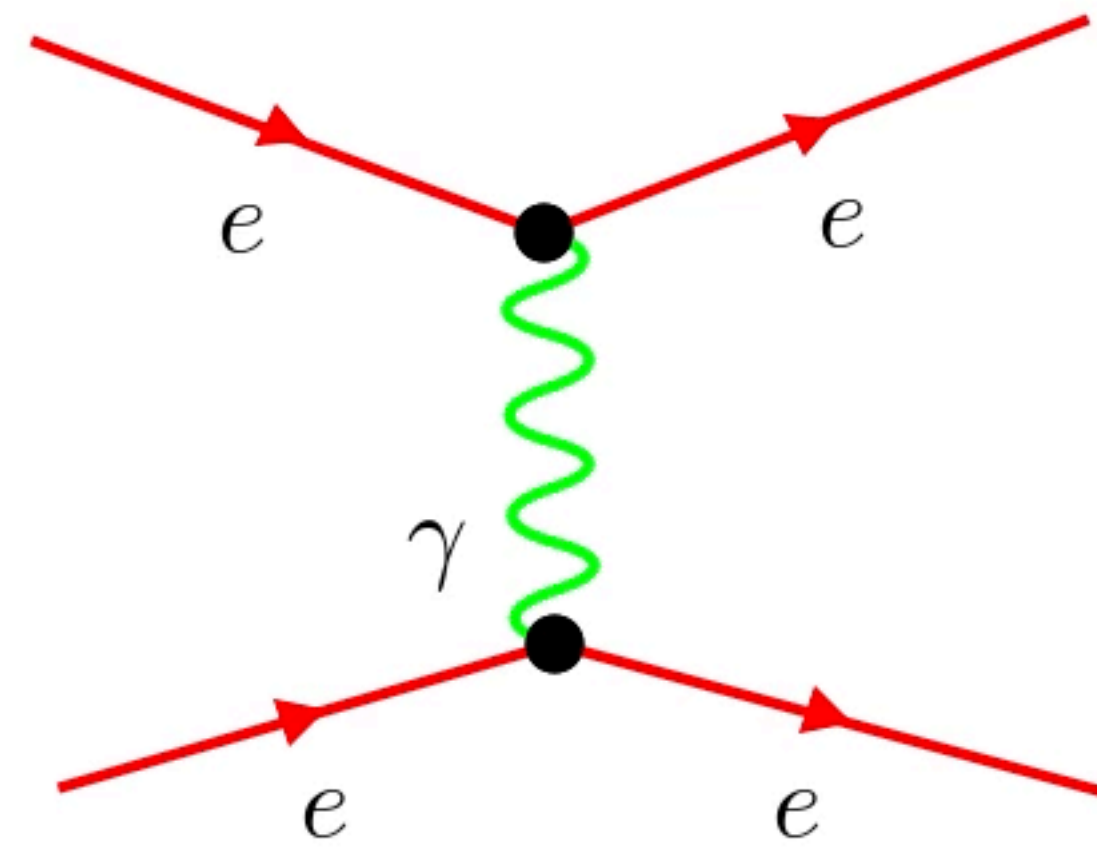
$$= ie\gamma^\mu$$

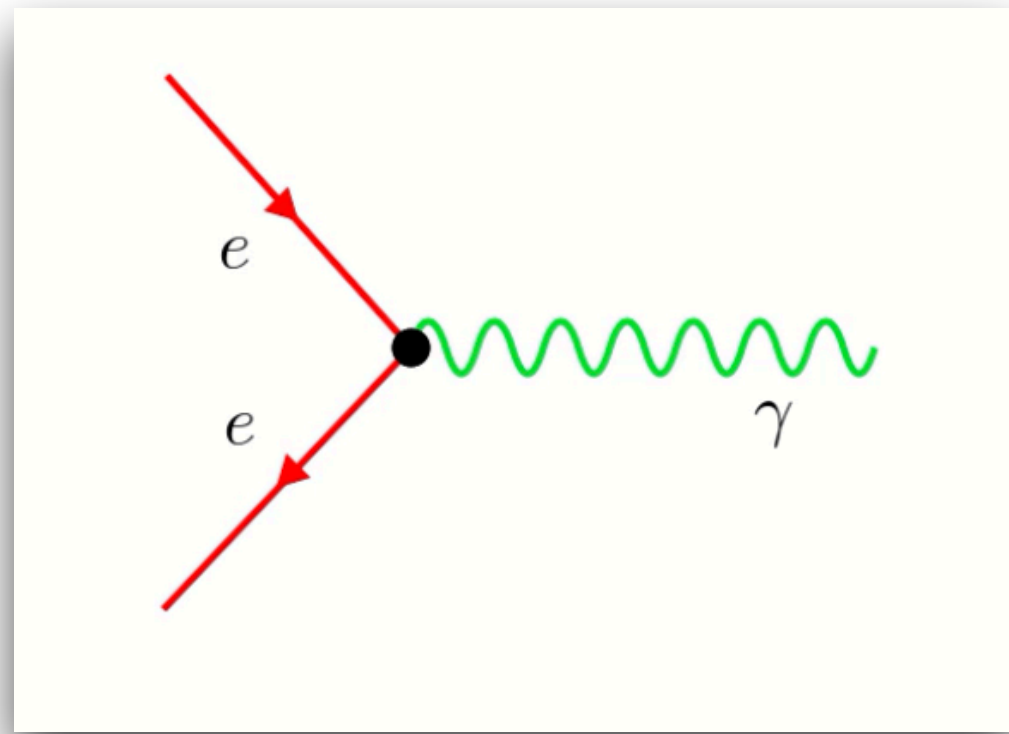
● e^-

● e^-



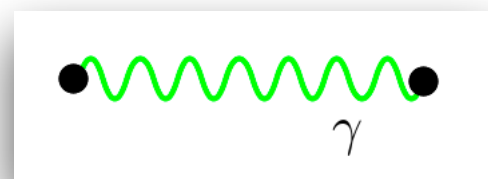
$$e^+e^- \rightarrow e^+e^-$$





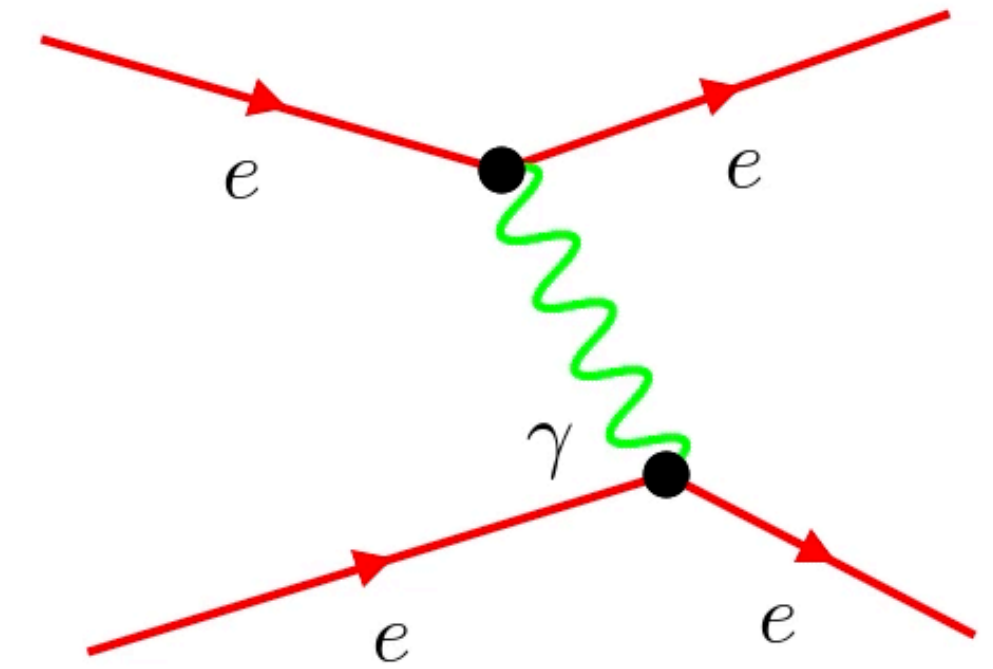
$$= i e \gamma^\mu$$

● e^-

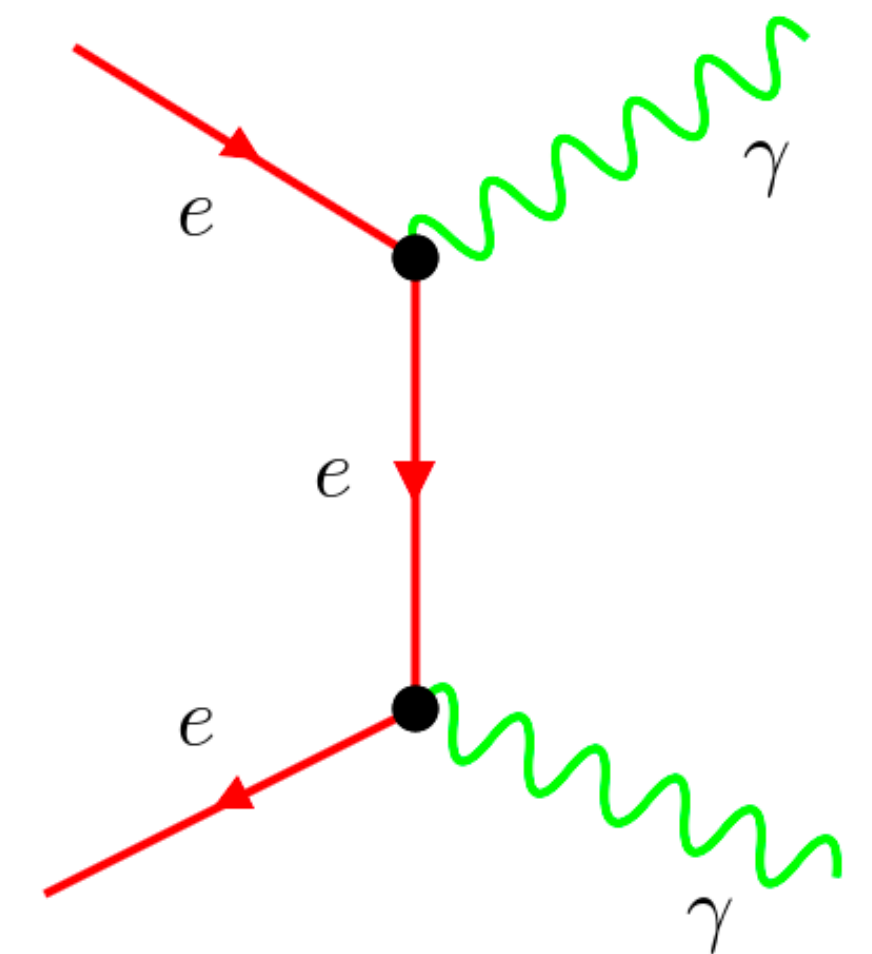
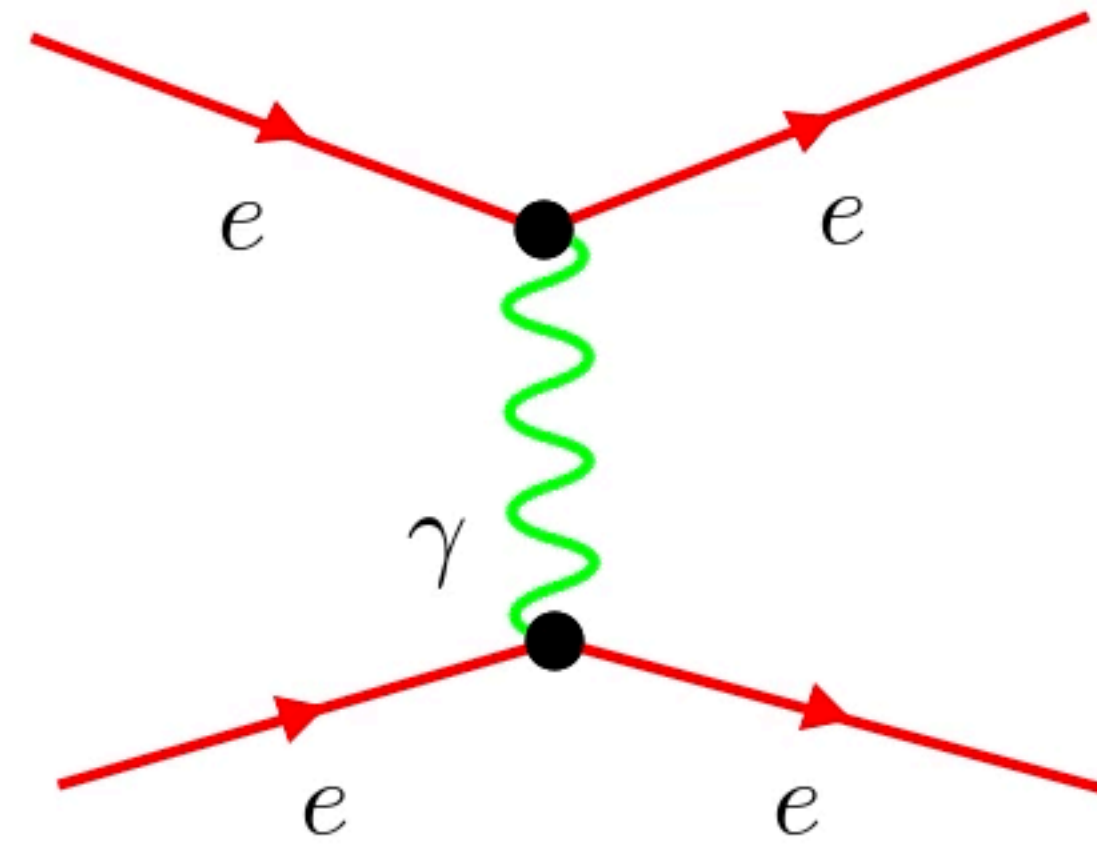


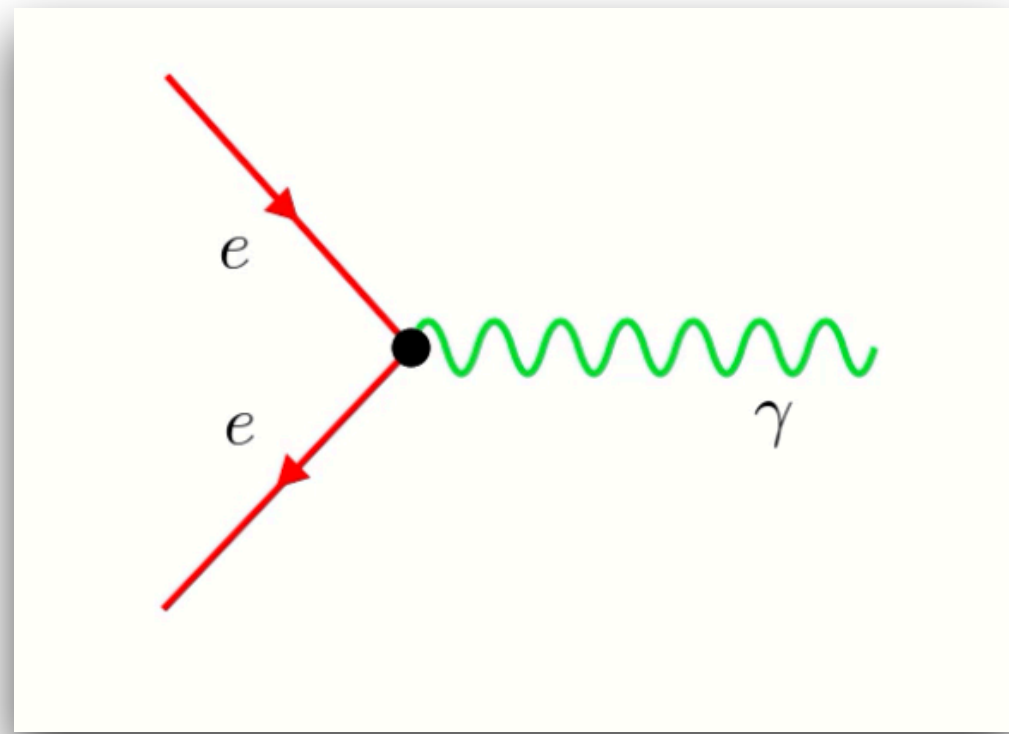
$$= \frac{-i g_{\mu\nu}}{p^2}$$

● e^-



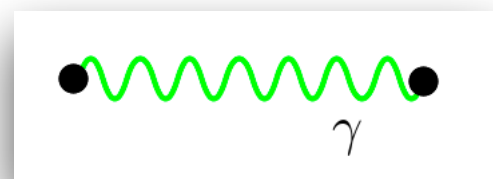
$$e^+ e^- \rightarrow e^+ e^-$$





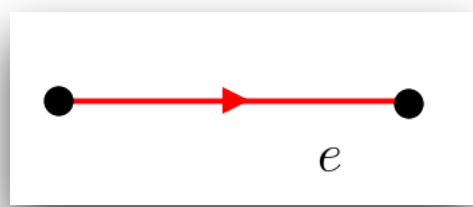
$$= i e \gamma^\mu$$

● e^-

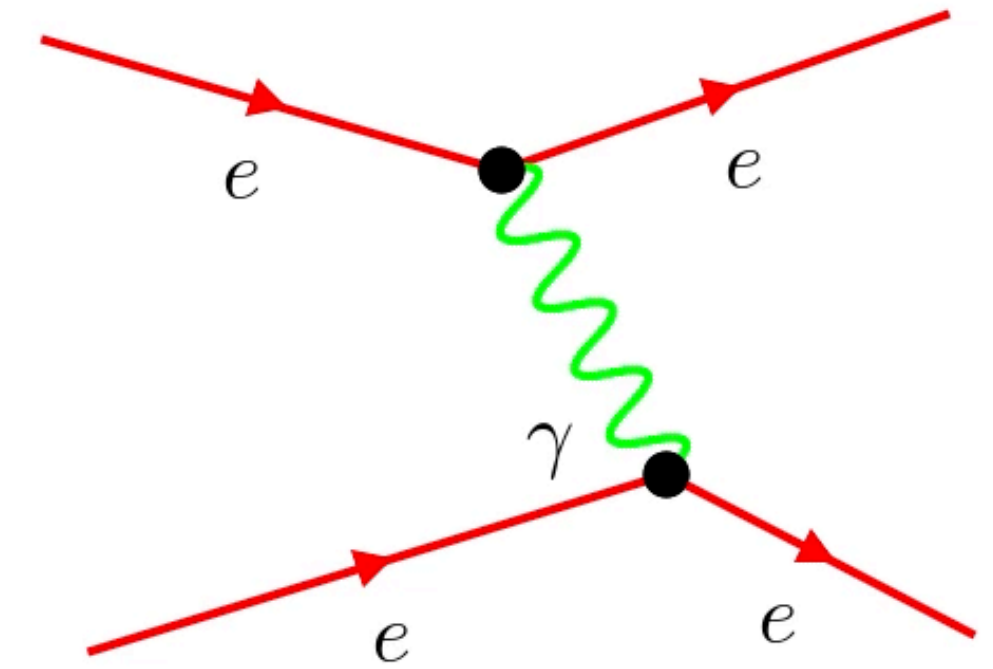


$$= \frac{-i g_{\mu\nu}}{p^2}$$

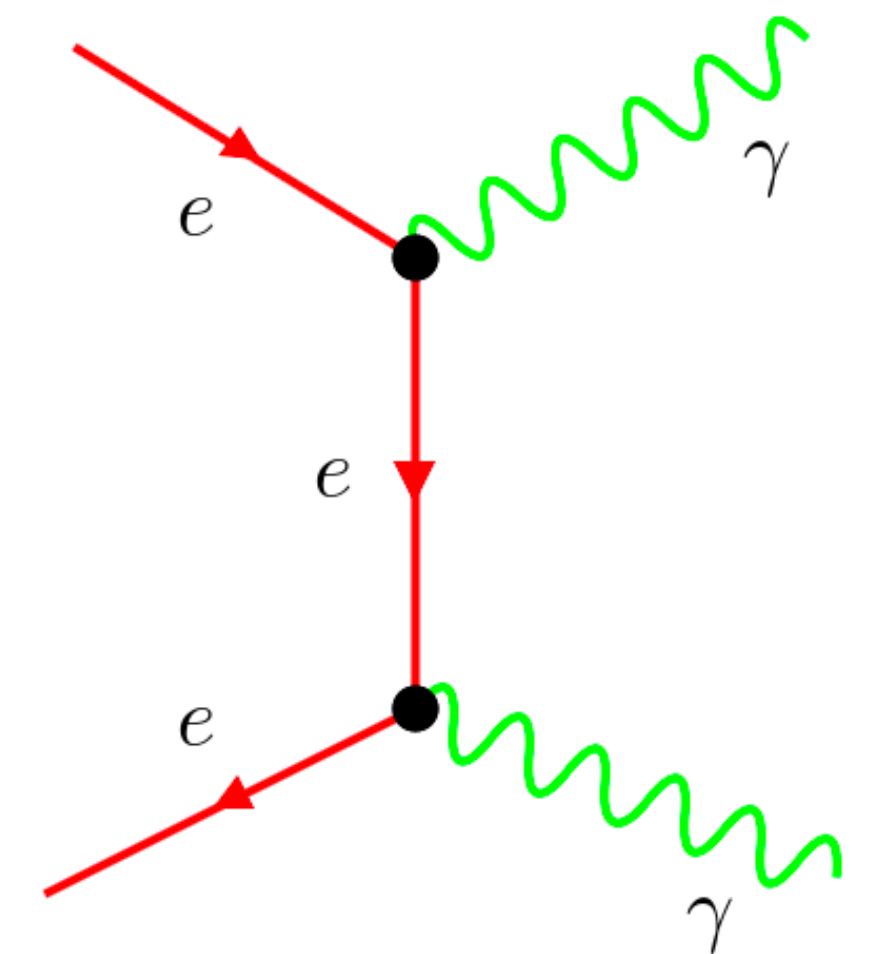
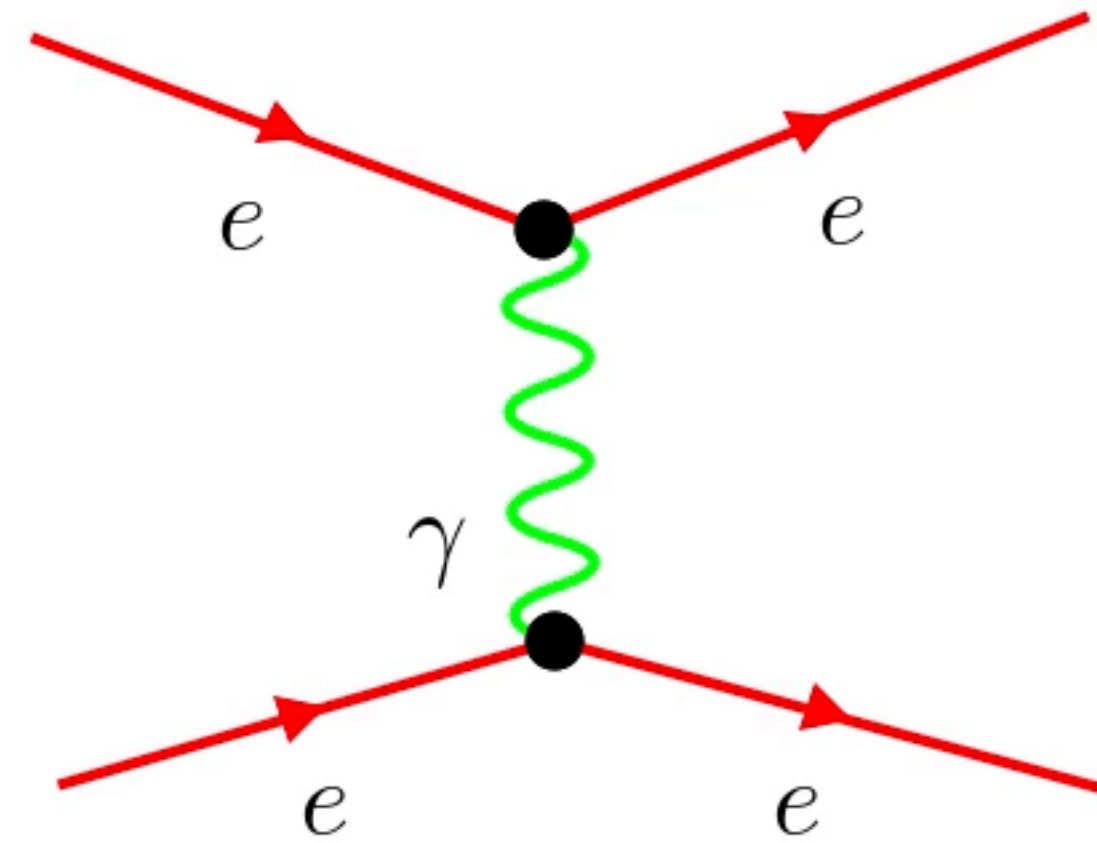
● e^-

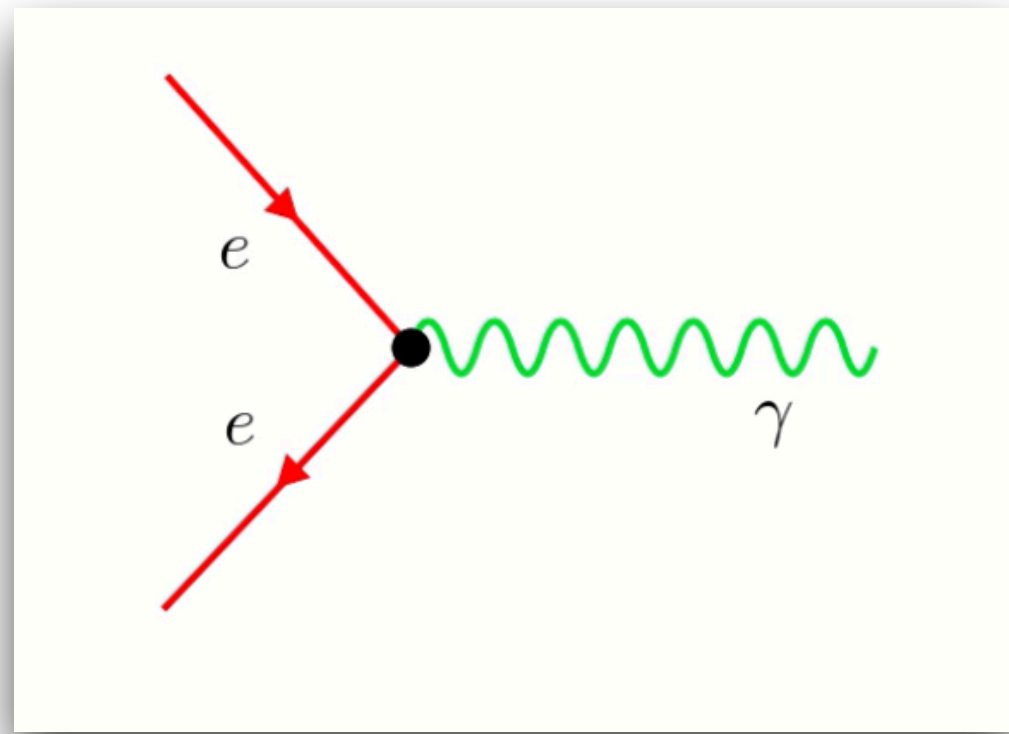


$$= \frac{\gamma^\mu p_\mu - m}{p^2 - m^2}$$



$$e^+ e^- \rightarrow e^+ e^-$$

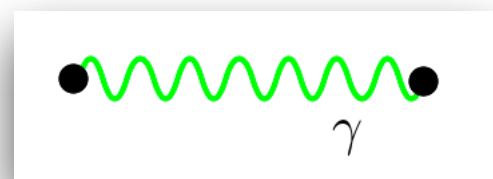




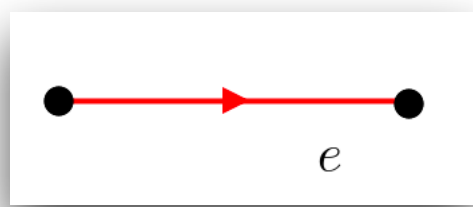
$$= ie\gamma^\mu$$

● e^-

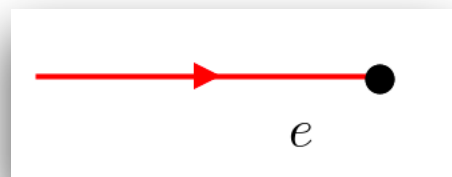
● e^-



$$= \frac{-ig_{\mu\nu}}{p^2}$$



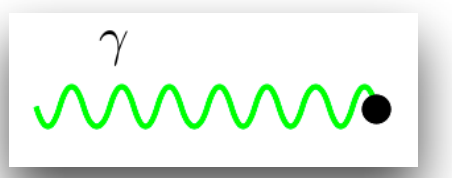
$$= \frac{\gamma^\mu p_\mu - m}{p^2 - m^2}$$



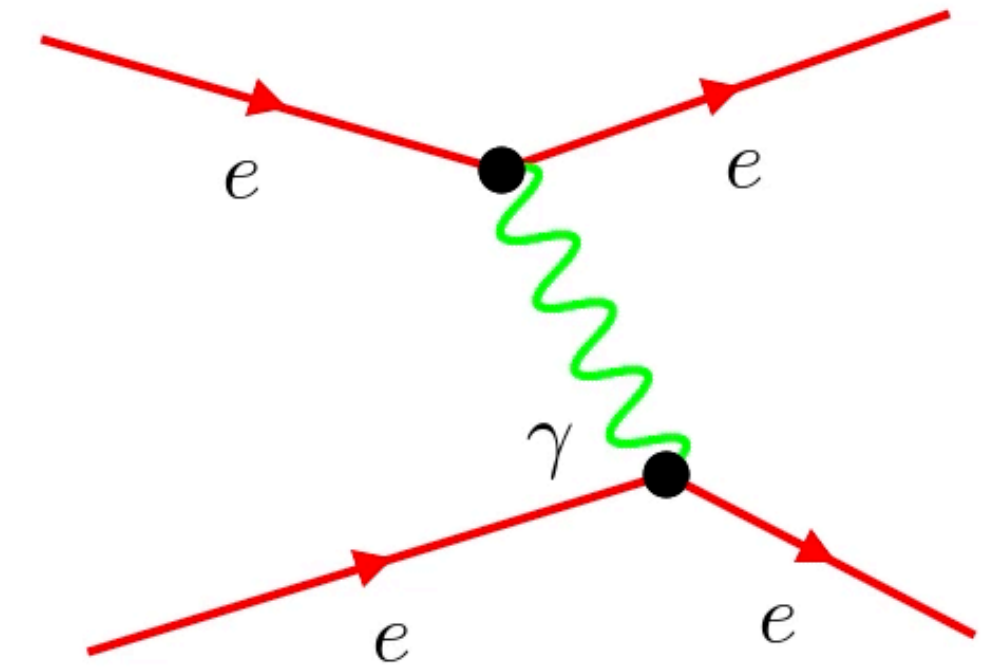
$$= u(p)$$



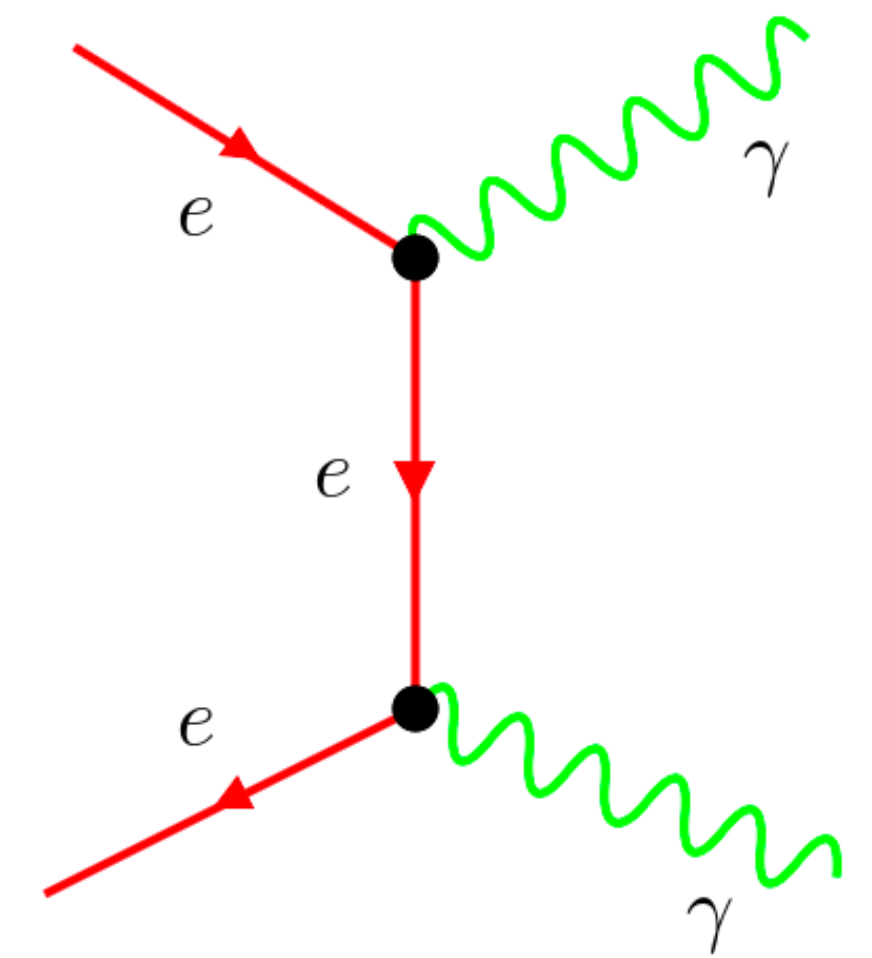
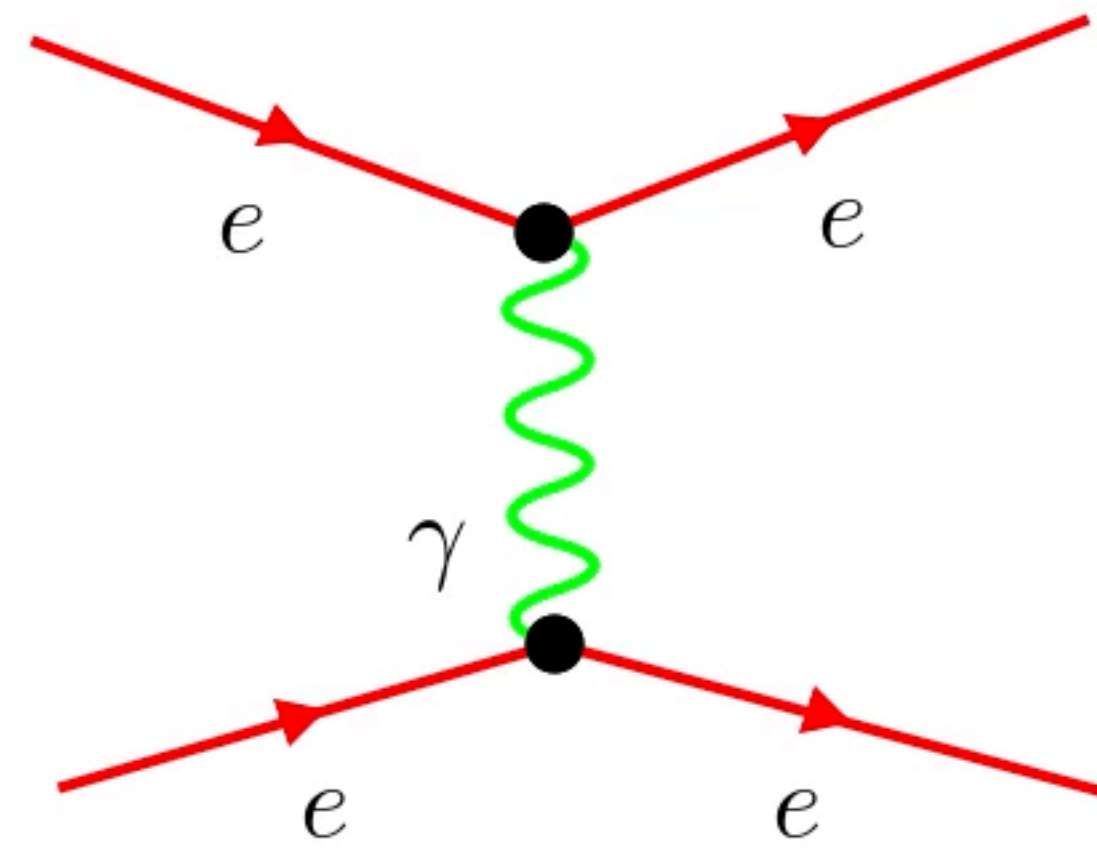
$$= v(p)$$

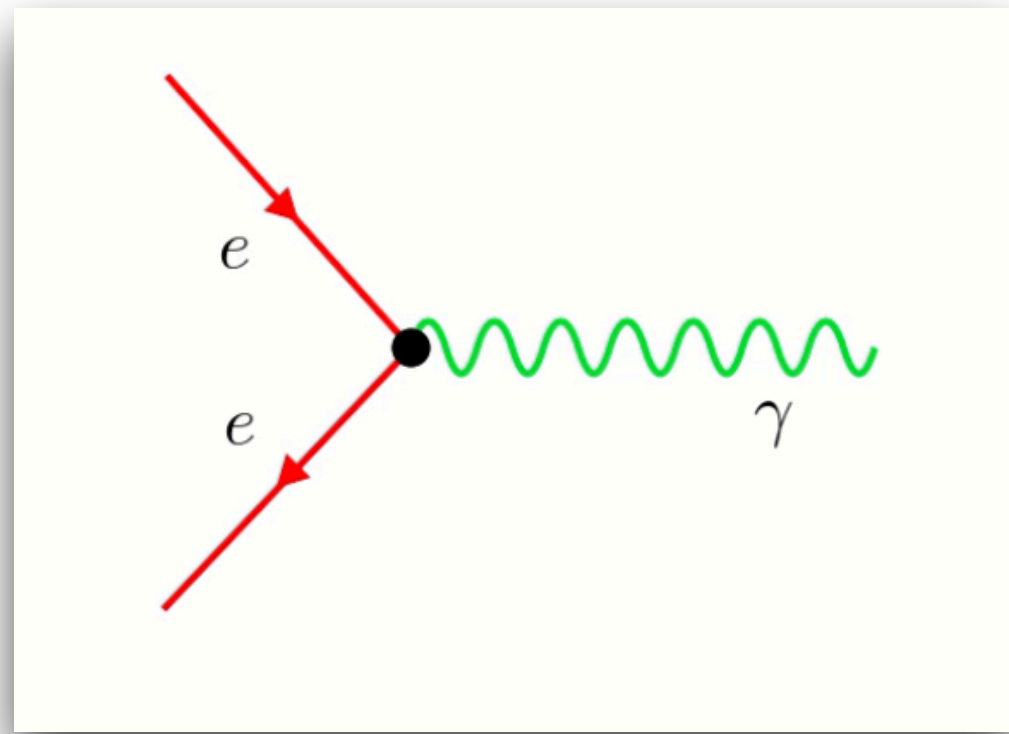


$$= \epsilon_\mu(p)$$



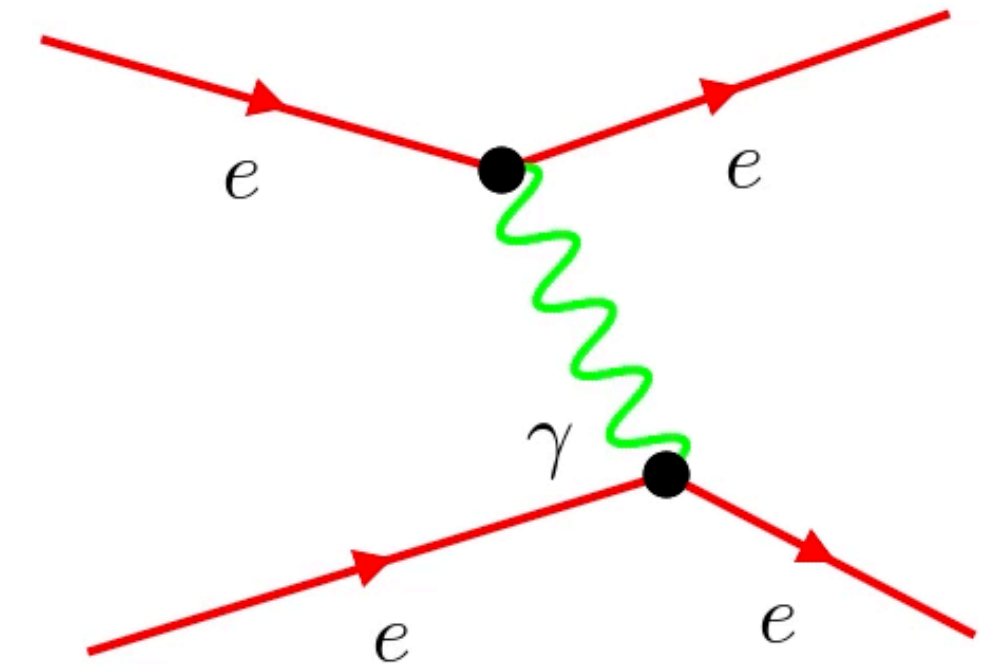
$$e^+e^- \rightarrow e^+e^-$$



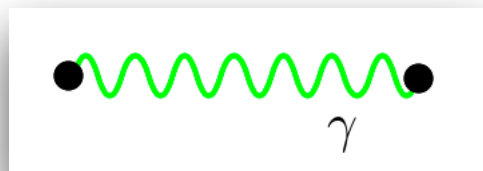


$$= ie\gamma^\mu$$

● e^-

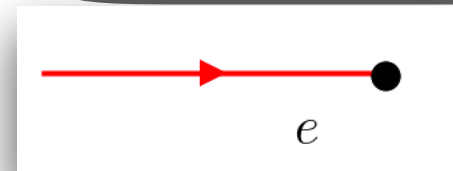


● e^-



$$= \frac{-ig_{\mu\nu}}{p^2}$$

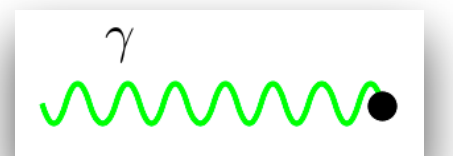
$$e^2 u_{\alpha_1}(\vec{p}_1) \bar{v}_{\beta_1}(\vec{p}_2) \frac{\gamma^\mu p_{\beta_1} - m}{p^2 - m^2} (-iQ_e \gamma_{\beta_1 \alpha_1}^{\mu_1}) \frac{-ig_{\mu_1 \nu_1}}{(-p_2 + p_1)^2 + i\epsilon} e^+ e^- \rightarrow e^+ e^- (-iQ_e \gamma_{\delta_1 \gamma_1}^{\nu_1}) v_{\gamma_1}(-\vec{q}_1) \bar{u}_{\delta_1}(-\vec{p}_2 + \vec{q}_1 + \vec{p}_1)$$



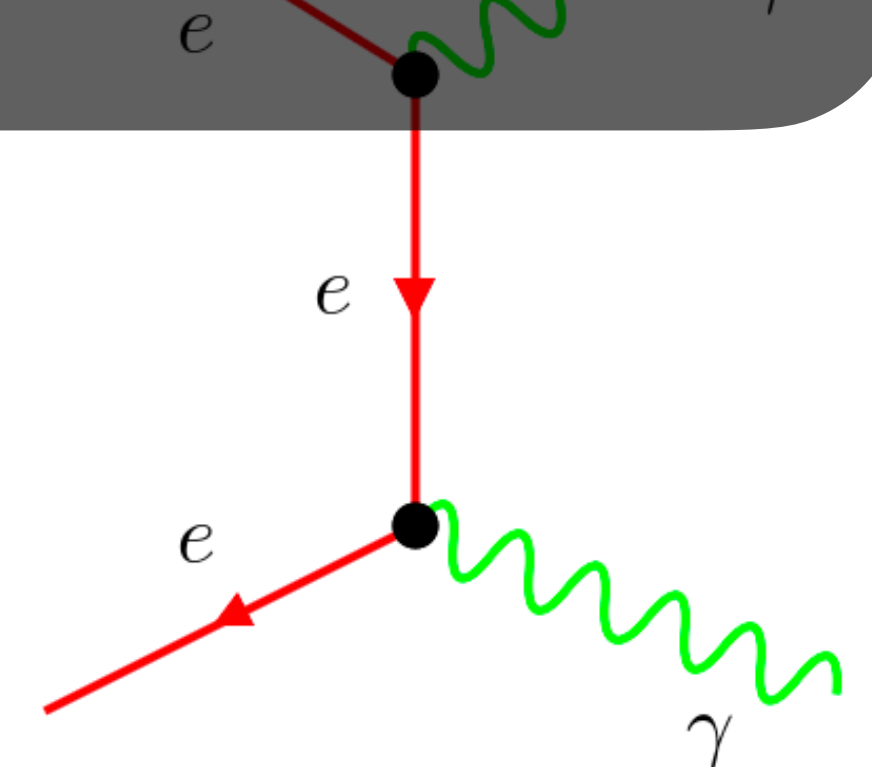
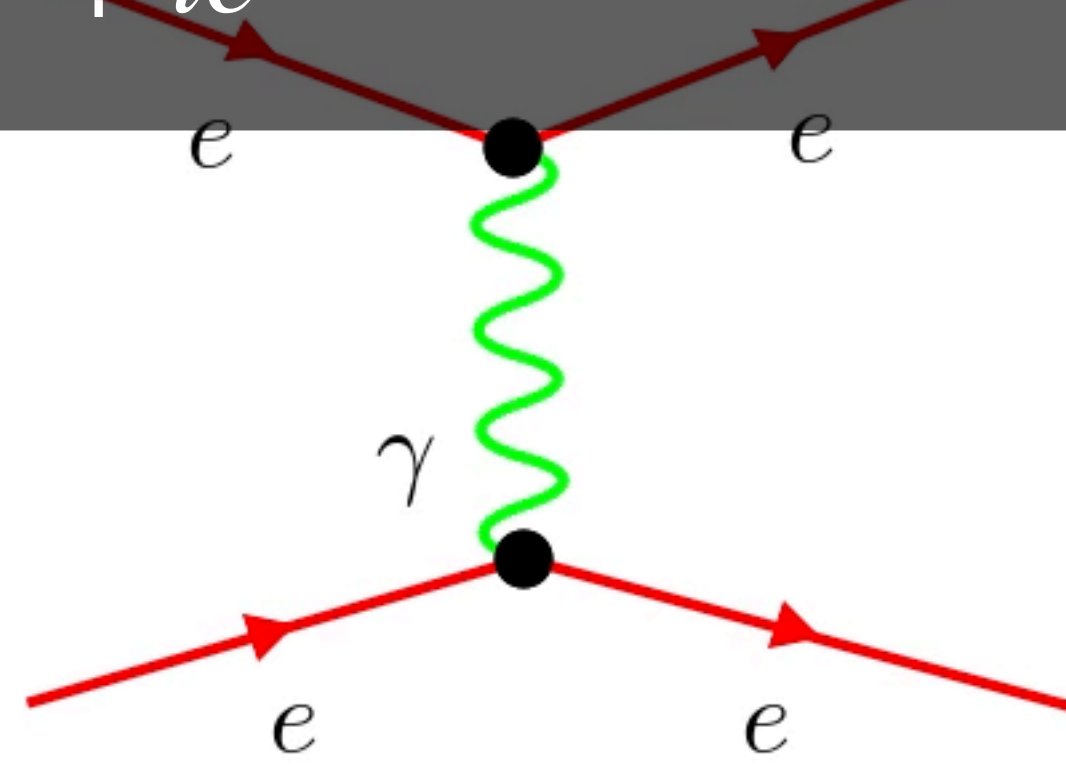
$$= u(p)$$



$$= v(p)$$



$$= \epsilon_\mu(p)$$



Synthese (2021) 199:15087–15111
<https://doi.org/10.1007/s11229-021-03387-y>

ORIGINAL RESEARCH



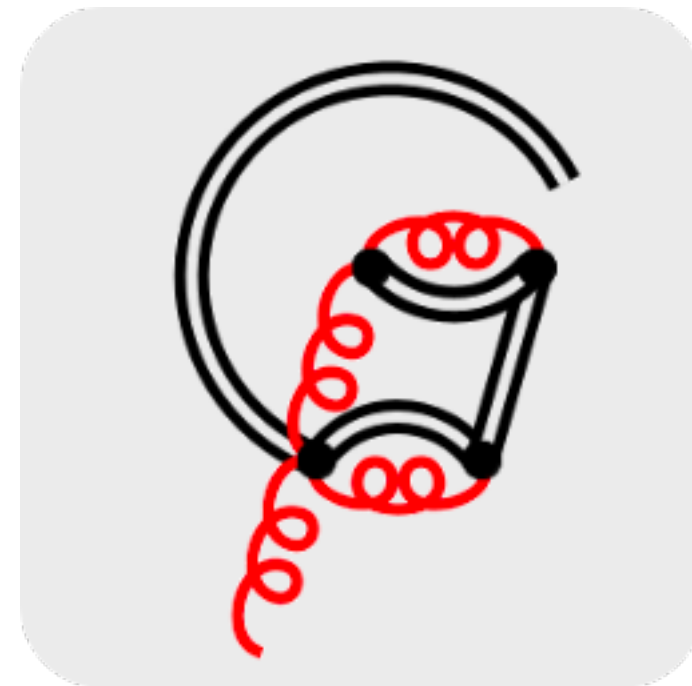
Feynman diagrams

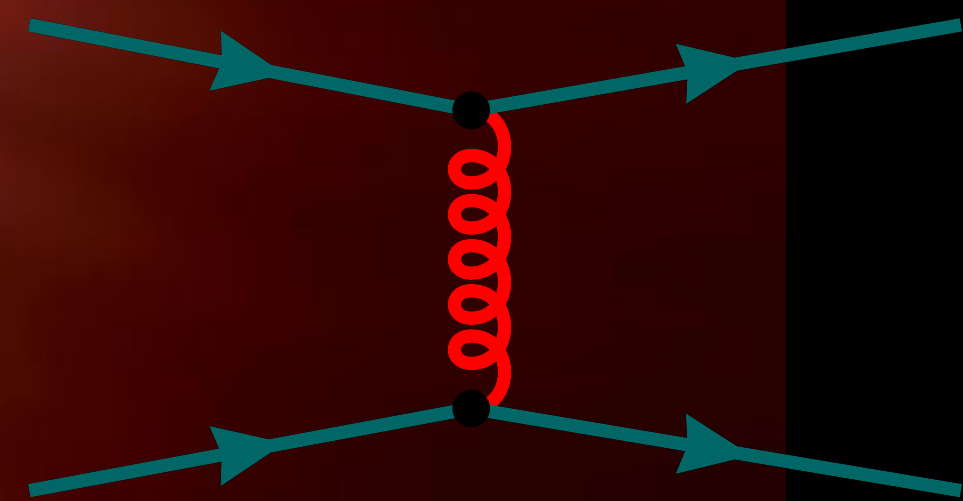
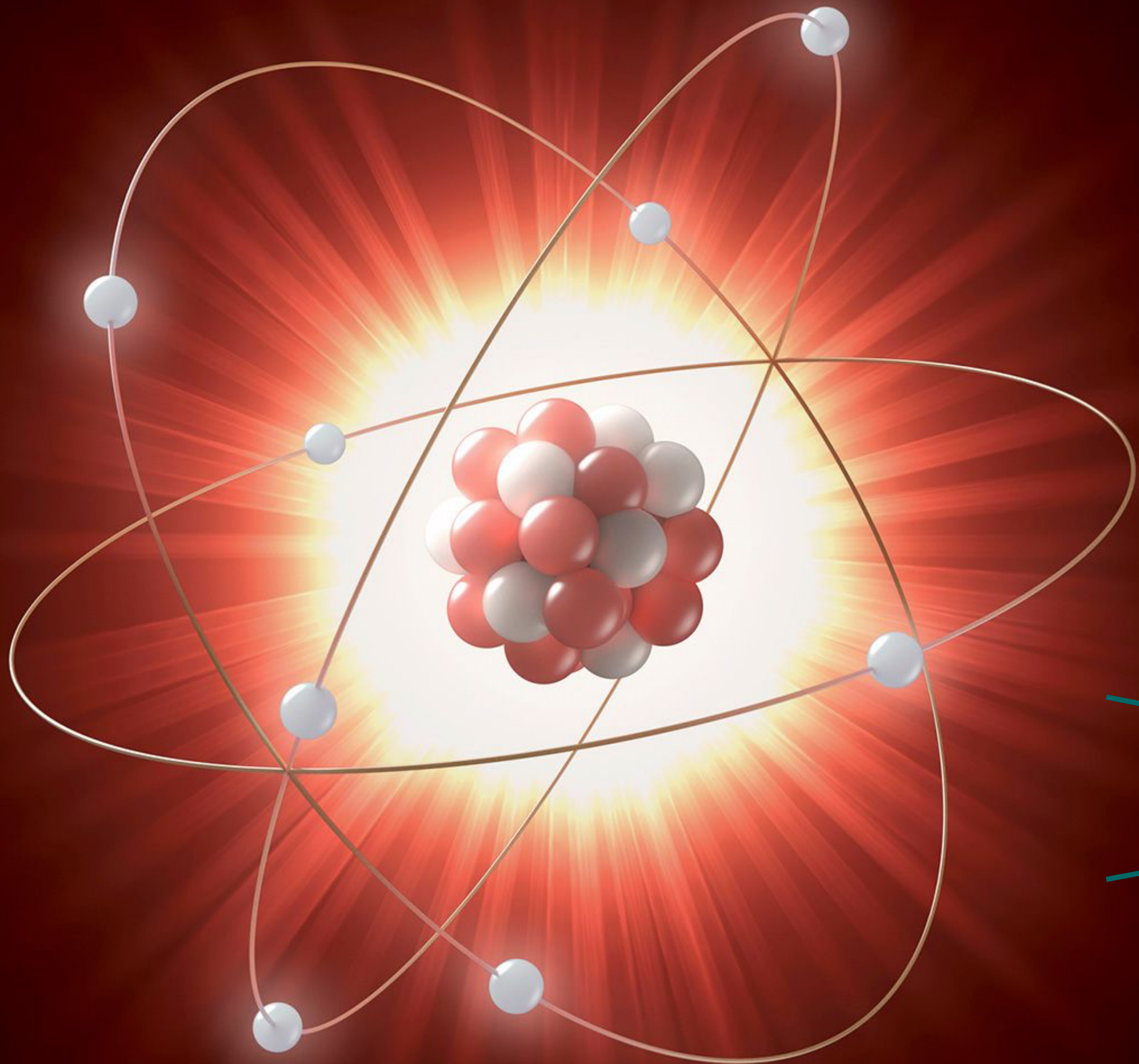
From complexity to simplicity and back

Robert Harlander¹ 

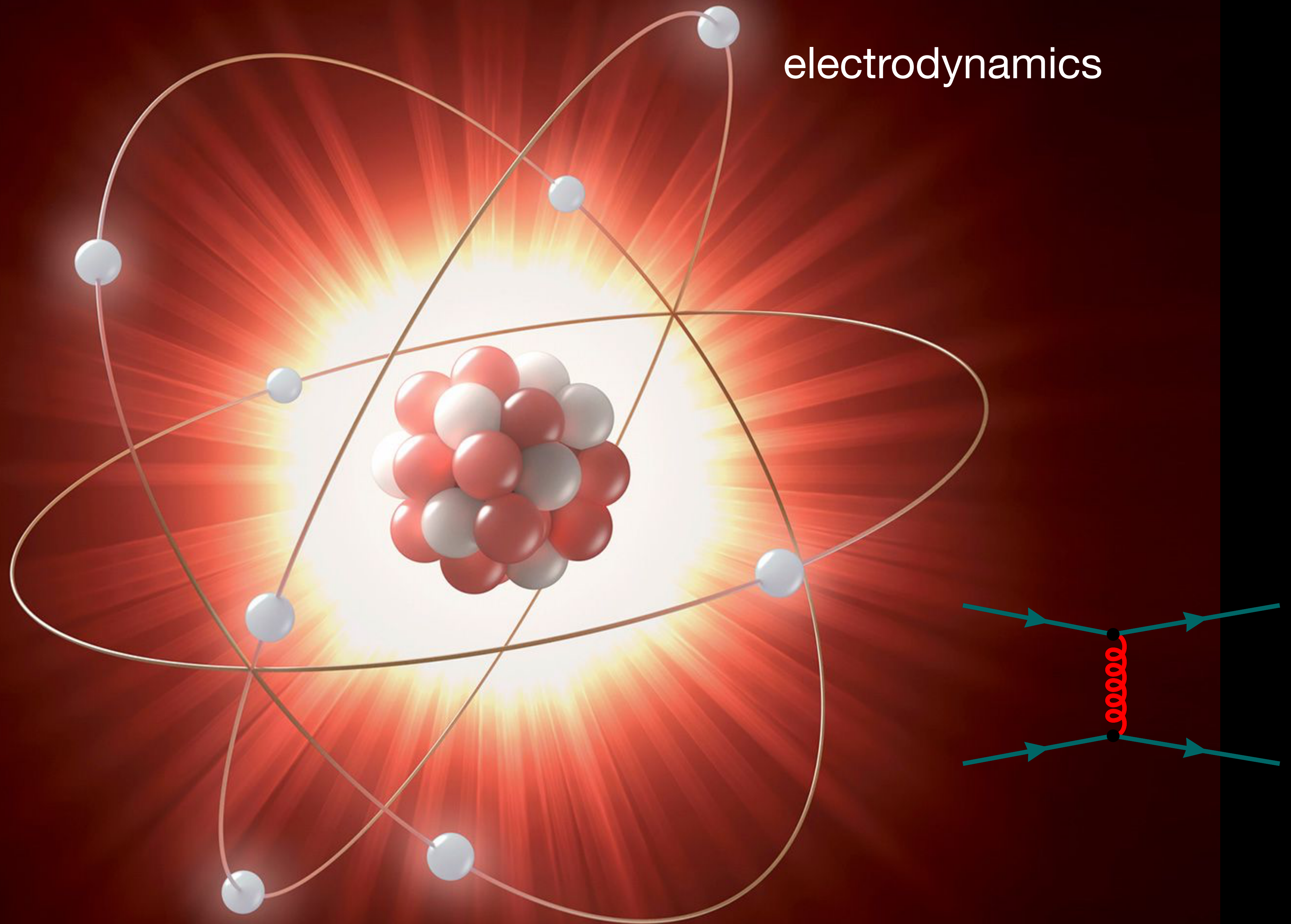


FeynGame

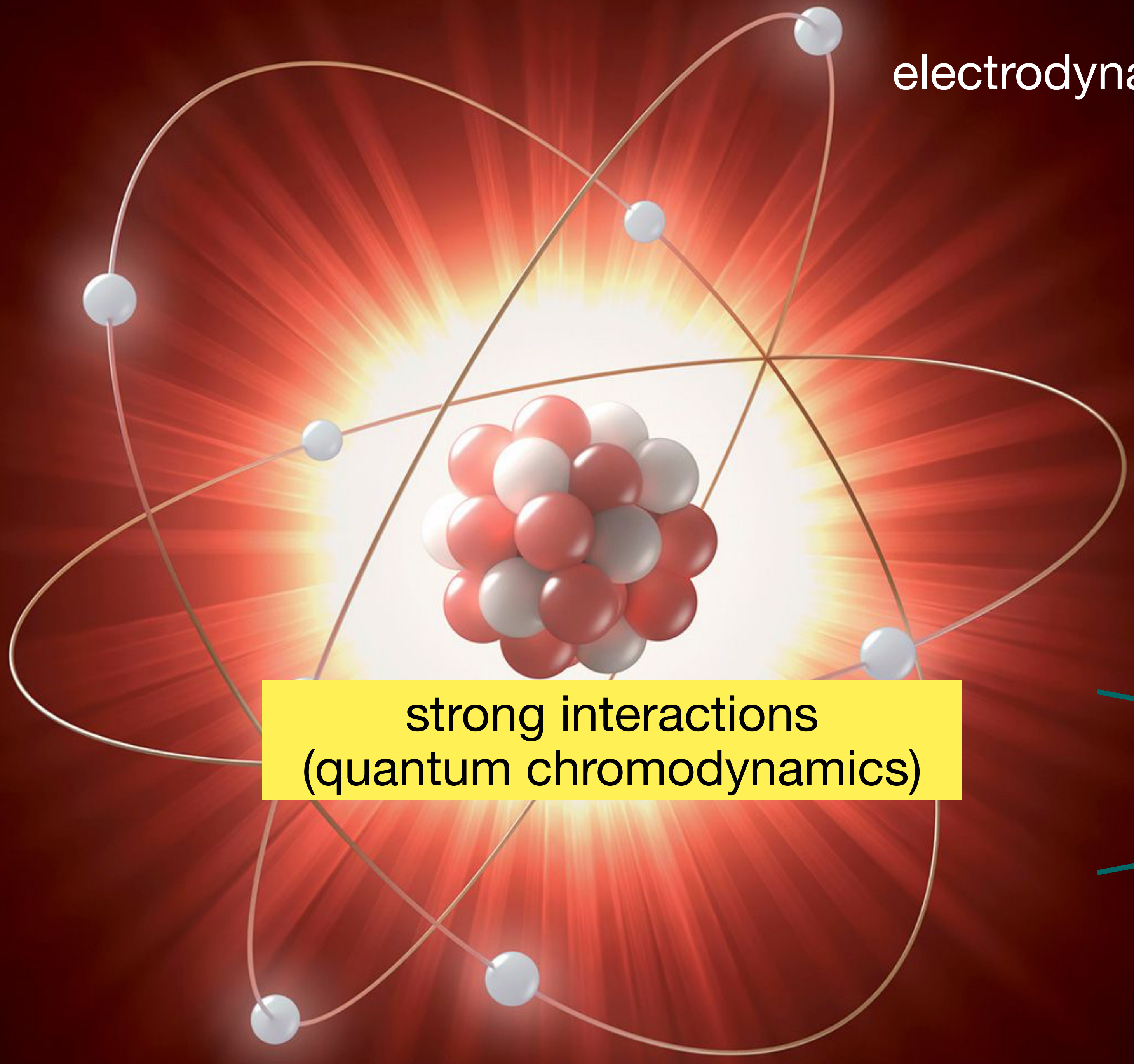




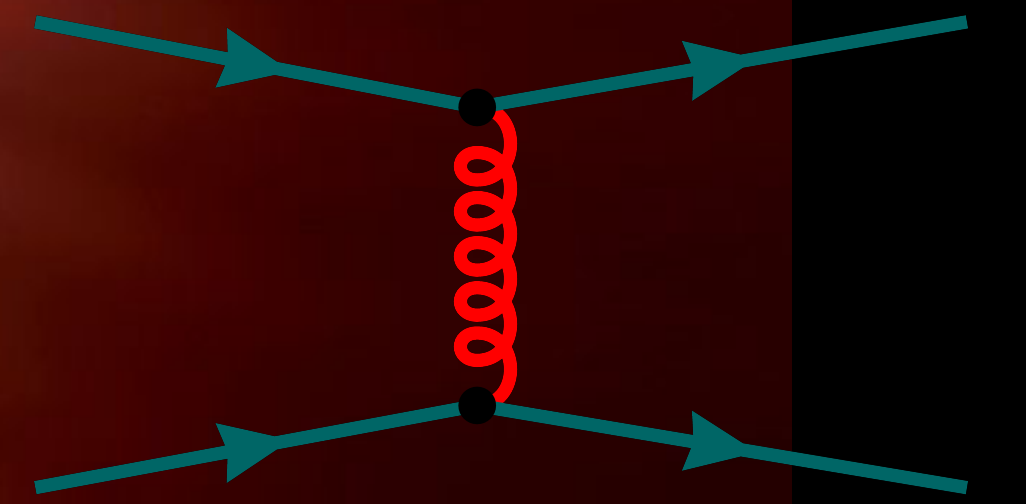
electrodynamics



electrodynamics

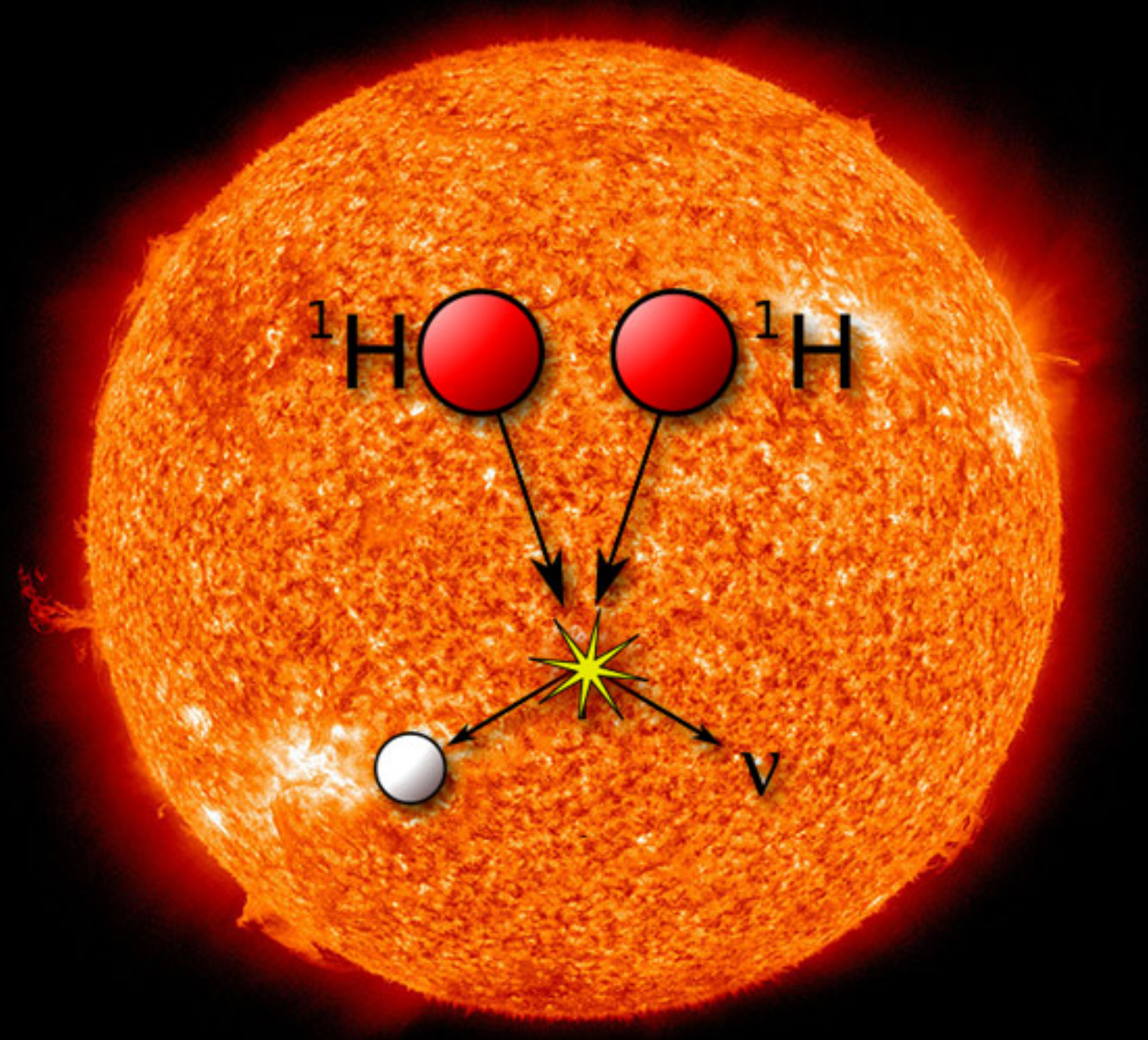


strong interactions
(quantum chromodynamics)

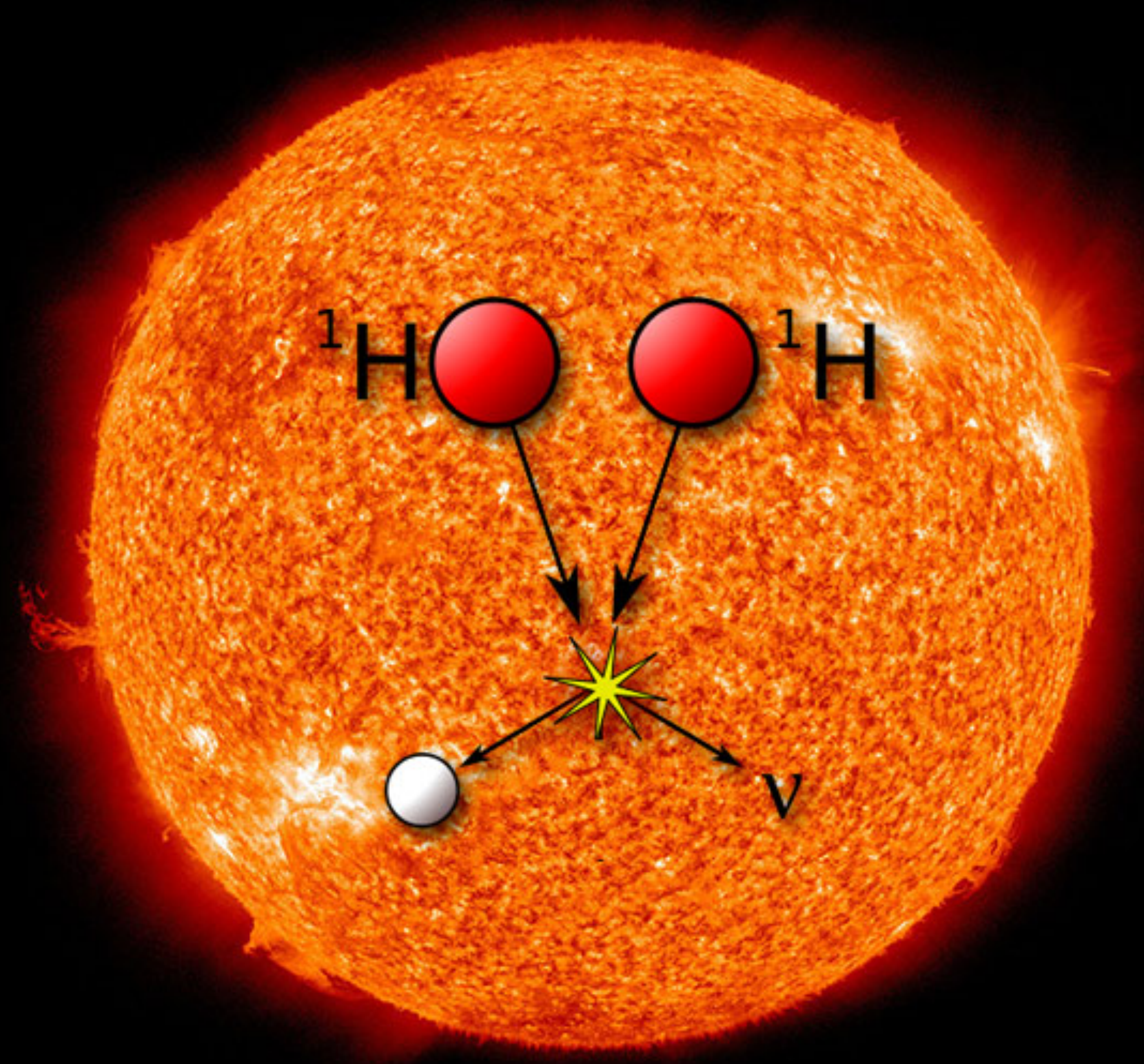
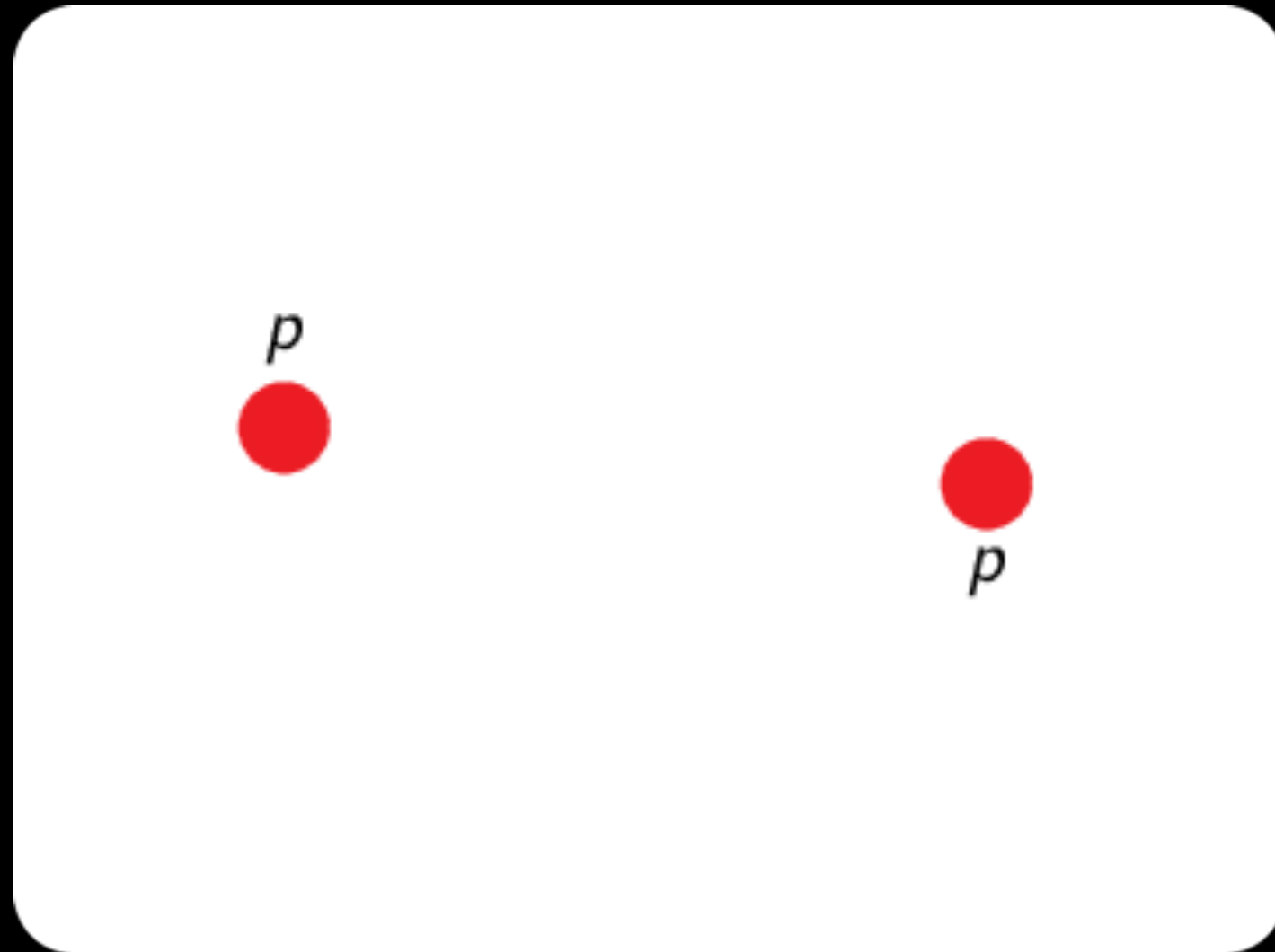


weak interaction

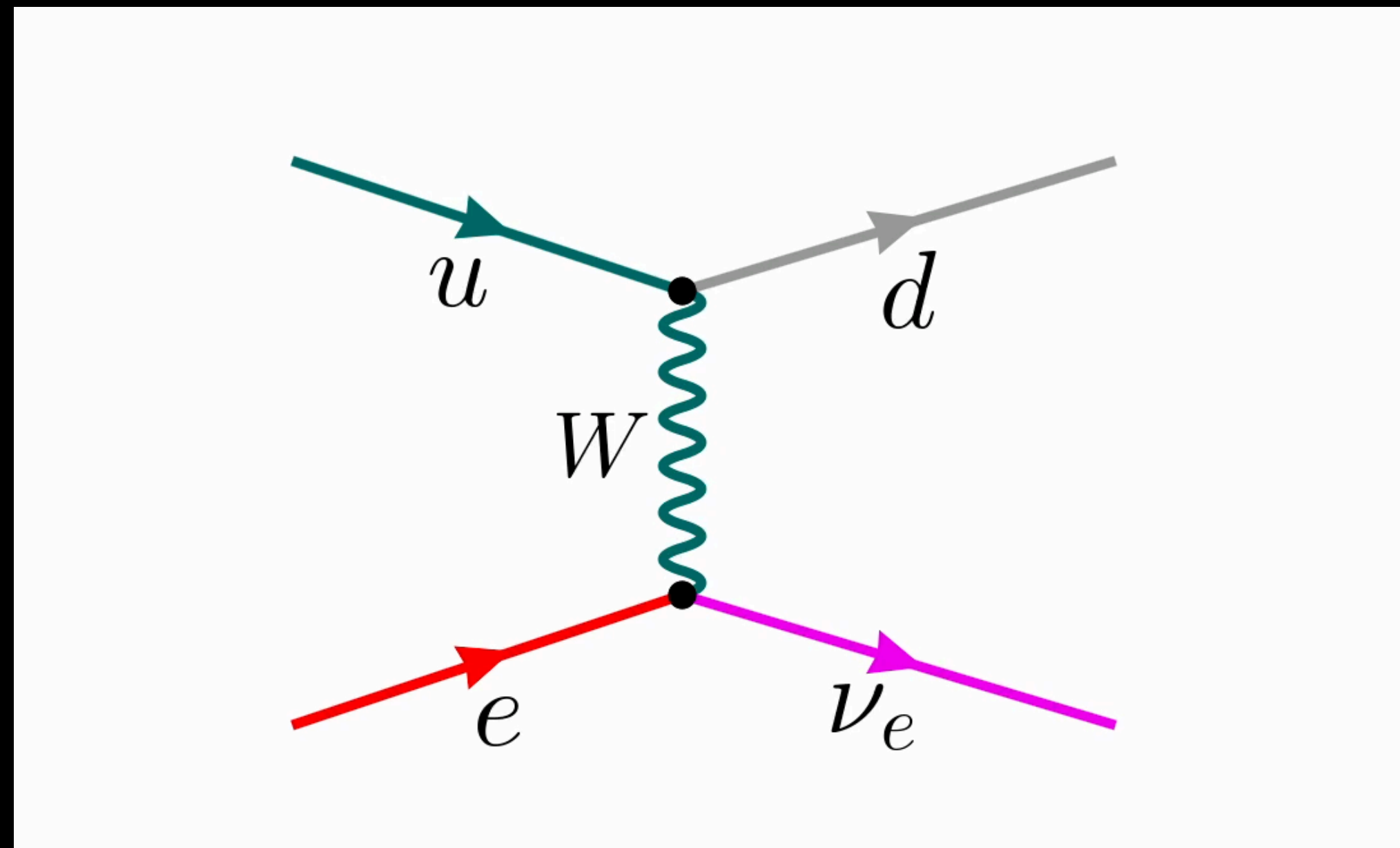
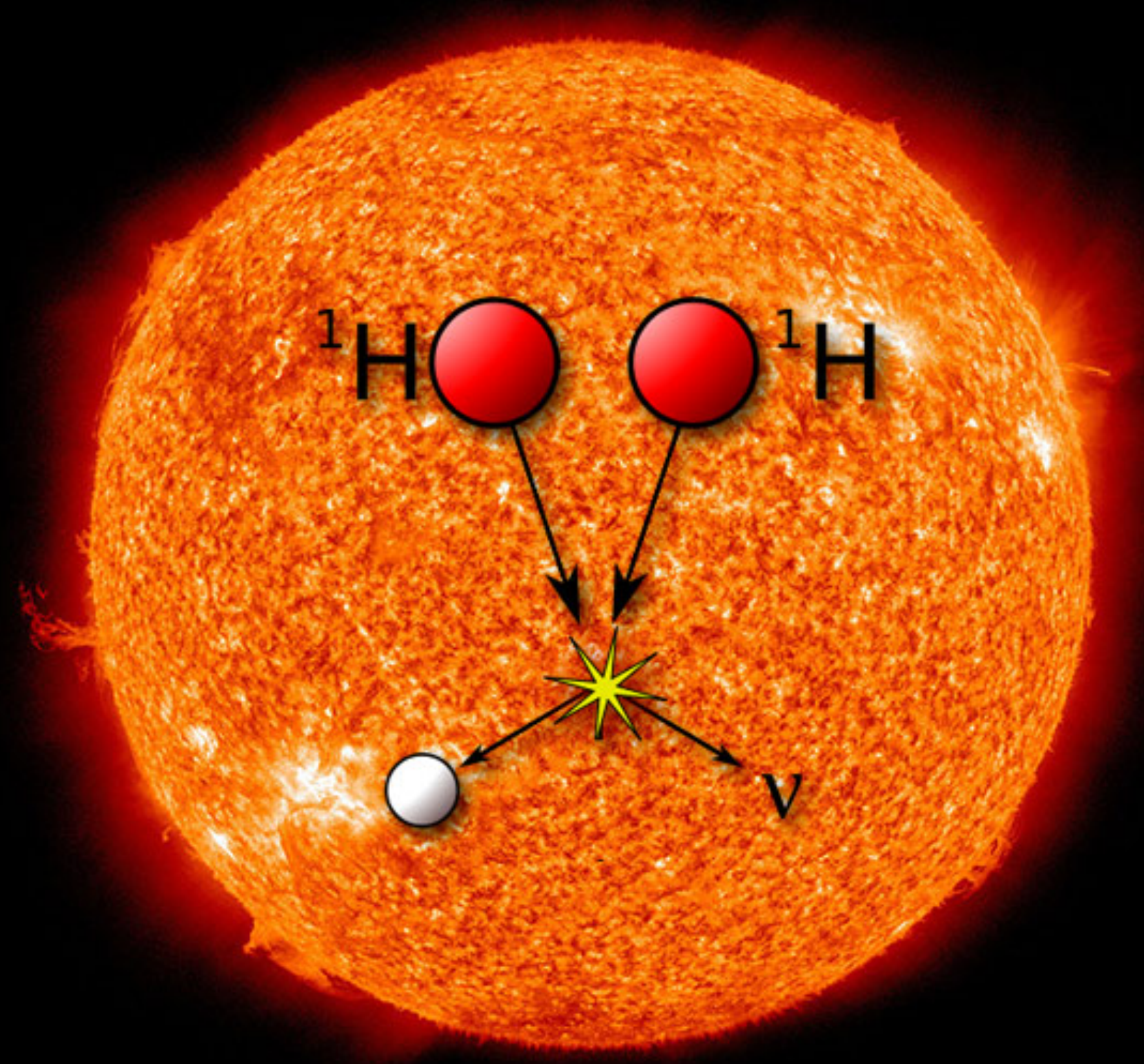
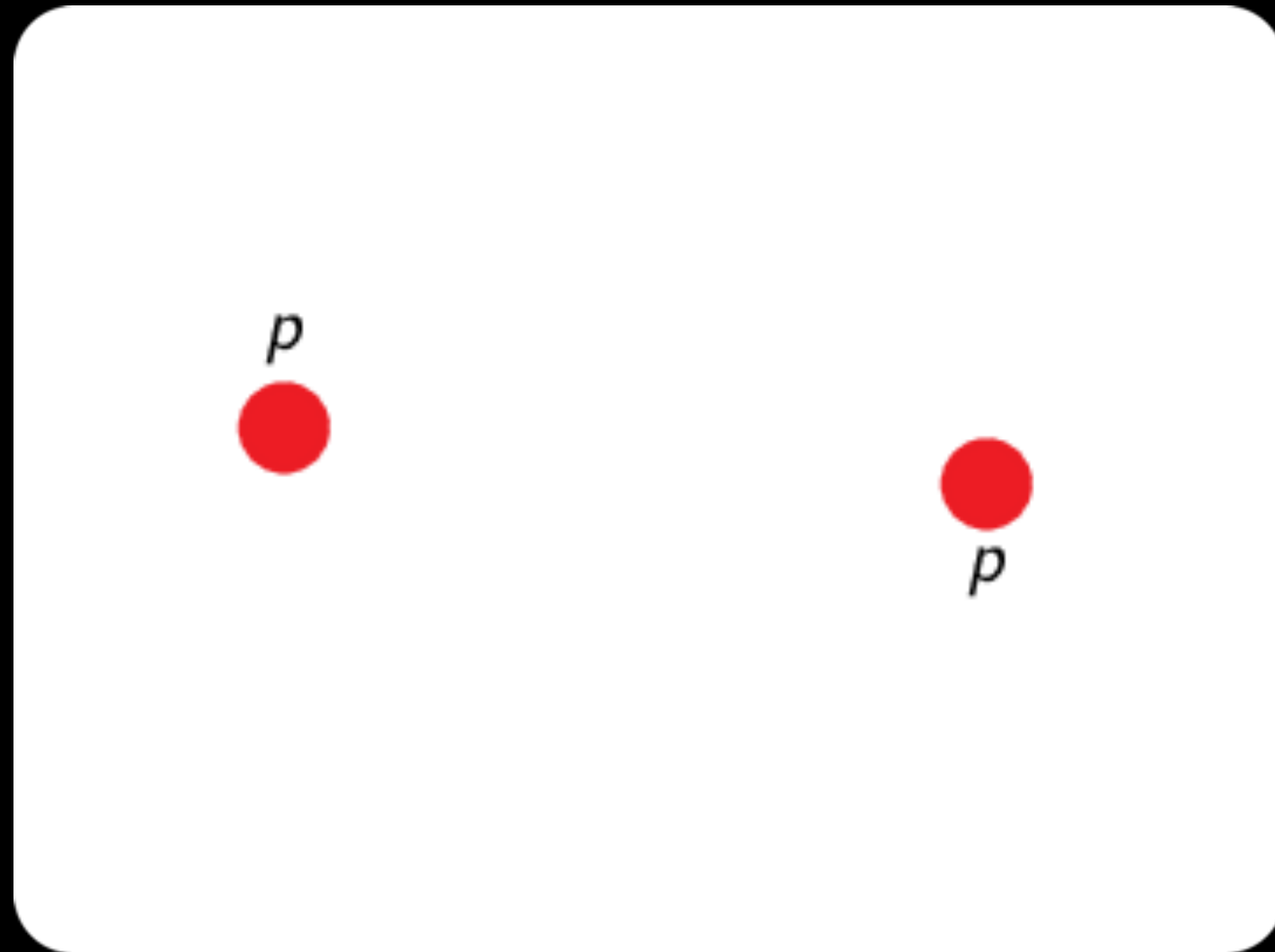
weak interaction



weak interaction



weak interaction

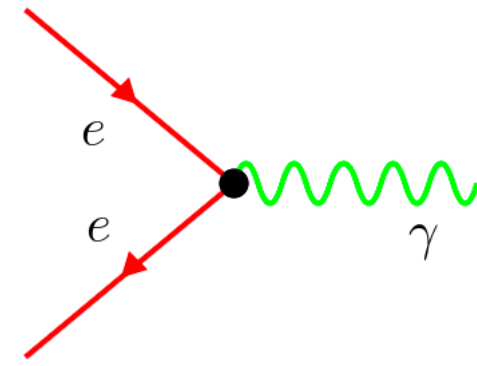


Standard Model of particle physics

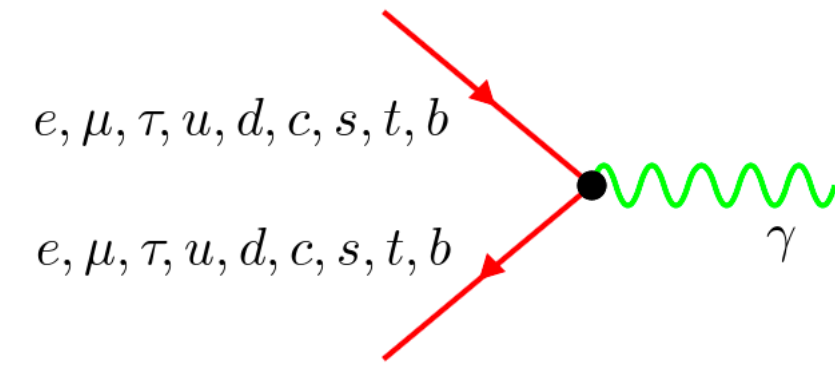
	<p>mass → ≈2.3 MeV/c²</p> <p>charge → 2/3</p> <p>spin → 1/2</p> <p>u</p> <p>up</p>	<p>mass → ≈1.275 GeV/c²</p> <p>charge → 2/3</p> <p>spin → 1/2</p> <p>c</p> <p>charm</p>	<p>mass → ≈173.07 GeV/c²</p> <p>charge → 2/3</p> <p>spin → 1/2</p> <p>t</p> <p>top</p>	<p>mass → 0</p> <p>charge → 0</p> <p>spin → 1</p> <p>g</p> <p>gluon</p>	<p>mass → ≈126 GeV/c²</p> <p>charge → 0</p> <p>spin → 0</p> <p>H</p> <p>Higgs boson</p>	
QUARKS	<p>mass → ≈4.8 MeV/c²</p> <p>charge → -1/3</p> <p>spin → 1/2</p> <p>d</p> <p>down</p>	<p>mass → ≈95 MeV/c²</p> <p>charge → -1/3</p> <p>spin → 1/2</p> <p>s</p> <p>strange</p>	<p>mass → ≈4.18 GeV/c²</p> <p>charge → -1/3</p> <p>spin → 1/2</p> <p>b</p> <p>bottom</p>	<p>mass → 0</p> <p>charge → 0</p> <p>spin → 1</p> <p>γ</p> <p>photon</p>		
	<p>mass → 0.511 MeV/c²</p> <p>charge → -1</p> <p>spin → 1/2</p> <p>e</p> <p>electron</p>	<p>mass → 105.7 MeV/c²</p> <p>charge → -1</p> <p>spin → 1/2</p> <p>μ</p> <p>muon</p>	<p>mass → 1.777 GeV/c²</p> <p>charge → -1</p> <p>spin → 1/2</p> <p>τ</p> <p>tau</p>	<p>mass → 91.2 GeV/c²</p> <p>charge → 0</p> <p>spin → 1</p> <p>Z</p> <p>Z boson</p>	GAUGE BOSONS	
	<p>mass → <2.2 eV/c²</p> <p>charge → 0</p> <p>spin → 1/2</p> <p>ν_e</p> <p>electron neutrino</p>	<p>mass → <0.17 MeV/c²</p> <p>charge → 0</p> <p>spin → 1/2</p> <p>ν_μ</p> <p>muon neutrino</p>	<p>mass → <15.5 MeV/c²</p> <p>charge → 0</p> <p>spin → 1/2</p> <p>ν_τ</p> <p>tau neutrino</p>	<p>mass → 80.4 GeV/c²</p> <p>charge → ±1</p> <p>spin → 1</p> <p>W</p> <p>W boson</p>		

$$\begin{aligned}
 \mathcal{L}_{SM} = & -\frac{1}{2}\partial_\nu g_\mu^a \partial_\nu g_\mu^a - g_s f^{abc} \partial_\mu g_\nu^a g_\mu^b g_\nu^c - \frac{1}{4}g_s^2 f^{abc} f^{ade} g_\mu^b g_\nu^c g_\mu^d g_\nu^e - \partial_\nu W_\mu^+ \partial_\nu W_\mu^- - \\
 & M^2 W_\mu^+ W_\mu^- - \frac{1}{2}\partial_\nu Z_\mu^0 \partial_\nu Z_\mu^0 - \frac{1}{2c_w^2} M^2 Z_\mu^0 Z_\mu^0 - \frac{1}{2}\partial_\mu A_\nu \partial_\mu A_\nu - igc_w (\partial_\nu Z_\mu^0 (W_\mu^+ W_\nu^- - \\
 & W_\nu^+ W_\mu^-) - Z_\nu^0 (W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + Z_\mu^0 (W_\nu^+ \partial_\nu W_\mu^- - W_\nu^- \partial_\nu W_\mu^+)) - \\
 & ig s_w (\partial_\nu A_\mu (W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - A_\nu (W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + A_\mu (W_\nu^+ \partial_\nu W_\mu^- - \\
 & W_\nu^- \partial_\nu W_\mu^+)) - \frac{1}{2}g^2 W_\mu^+ W_\mu^- W_\nu^+ W_\nu^- + \frac{1}{2}g^2 W_\mu^+ W_\nu^- W_\mu^- W_\nu^+ + g^2 c_w^2 (Z_\mu^0 W_\mu^+ Z_\nu^0 W_\nu^- - \\
 & Z_\mu^0 Z_\nu^0 W_\mu^+ W_\nu^-) + g^2 s_w^2 (A_\mu W_\mu^+ A_\nu W_\nu^- - A_\mu A_\nu W_\mu^+ W_\nu^-) + g^2 s_w c_w (A_\mu Z_\nu^0 (W_\mu^+ W_\nu^- - \\
 & W_\nu^+ W_\mu^-) - 2A_\mu Z_\mu^0 W_\nu^+ W_\nu^-) - \frac{1}{2}\partial_\mu H \partial_\mu H - 2M^2 \alpha_h H^2 - \partial_\mu \phi^+ \partial_\mu \phi^- - \frac{1}{2}\partial_\mu \phi^0 \partial_\mu \phi^0 - \\
 & \beta_h \left(\frac{2M^2}{g^2} + \frac{2M}{g} H + \frac{1}{2}(H^2 + \phi^0 \phi^0 + 2\phi^+ \phi^-) \right) + \frac{2M^4}{g^2} \alpha_h - \\
 & g \alpha_h M (H^3 + H \phi^0 \phi^0 + 2H \phi^+ \phi^-) - \\
 & \frac{1}{8}g^2 \alpha_h (H^4 + (\phi^0)^4 + 4(\phi^+ \phi^-)^2 + 4(\phi^0)^2 \phi^+ \phi^- + 4H^2 \phi^+ \phi^- + 2(\phi^0)^2 H^2) - \\
 & g M W_\mu^+ W_\mu^- H - \frac{1}{2}g \frac{M}{c_w^2} Z_\mu^0 Z_\mu^0 H - \\
 & \frac{1}{2}ig (W_\mu^+ (\phi^0 \partial_\mu \phi^- - \phi^- \partial_\mu \phi^0) - W_\mu^- (\phi^0 \partial_\mu \phi^+ - \phi^+ \partial_\mu \phi^0)) + \\
 & \frac{1}{2}g (W_\mu^+ (H \partial_\mu \phi^- - \phi^- \partial_\mu H) + W_\mu^- (H \partial_\mu \phi^+ - \phi^+ \partial_\mu H)) + \frac{1}{2}g \frac{1}{c_w} (Z_\mu^0 (H \partial_\mu \phi^0 - \phi^0 \partial_\mu H) + \\
 & M (\frac{1}{c_w} Z_\mu^0 \partial_\mu \phi^0 + W_\mu^+ \partial_\mu \phi^- + W_\mu^- \partial_\mu \phi^+) - ig \frac{s_w^2}{c_w} M Z_\mu^0 (W_\mu^+ \phi^- - W_\mu^- \phi^+) + ig s_w M A_\mu (W_\mu^+ \phi^- - \\
 & W_\mu^- \phi^+) - ig \frac{1-2c_w^2}{2c_w} Z_\mu^0 (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) + ig s_w A_\mu (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) - \\
 & \frac{1}{4}g^2 W_\mu^+ W_\mu^- (H^2 + (\phi^0)^2 + 2\phi^+ \phi^-) - \frac{1}{8}g^2 \frac{1}{c_w^2} Z_\mu^0 Z_\mu^0 (H^2 + (\phi^0)^2 + 2(2s_w^2 - 1)^2 \phi^+ \phi^-) - \\
 & \frac{1}{2}g^2 \frac{s_w^2}{c_w} Z_\mu^0 \phi^0 (W_\mu^+ \phi^- + W_\mu^- \phi^+) - \frac{1}{2}ig^2 \frac{s_w^2}{c_w} Z_\mu^0 H (W_\mu^+ \phi^- - W_\mu^- \phi^+) + \frac{1}{2}g^2 s_w A_\mu \phi^0 (W_\mu^+ \phi^- + \\
 & W_\mu^- \phi^+) + \frac{1}{2}ig^2 s_w A_\mu H (W_\mu^+ \phi^- - W_\mu^- \phi^+) - g^2 \frac{s_w}{c_w} (2c_w^2 - 1) Z_\mu^0 A_\mu \phi^+ \phi^- - \\
 & g^2 s_w^2 A_\mu A_\mu \phi^+ \phi^- + \frac{1}{2}ig_s \lambda_{ij}^a (\bar{q}_i^\sigma \gamma^\mu q_j^\sigma) g_\mu^a - \bar{e}^\lambda (\gamma^\partial + m_e^\lambda) e^\lambda - \bar{\nu}^\lambda (\gamma^\partial + m_\nu^\lambda) \nu^\lambda - \bar{u}_j^\lambda (\gamma^\partial + \\
 & m_u^\lambda) u_j^\lambda - \bar{d}_j^\lambda (\gamma^\partial + m_d^\lambda) d_j^\lambda + ig s_w A_\mu (-\bar{e}^\lambda \gamma^\mu e^\lambda) + \frac{2}{3}(\bar{u}_j^\lambda \gamma^\mu u_j^\lambda) - \frac{1}{3}(\bar{d}_j^\lambda \gamma^\mu d_j^\lambda) + \\
 & \frac{ig}{4c_w} Z_\mu^0 \{ (\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{e}^\lambda \gamma^\mu (4s_w^2 - 1 - \gamma^5) e^\lambda) + (\bar{d}_j^\lambda \gamma^\mu (\frac{4}{3}s_w^2 - 1 - \gamma^5) d_j^\lambda) + \\
 & (\bar{u}_j^\lambda \gamma^\mu (1 - \frac{8}{3}s_w^2 + \gamma^5) u_j^\lambda) \} + \frac{ig}{2\sqrt{2}} W_\mu^+ ((\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) U^{lep}{}_{\lambda\kappa} e^\kappa) + (\bar{u}_j^\lambda \gamma^\mu (1 + \gamma^5) C_{\lambda\kappa} d_j^\kappa)) + \\
 & \frac{ig}{2\sqrt{2}} W_\mu^- ((\bar{e}^\kappa U^{lep}{}_{\kappa\lambda}^\dagger \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{d}_j^\kappa C_{\kappa\lambda}^\dagger \gamma^\mu (1 + \gamma^5) u_j^\lambda)) + \\
 & \frac{ig}{2M\sqrt{2}} \phi^+ (-m_e^\kappa (\bar{\nu}^\lambda U^{lep}{}_{\lambda\kappa} (1 - \gamma^5) e^\kappa) + m_\nu^\lambda (\bar{\nu}^\lambda U^{lep}{}_{\lambda\kappa} (1 + \gamma^5) e^\kappa) + \\
 & \frac{ig}{2M\sqrt{2}} \phi^- (m_e^\lambda (\bar{e}^\lambda U^{lep}{}_{\lambda\kappa}^\dagger (1 + \gamma^5) \nu^\kappa) - m_\nu^\kappa (\bar{e}^\lambda U^{lep}{}_{\lambda\kappa}^\dagger (1 - \gamma^5) \nu^\kappa) - \frac{g m_\lambda^2}{2M} H (\bar{\nu}^\lambda \nu^\lambda) - \\
 & \frac{g m_e^\lambda}{2M} H (\bar{e}^\lambda e^\lambda) + \frac{ig m_\nu^\lambda}{2M} \phi^0 (\bar{\nu}^\lambda \gamma^5 \nu^\lambda) - \frac{ig m_e^\lambda}{2M} \phi^0 (\bar{e}^\lambda \gamma^5 e^\lambda) - \frac{1}{4} \bar{\nu}_\lambda M_{\lambda\kappa}^R (1 - \gamma^5) \hat{\nu}_\kappa - \\
 & \frac{1}{4} \bar{\nu}_\lambda M_{\lambda\kappa}^R (1 - \gamma^5) \hat{\nu}_\kappa + \frac{ig}{2M\sqrt{2}} \phi^+ (-m_d^\kappa (\bar{u}_j^\lambda C_{\lambda\kappa} (1 - \gamma^5) d_j^\kappa) + m_u^\lambda (\bar{u}_j^\lambda C_{\lambda\kappa} (1 + \gamma^5) d_j^\kappa) + \\
 & \frac{ig}{2M\sqrt{2}} \phi^- (m_d^\lambda (\bar{d}_j^\lambda C_{\lambda\kappa}^\dagger (1 + \gamma^5) u_j^\kappa) - m_u^\kappa (\bar{d}_j^\lambda C_{\lambda\kappa}^\dagger (1 - \gamma^5) u_j^\kappa) - \frac{g m_\lambda^2}{2M} H (\bar{u}_j^\lambda u_j^\lambda) - \\
 & \frac{g m_d^\lambda}{2M} H (\bar{d}_j^\lambda d_j^\lambda) + \frac{ig m_u^\lambda}{2M} \phi^0 (\bar{u}_j^\lambda \gamma^5 u_j^\lambda) - \frac{ig m_d^\lambda}{2M} \phi^0 (\bar{d}_j^\lambda \gamma^5 d_j^\lambda) + \bar{G}^a \partial^2 G^a + g_s f^{abc} \partial_\mu \bar{G}^a G^b g_\mu^c + \\
 & \bar{X}^+ (\partial^2 - M^2) X^+ + \bar{X}^- (\partial^2 - M^2) X^- + \bar{X}^0 (\partial^2 - \frac{M^2}{c_w^2}) X^0 + \bar{Y} \partial^2 Y + igc_w W_\mu^+ (\partial_\mu \bar{X}^0 X^- - \\
 & \partial_\mu \bar{X}^+ X^0) + ig s_w W_\mu^+ (\partial_\mu \bar{Y} X^- - \partial_\mu \bar{X}^+ Y) + igc_w W_\mu^- (\partial_\mu \bar{X}^- X^0 -
 \end{aligned}$$

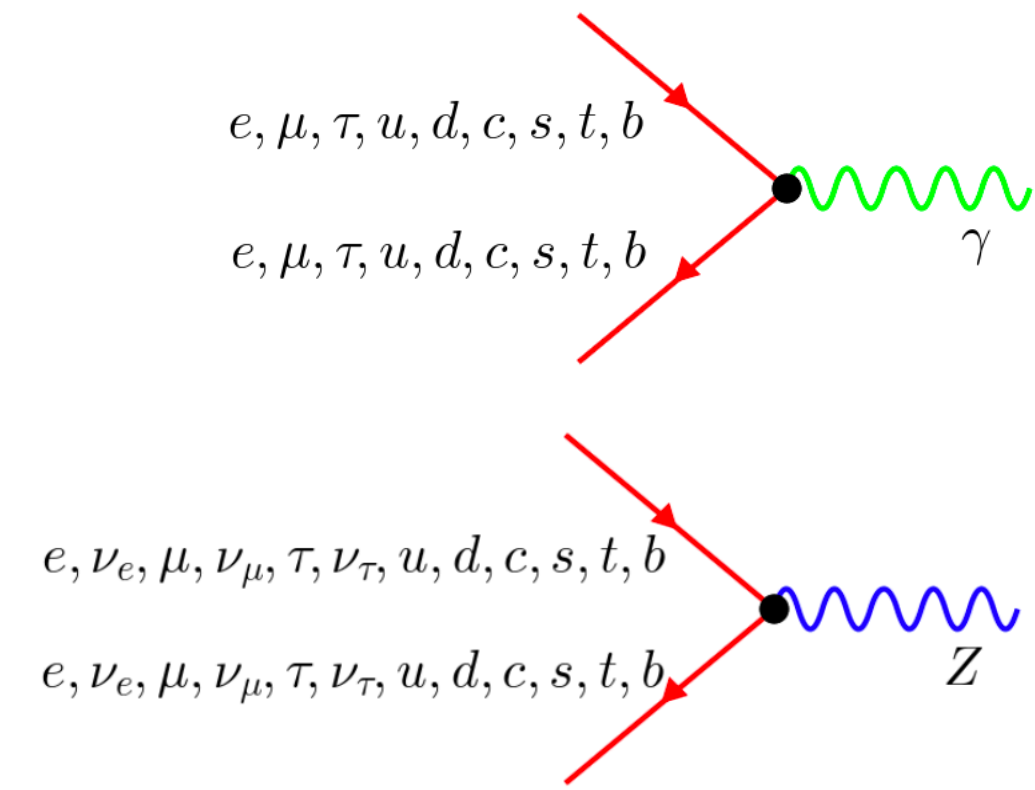
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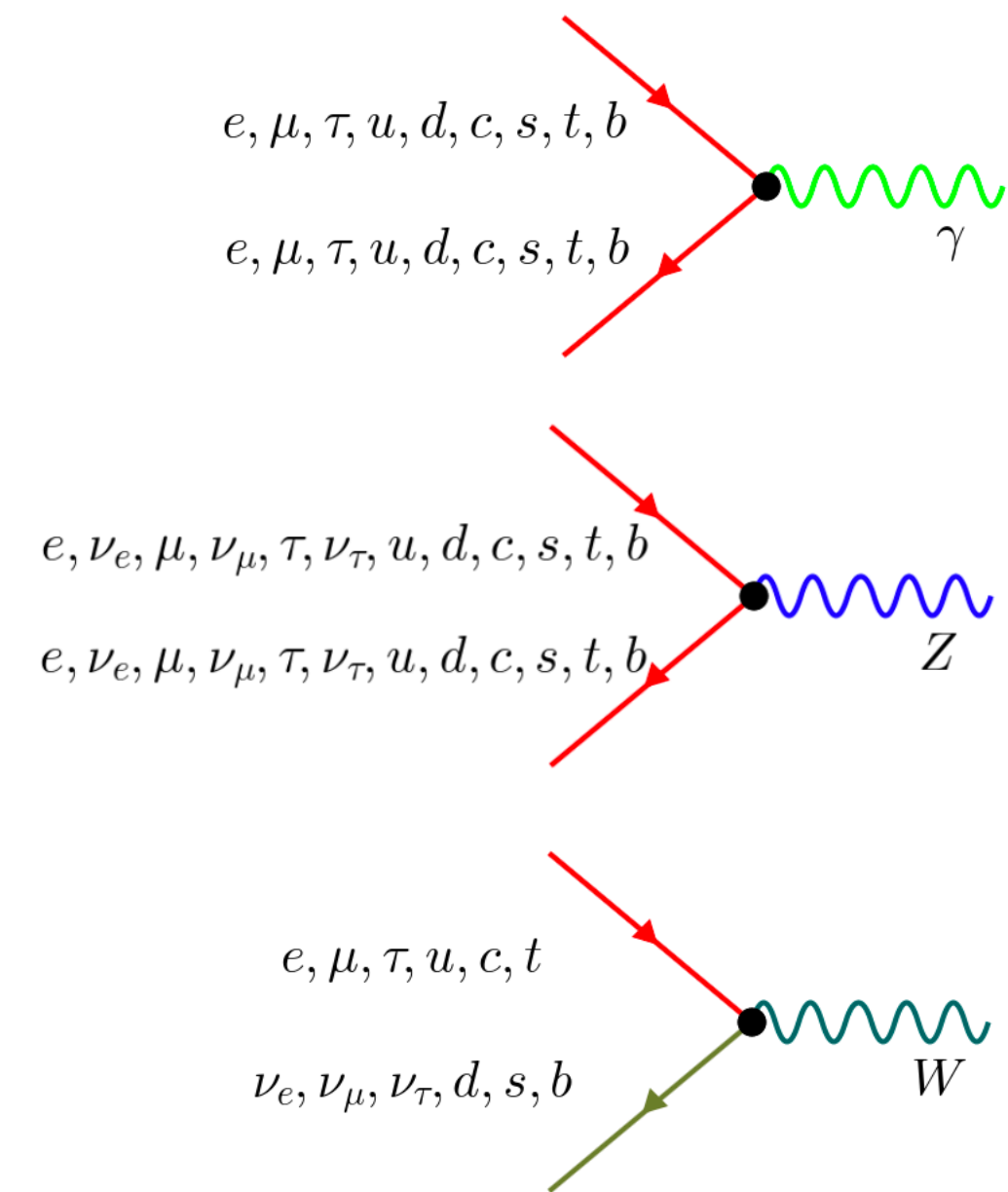
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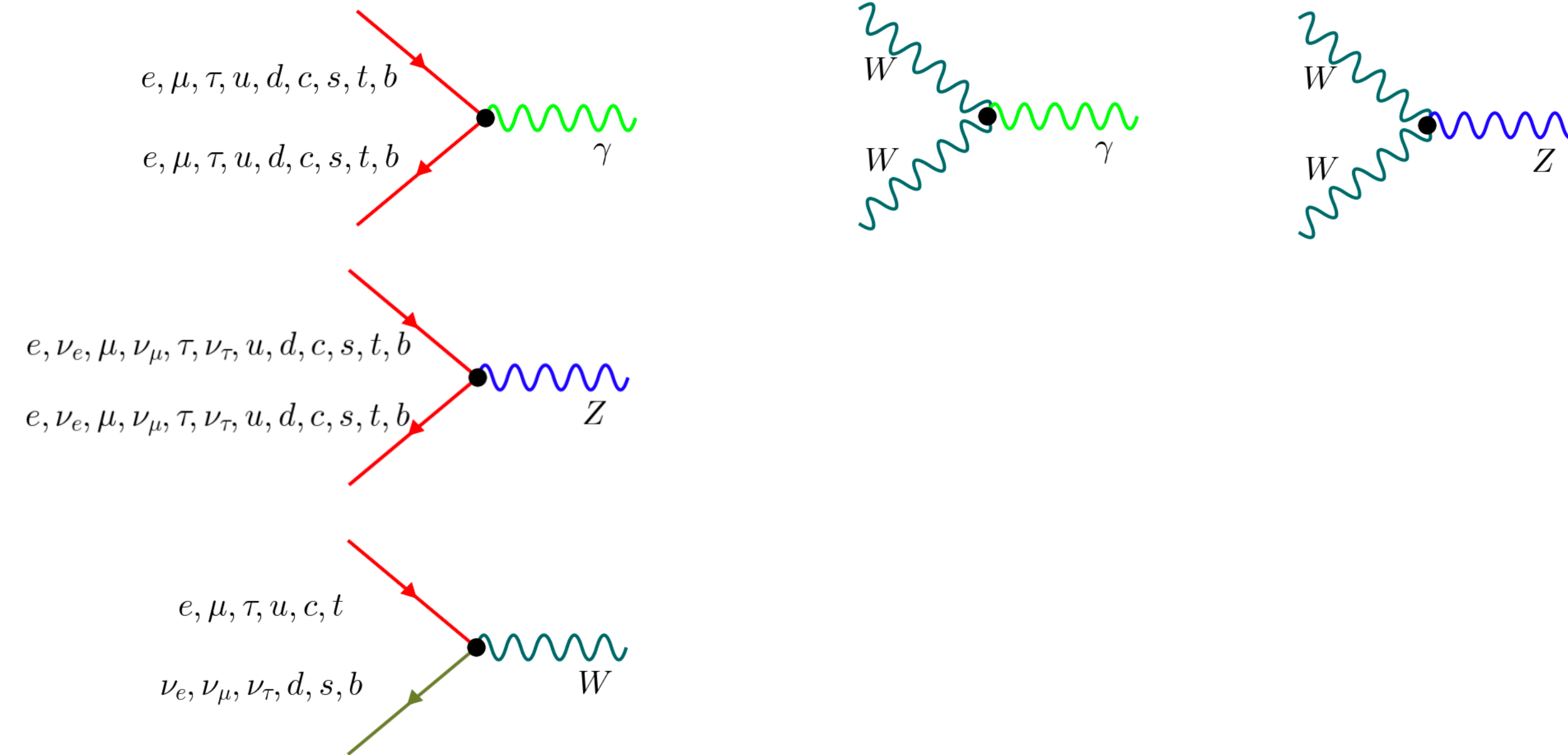
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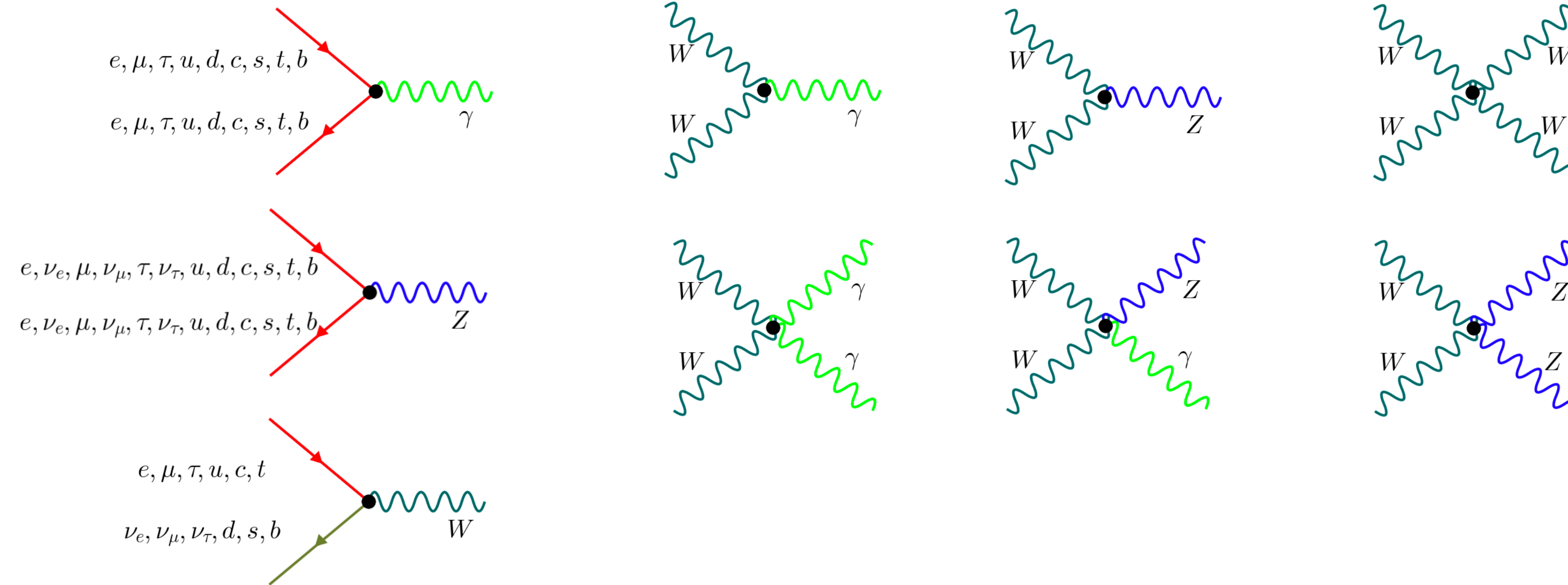
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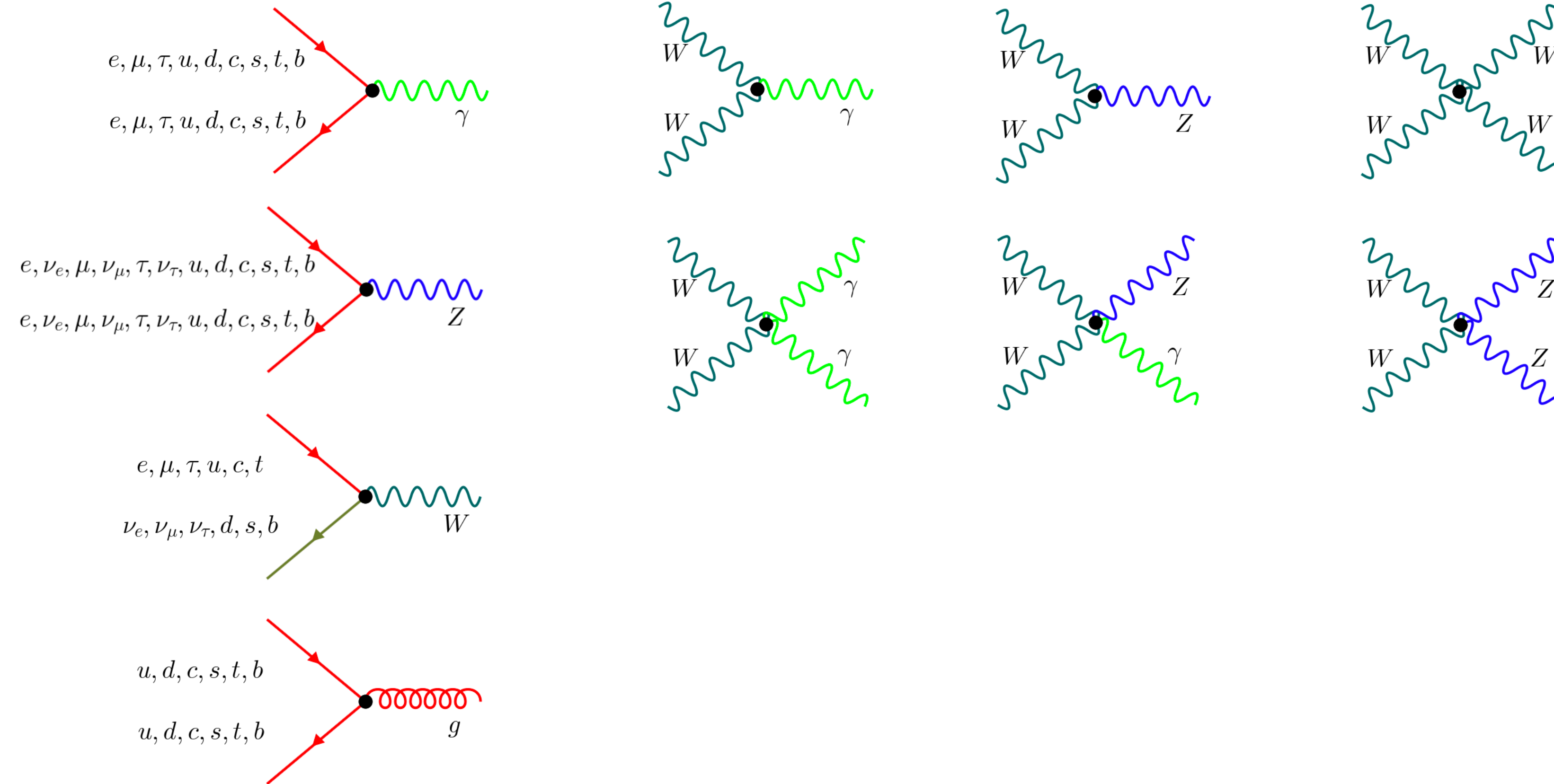
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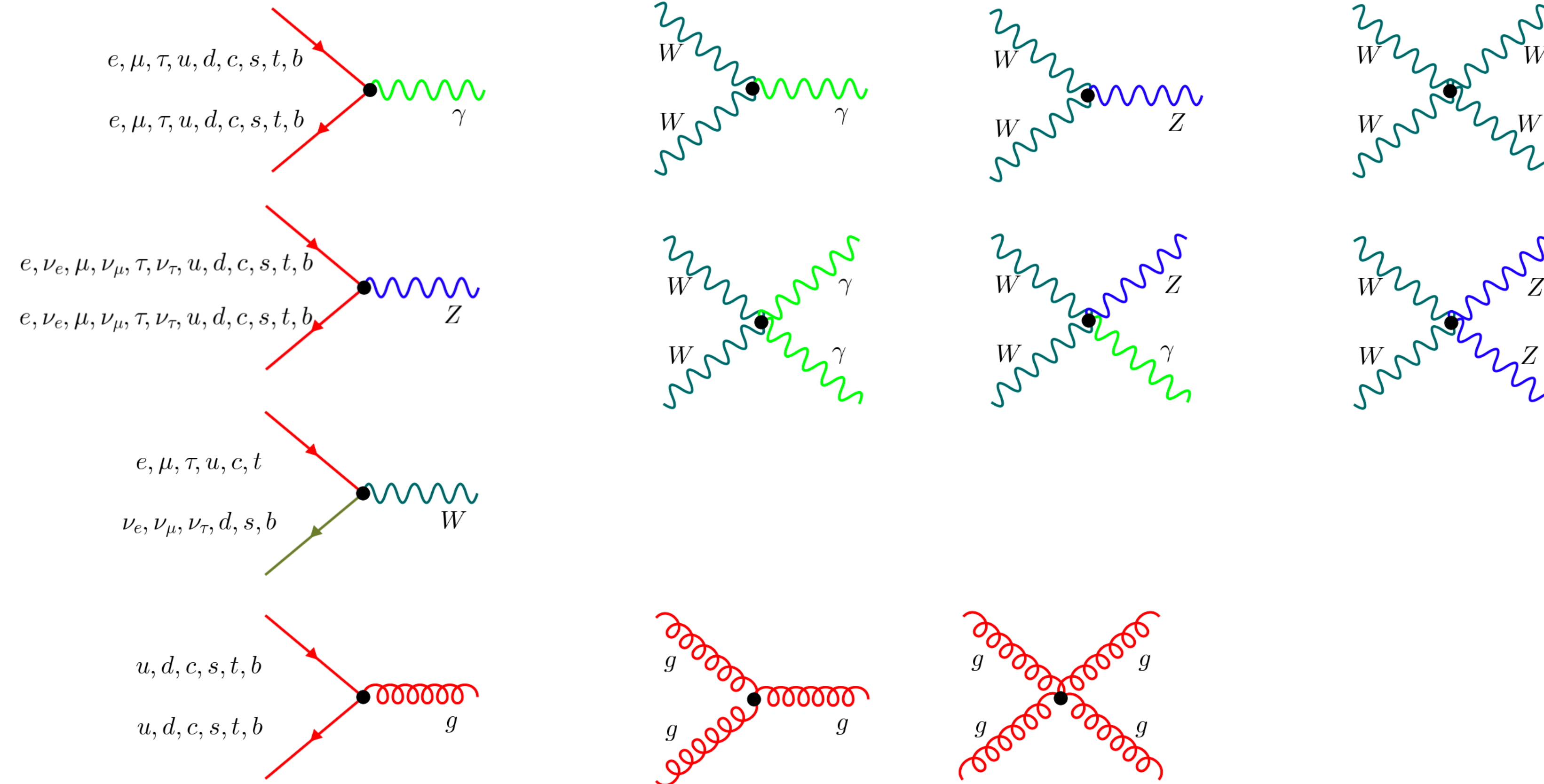
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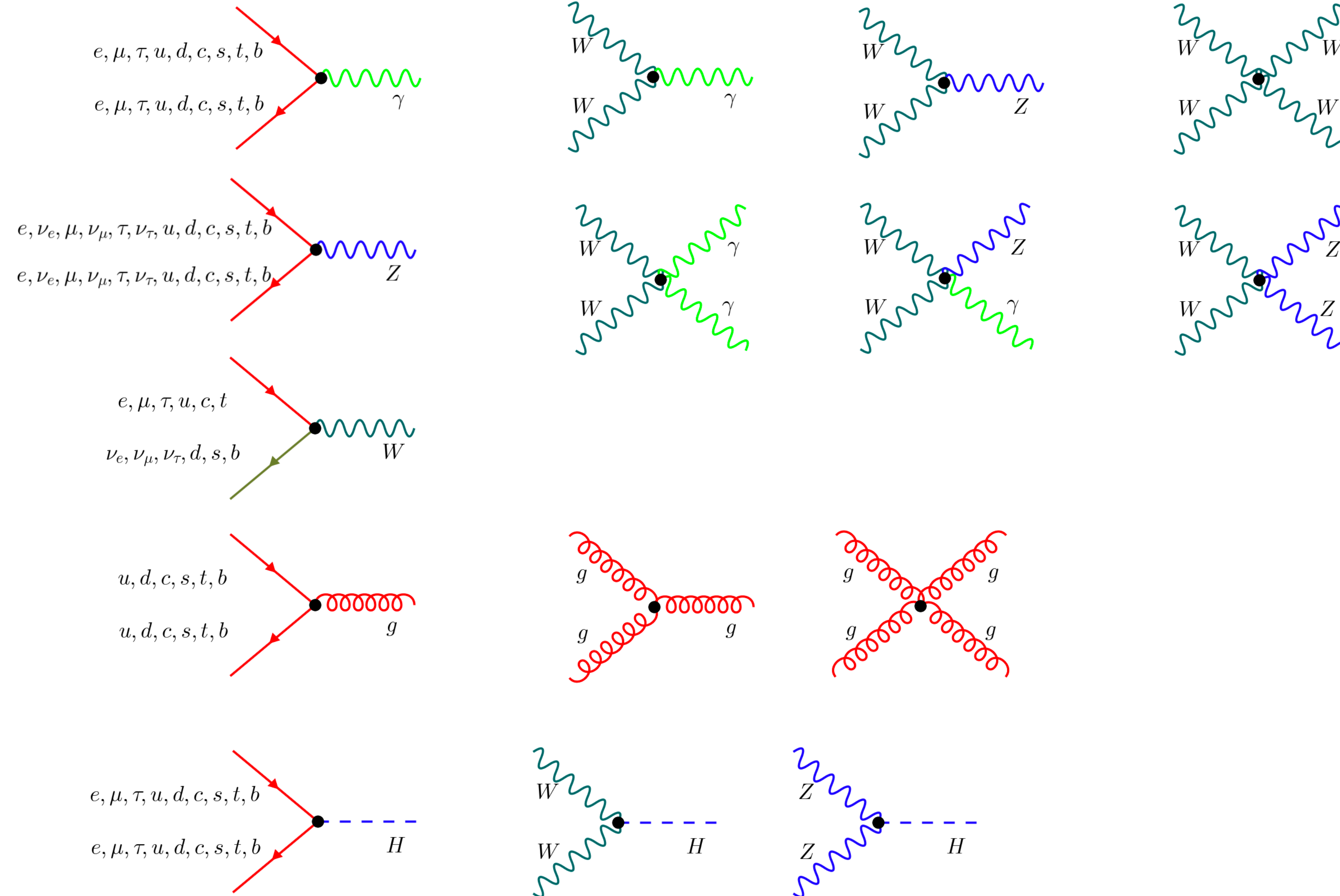
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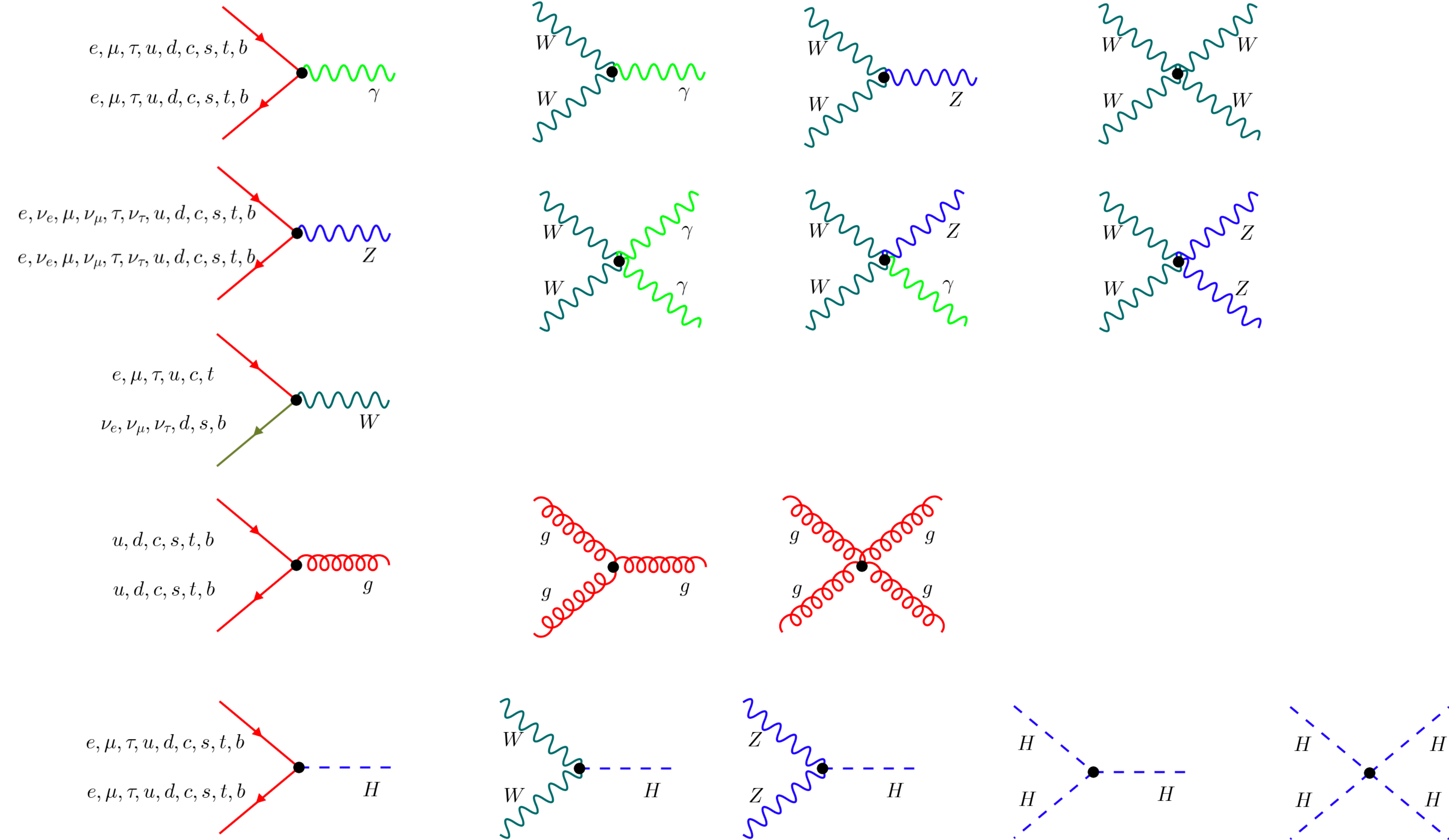
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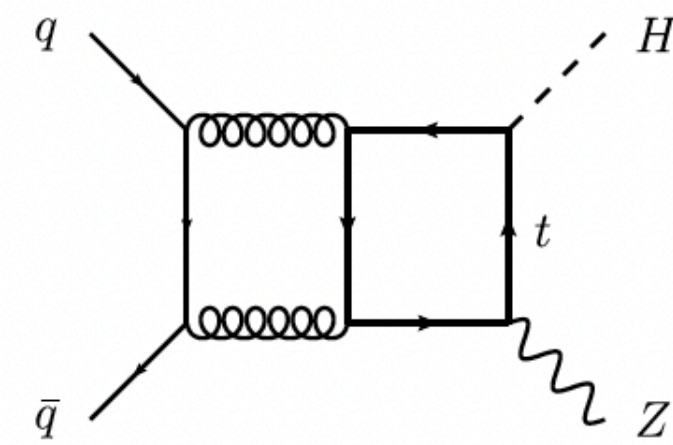
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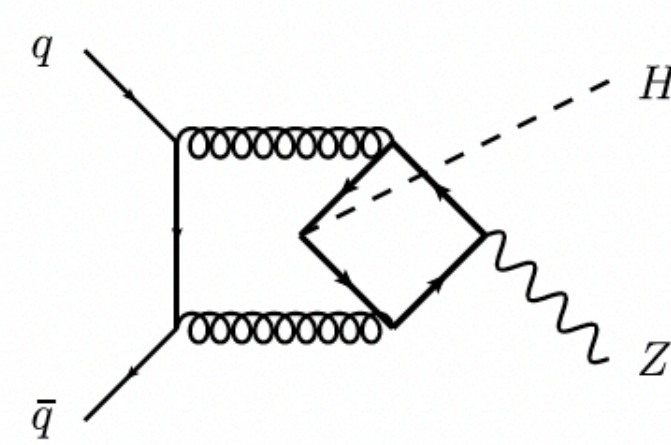
Standard Model of particle physics



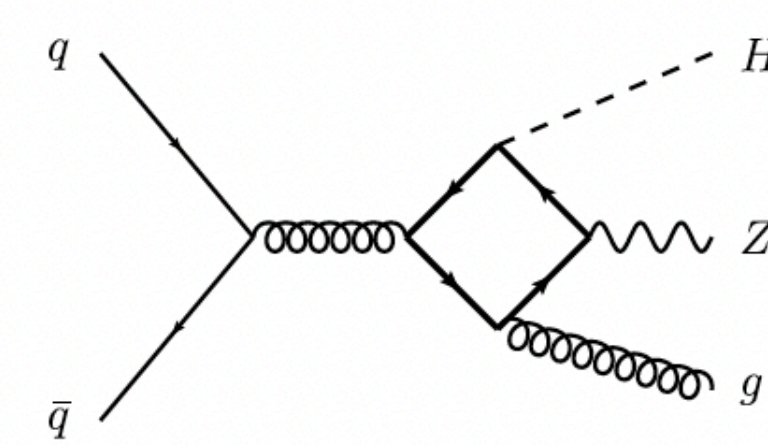
3 (a, b) Diagrams of group R_{II} and (c) group R_{III} contributing to the process $q\bar{q} \rightarrow ZH(g)$ at order $g^3\lambda_t\alpha_s^2$



(a)

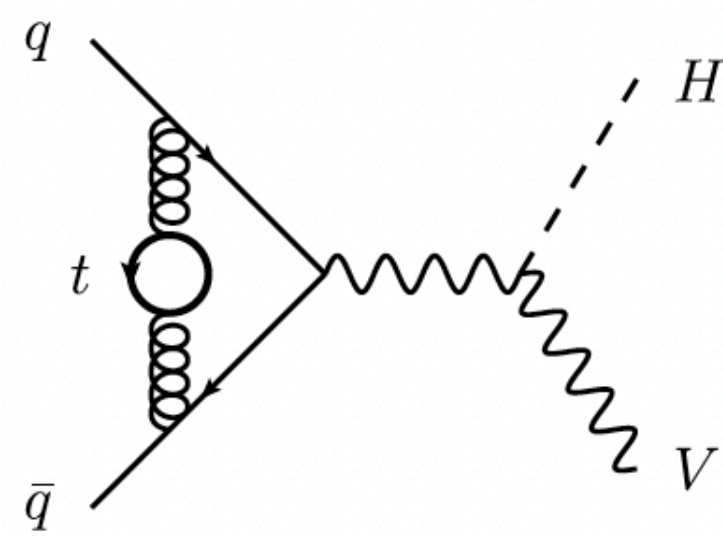


(b)

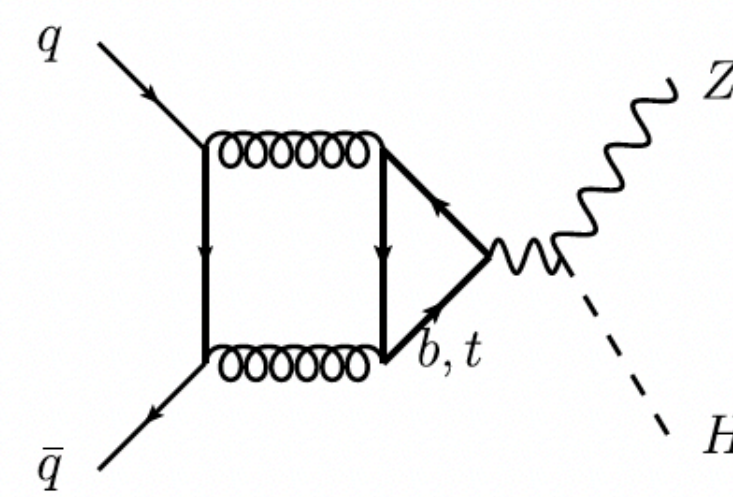


(c)

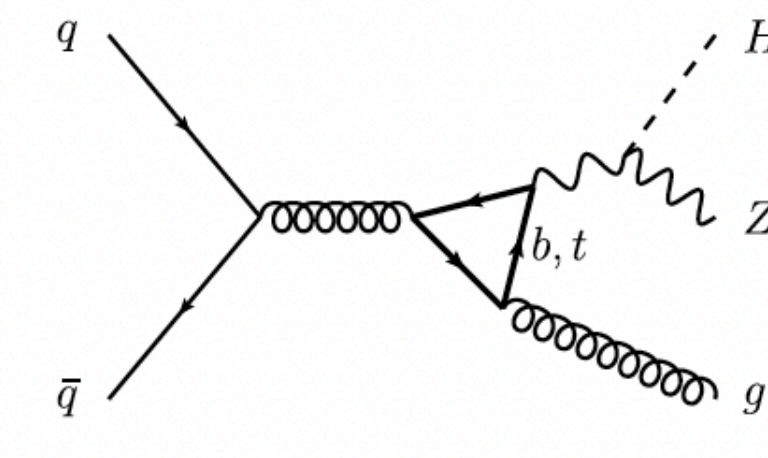
4 Drell–Yan-like diagrams with closed top- and bottom-quark loops



(a)

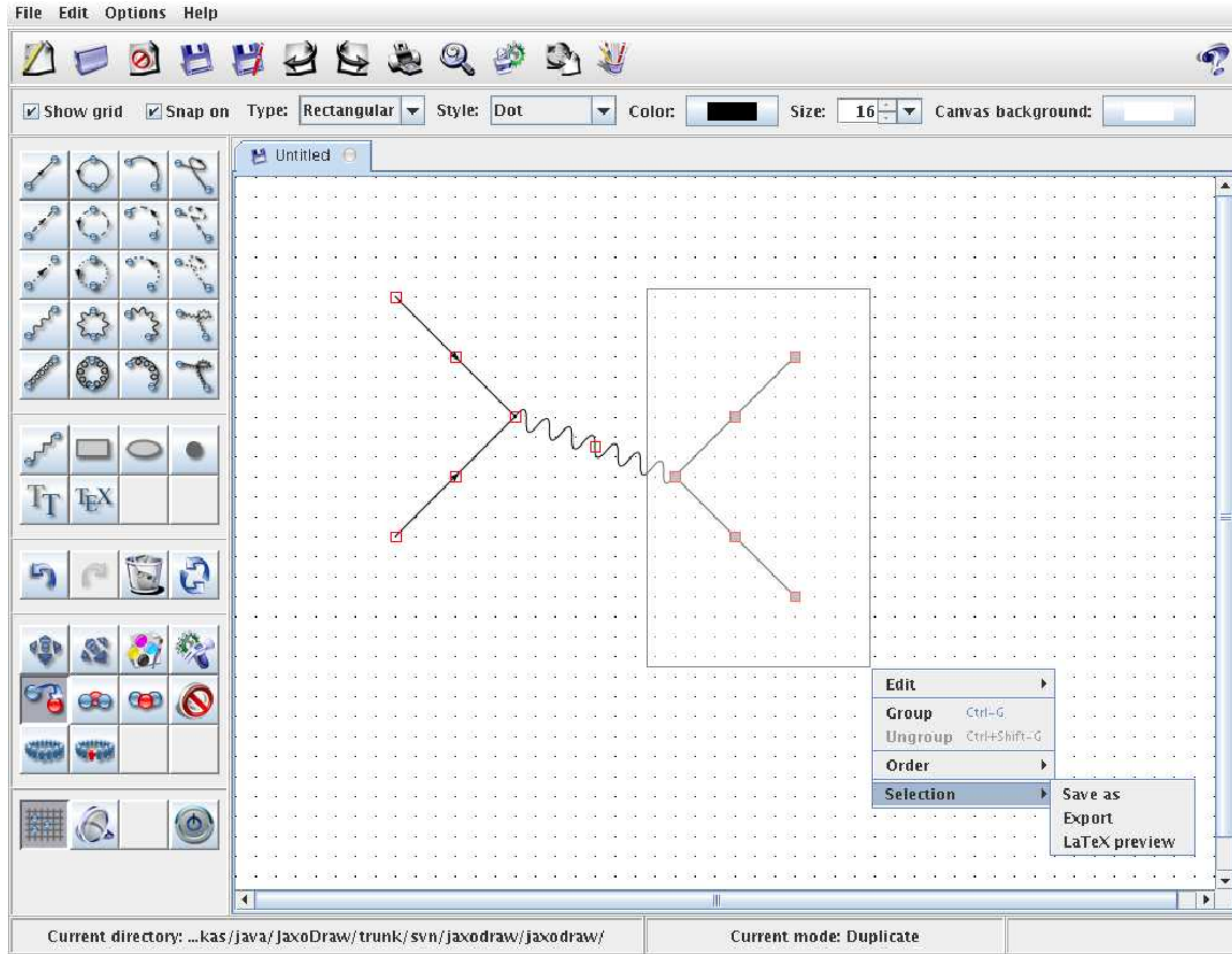


(b)



(c)

```
dum.tex - GNU Emacs at MacRobiwan.fritz.box
qft.tex dum.py citations.py paper.tex flint_resources.py dum.dat plot.gp bibliography.tex tutorial.tex aximate.pm dum.tex
\documentclass{beamer}
\usepackage{axodraw}
\usepackage{rotate}
\usepackage{scalegnt}
\usepackage{color}
\begin{document}
\pagestyle{empty}
\setbeamertemplate{footline}[page number]{}
\setbeamertemplate{navigation symbols}{}
\begin{picture}(300,260)(-40,-160)
\SetScale{1}
\SetWidth{2}
\SetWidth{2}
\Circ(98.989898989899,-20){5}{Red}{Red}
\SetWidth{2}
\Circ(98.989898989899,-49.8737373737374){5}{Blue}{Blue}
\SetWidth{2}
\SetColor{Black}
\Line(0,50)(80,40)
\SetWidth{2}
\SetColor{Black}
\Line(0,-30)(60,20)
\SetWidth{2}
\SetColor{Black}
\Line(40,-20)(98.989898989899,-20)
\SetWidth{2}
\SetColor{Black}
\Line(20,-40)(98.989898989899,-49.8737373737374)
\SetWidth{2}
\SetColor{Black}
\Line(20,-40)(40,-20)
\SetWidth{2}
\SetColor{Black}
\Photon(40,-20)(60,20){5}{3}
\SetWidth{2}
\SetColor{Black}
\Line(60,20)(80,40)
\end{picture}
\end{document}
-:--- dum.tex All L3 (LaTeX FlD FD Abbrev Fill)
```



Untitled.fg - FeynGame v2.1.0 | 29.02.2024 16:11:35

File Edit Layout View Help

default X +

	t	b	c	s	u	d	e	μ
τ	ν_e	ν_μ	ν_τ	γ	Z	W	g	H

Untitled.fg - FeynGame v2.0.0 | 03.03.2023 10:26:17

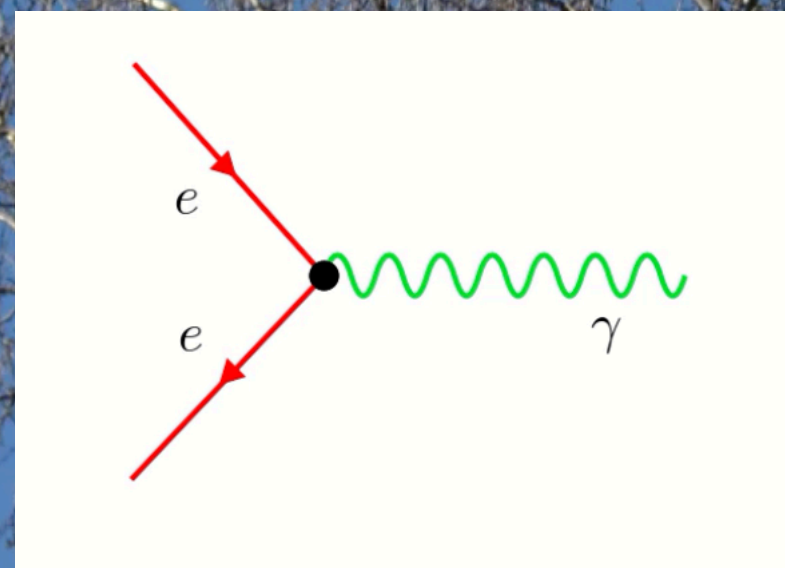
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Select a tile

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qed × +

+ e γ



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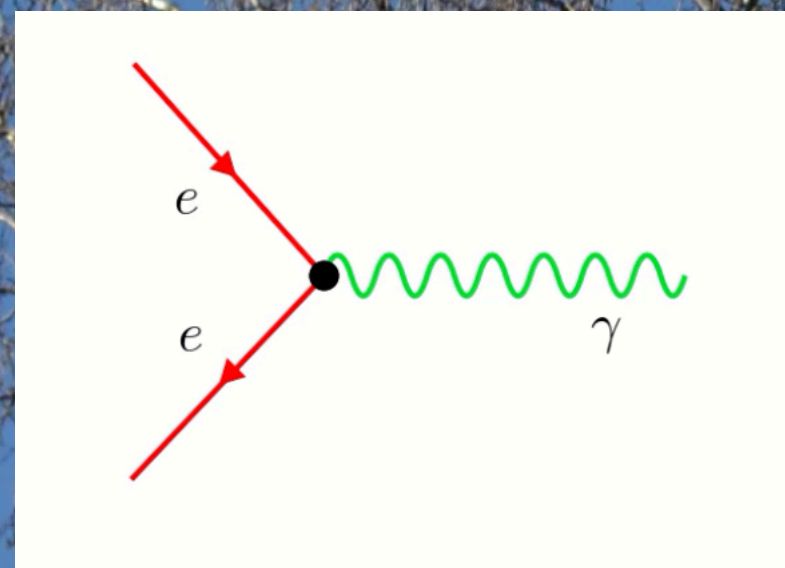
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Select a tile

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qed × +

+ e γ



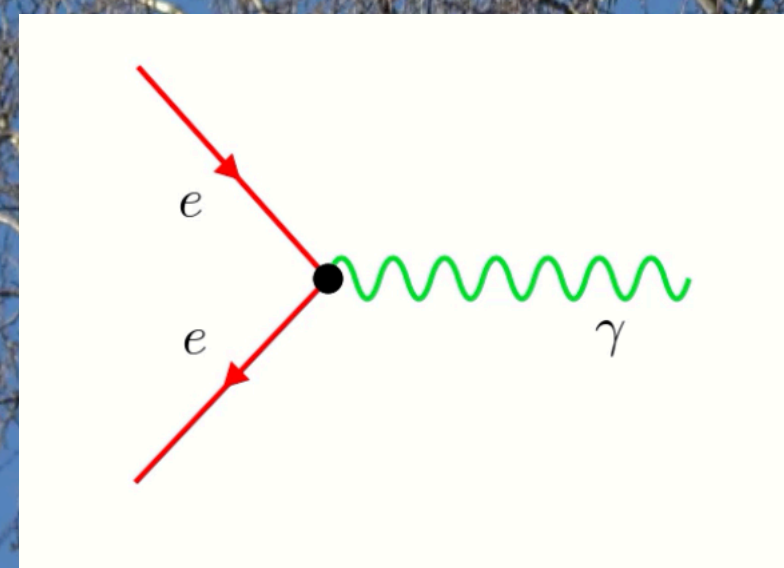
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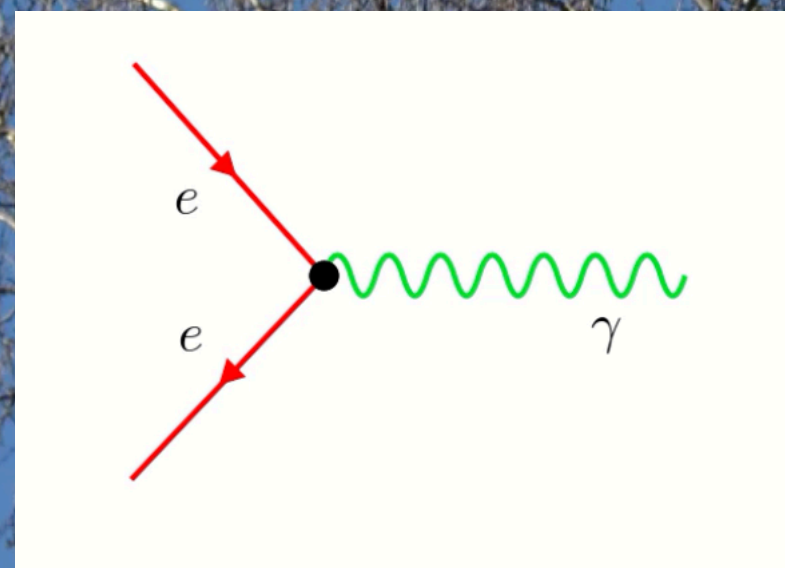
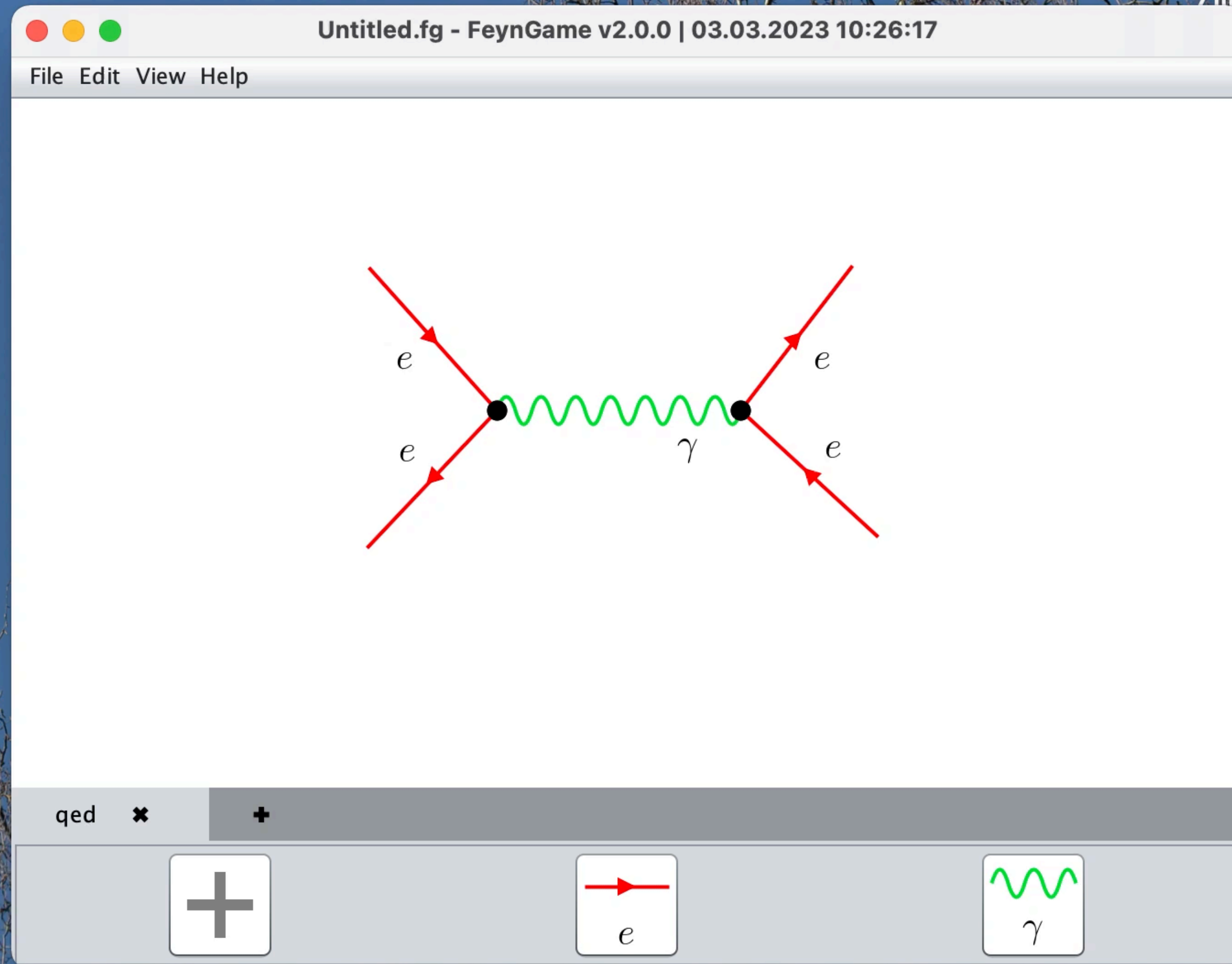
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A Feynman diagram showing two electrons (red lines with arrows) interacting via a photon (green wavy line). The diagram is centered in the main window. The left side shows two red lines entering from the top-left and bottom-left, meeting at a black vertex. The right side shows two red lines exiting to the top-right and bottom-right, meeting at another black vertex. A green wavy line connects the two vertices, labeled with the Greek letter gamma (γ).

qed × +

+ e γ





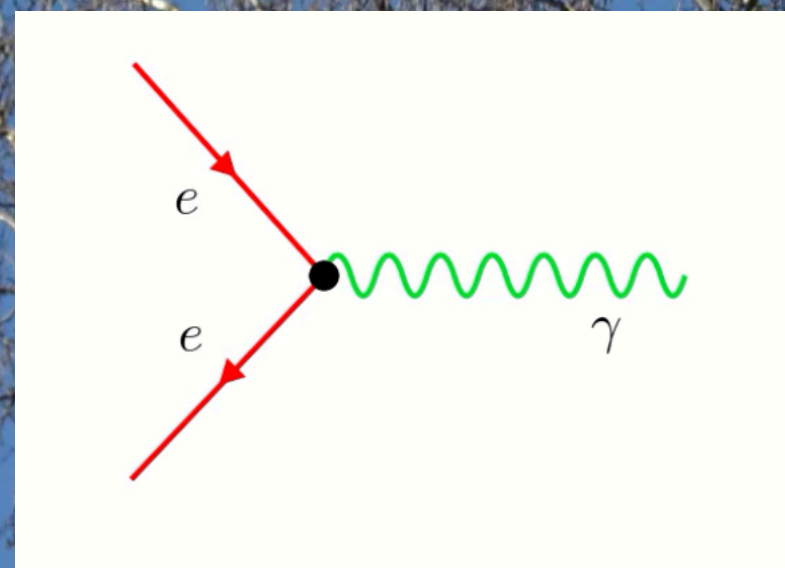
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The diagram shows two incoming electrons (red lines with arrows) from the left and two outgoing electrons to the right. Two green wavy lines, representing photons (γ), are exchanged between the electrons. The top photon connects the top-left and top-right vertices, and the bottom photon connects the bottom-left and bottom-right vertices. Vertical red lines with arrows connect the top-left to bottom-left and top-right to bottom-right vertices, representing the electron propagators.

qed × +

+ e γ



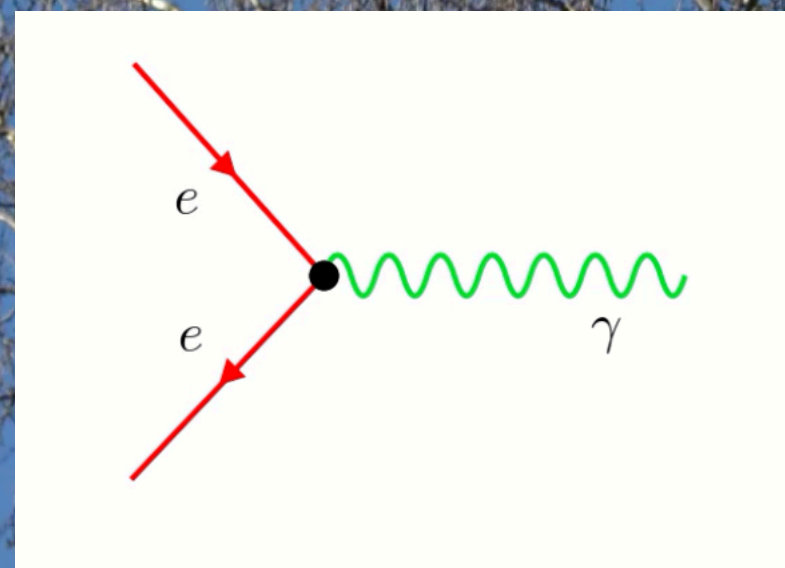
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The diagram shows two incoming electrons (red lines with arrows) from the left and two outgoing electrons to the right. Two green wavy lines, representing photons (γ), are exchanged between the electrons. The top photon is labeled γ and the bottom photon is also labeled γ . The electron lines are connected by two vertical red lines, forming a box-like structure.

qed × +

+ e γ



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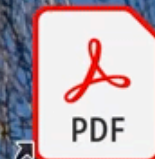
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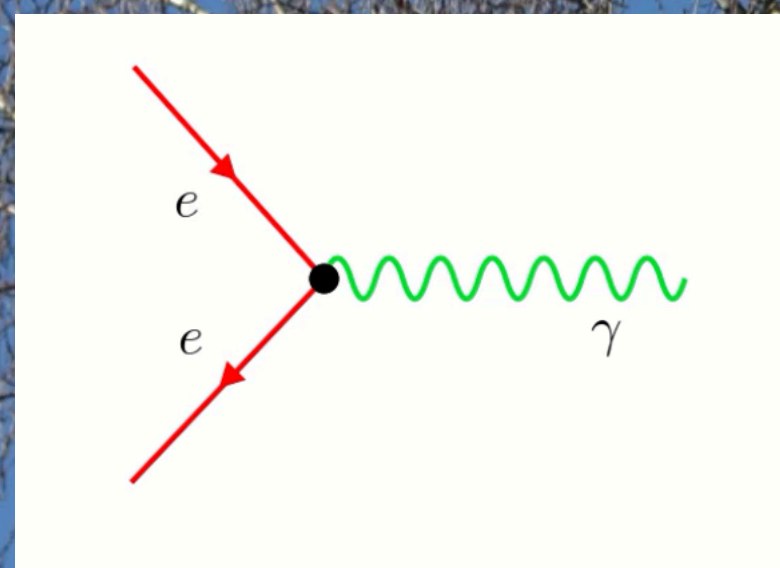
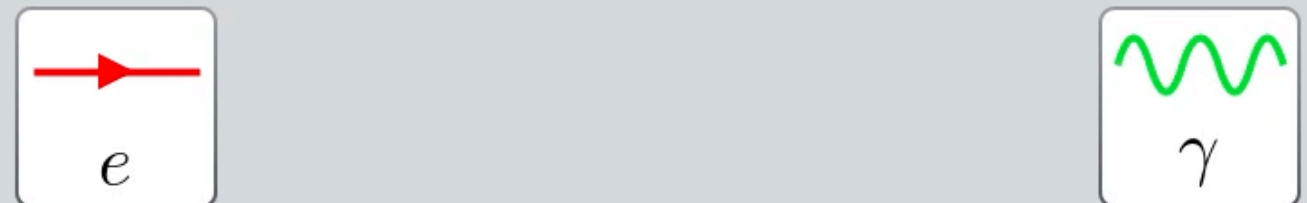
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Points of this challenge: 5 Points: 0

Retry Skip Finish



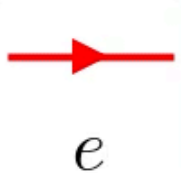
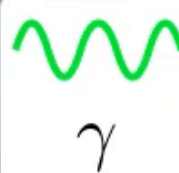
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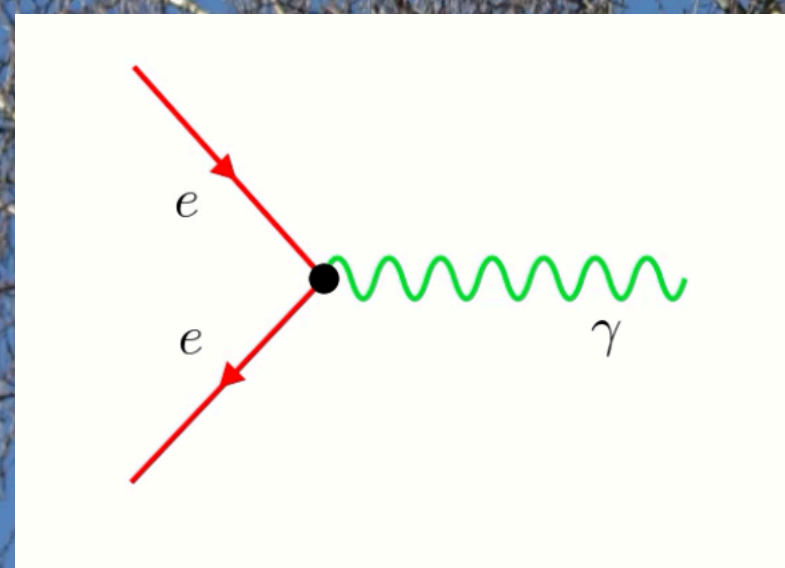
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Points of this challenge: 5 Points: 0

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SUISSE
FRANCE

CMS

LHCb

ATLAS

CERN Meyrin

CERN Preessin

SPS 7 km

ALICE

LHC 27 km

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Points of this challenge: **5** Points: **0**

Retry Skip Finish

t	b	c	s	u	d	e	ν_e
μ	ν_μ	τ	ν_τ	H	g	W	γ
Z							

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2023-0...6.47.mov
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YR3.pdf



YR2.pdf



YR1.pdf

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Points of this challenge: **5** Points: **0**

Retry Skip Finish

t	b	c	s	u	d	e	ν_e
μ	ν_μ	τ	ν_τ	H	g	W	γ
Z							

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Screen Recording
2023-0...6.47.mov
01:45

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YR3.pdf



YR2.pdf



YR1.pdf



FeynGame

Current developers:

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Other contributors:

Erik de la Haye, Lars Bündgen



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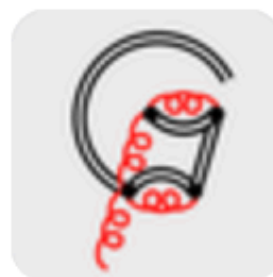
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FeynGame

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Sven Yannick Klein authored 1 year ago

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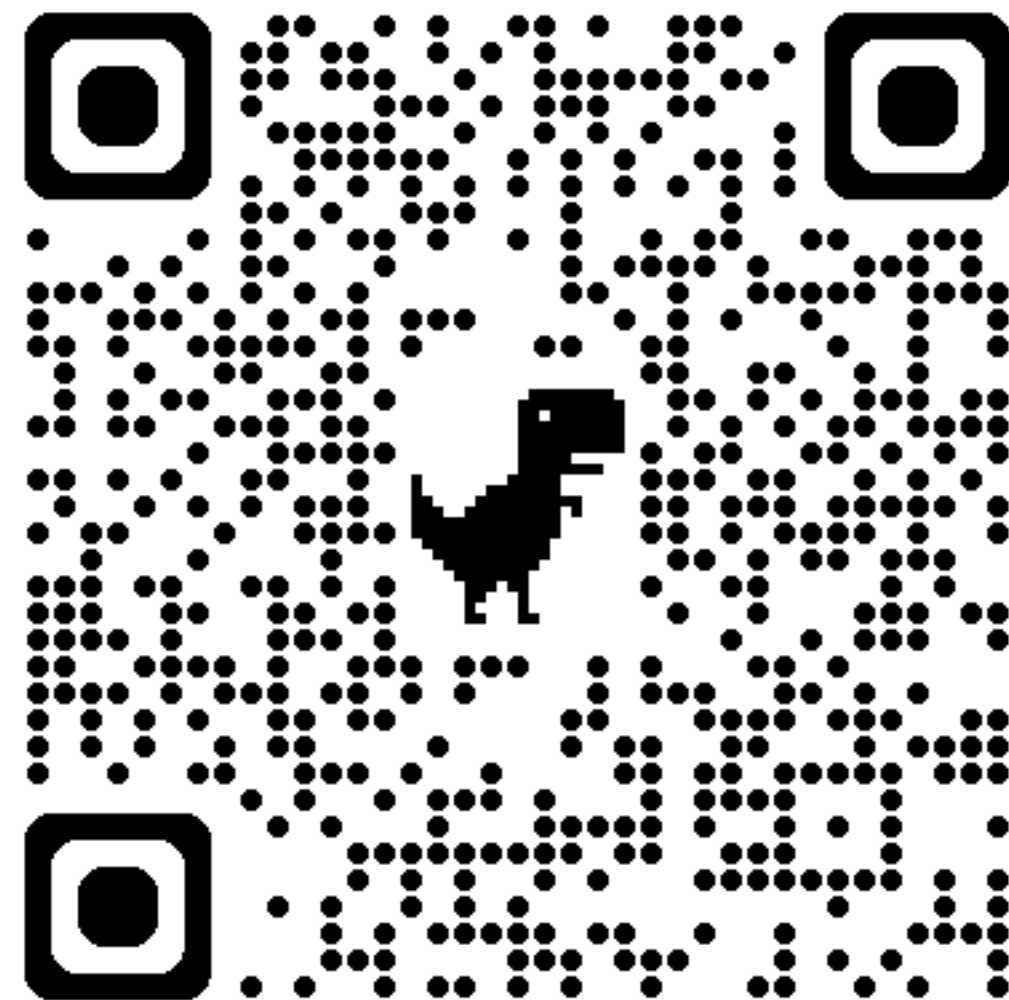
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https://web.physik.rwth-aachen.de/user/harlander/talks/Diagrams_2024/



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Robert Harlander

2



Oliver Passon
Thomas Zügge
Johannes Grebe-Ellis Hrsg.

Kohärenz im Unterricht der Elementarteilchenphysik

Tagungsband des Symposiums zur Didaktik der Teilchenphysik, Wuppertal 2018

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