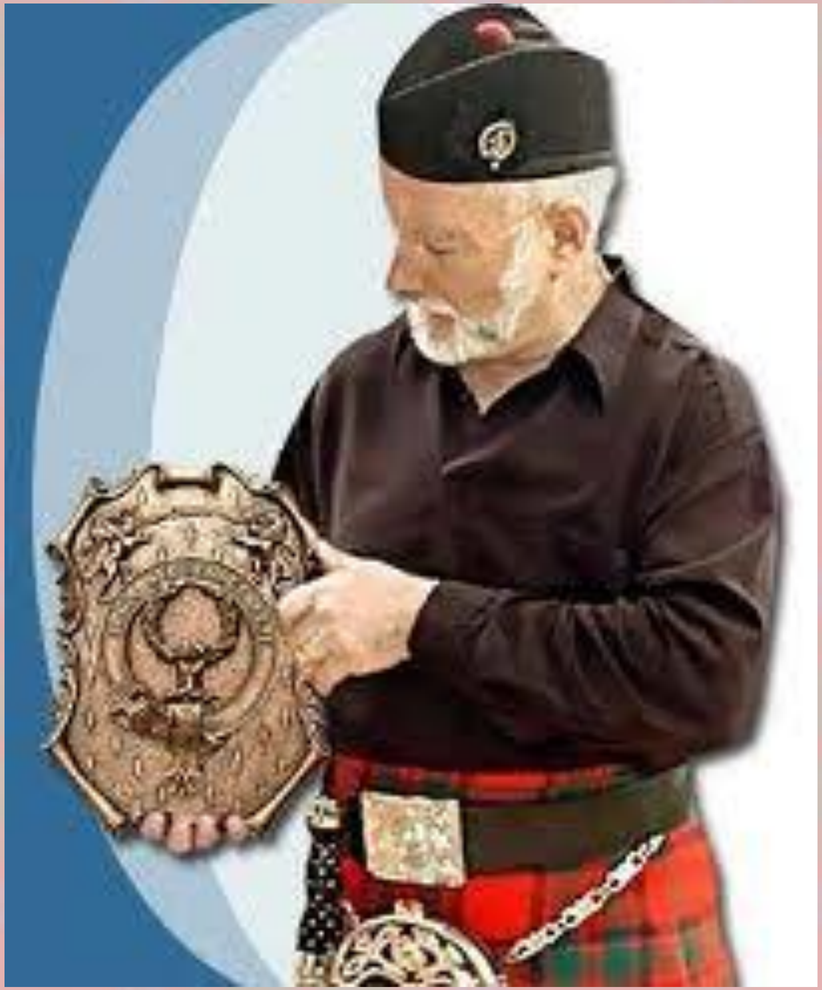
working with Graham Ross 1974-1984

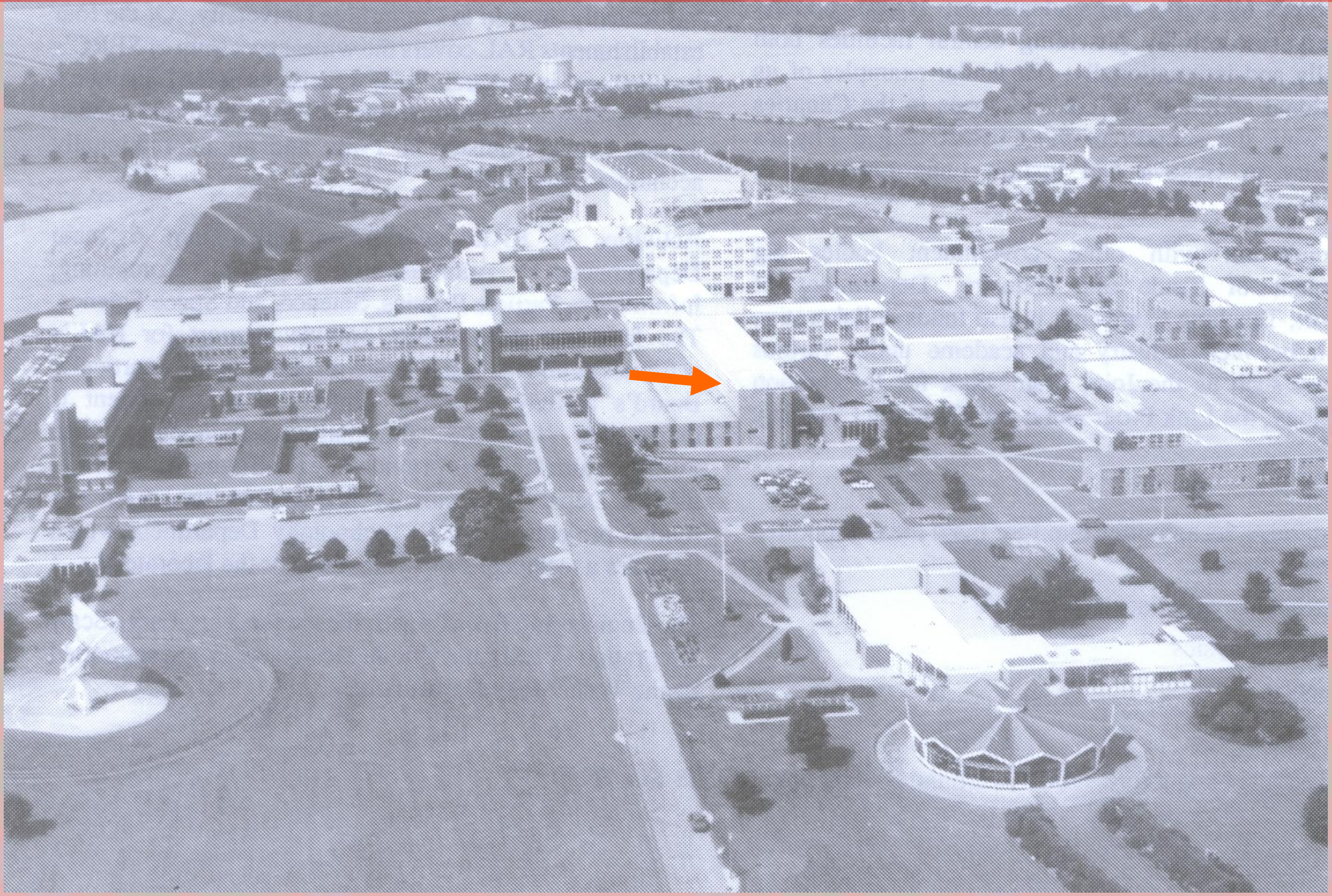
Michael Pennington
Jefferson Lab

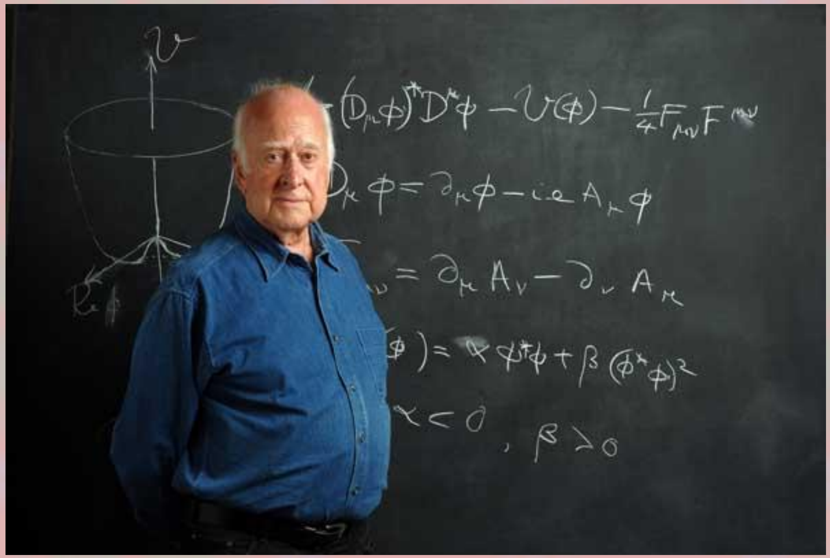
Les Chemins de la Liberté

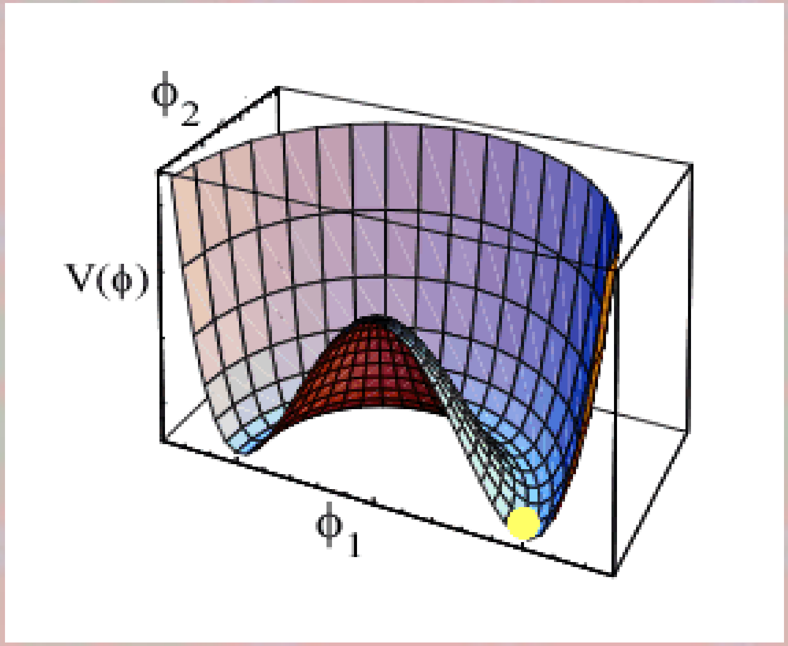
working with Graham Ross 1974-1984



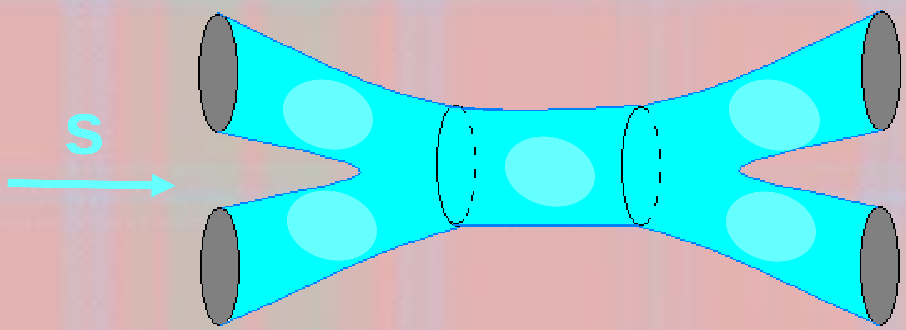
working with Graham Ross 1974-1984

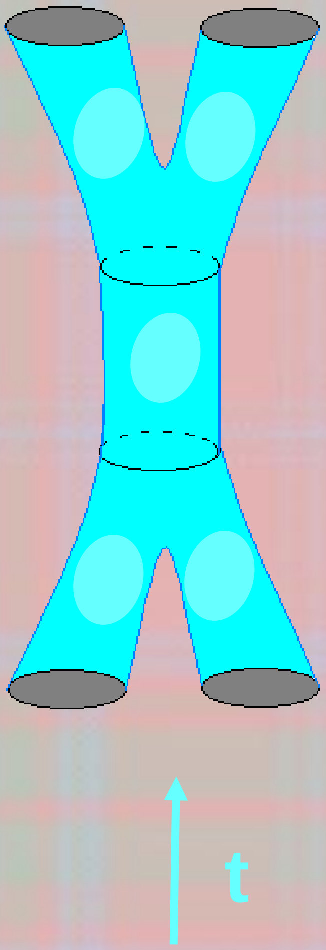


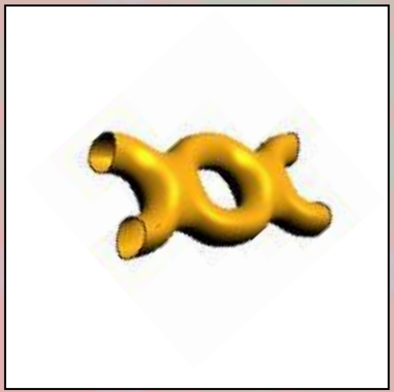



ϕ_2
$V(\phi)$
ϕ_1

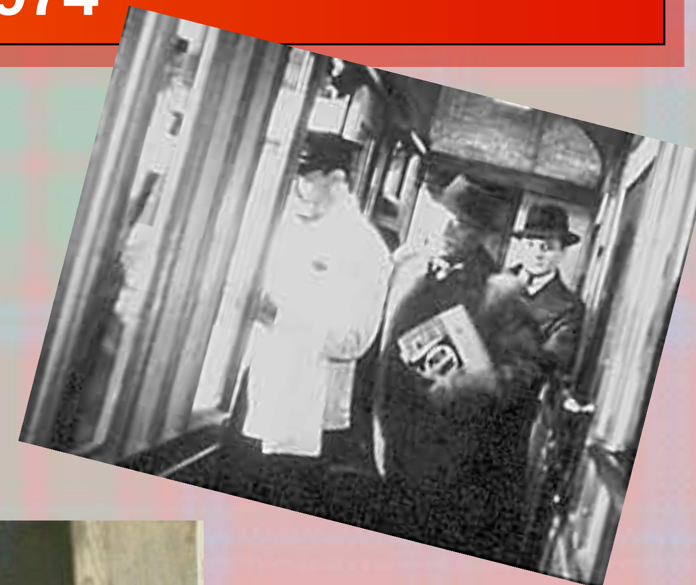
Duality & Unitarisation



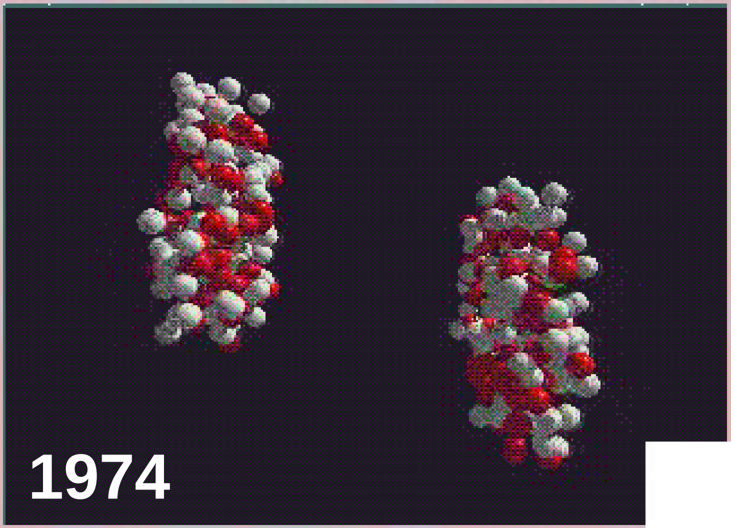


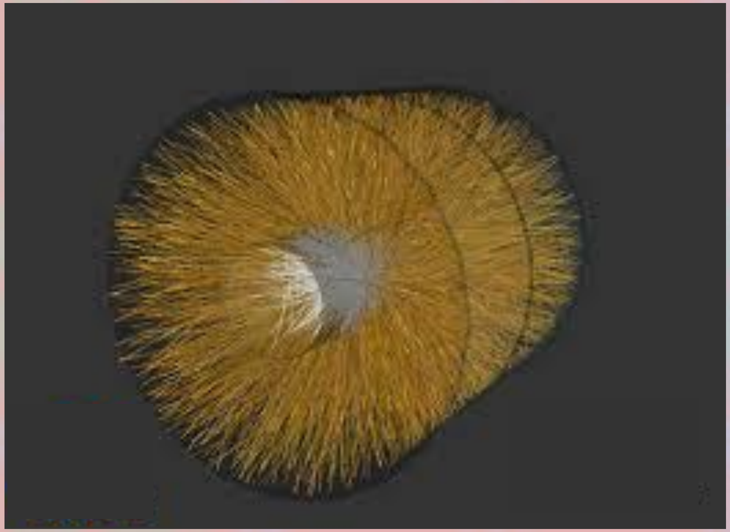


XVII International Conference on High Energy Physics, London, July 1974

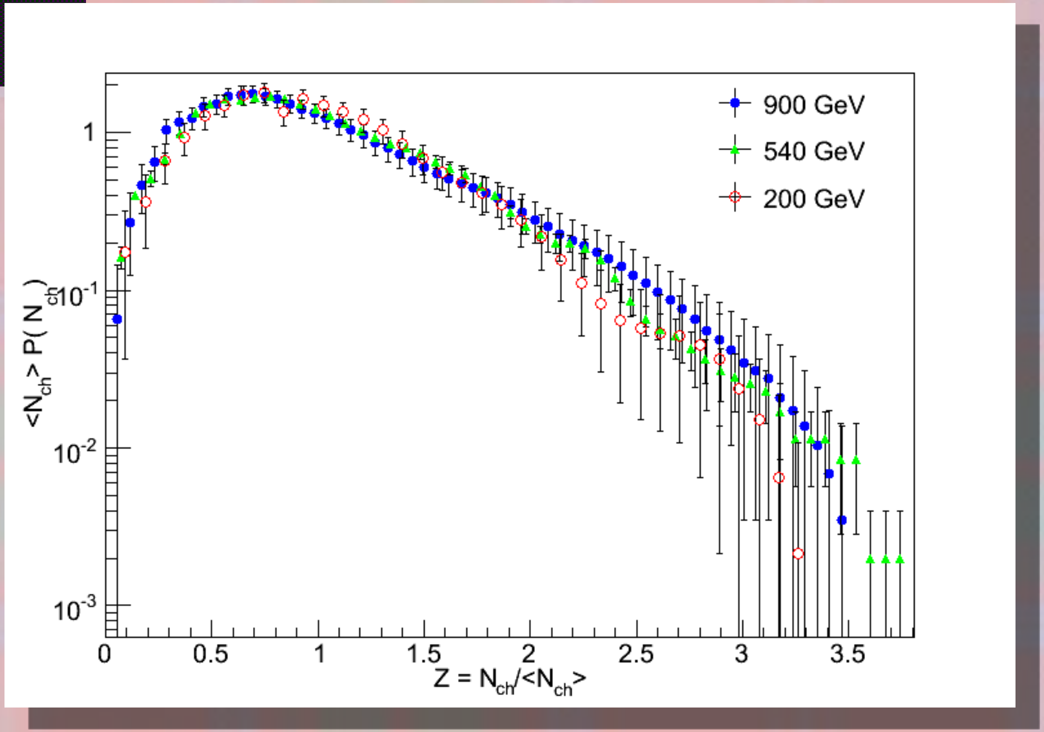


Footnote in Physics





KNO Scaling



Footnote in Physic

Nuclear Physics B88 (1975) 237–256

TESTS OF GEOMETRICAL SCALING AND GENERALIZATIONS *

V. BARGER and J. LUTHE
Department of Physics, University of Wisconsin, Madison, Wisconsin 53706

R.J.N. PHILLIPS
Rutherford Laboratory, Chilton, Didcot, Berkshire, England

Received 9 December 1974

the prescription

$$\frac{d\sigma/dt(s,t)}{d\sigma/dt(s,0)} = f(\sigma_t^2 t/\sigma_{el}) ,$$

with imaginary non-flip amplitudes and f some universal function, proposed independently as a generalization of GS by Pennington and Ross [12]. For small t this prescription is almost trivial, since it is well known that $d\sigma/dt$ is universally exponential here [13]; the interest lies at larger t-values.

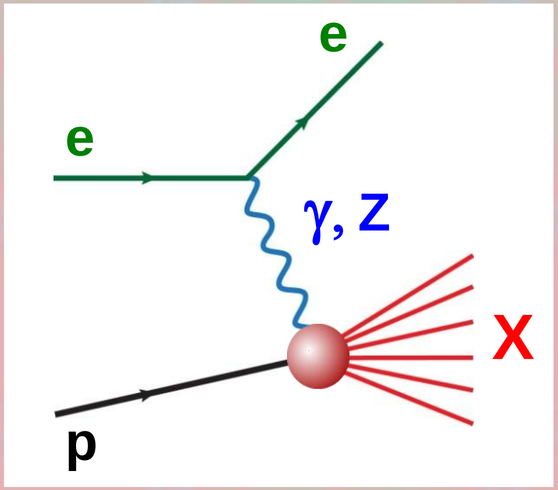
[11] A. Martin, Nucl. Phys. B77 (1974) 226.
[12] M.R. Pennington and G.G. Ross, to be published.
[13] V. Singh and S.M. Roy, Phys. Rev. Letters 24 (1970) 28.


Encarta Encyclopedia, Photo Researchers, Inc./CERN/Science Source

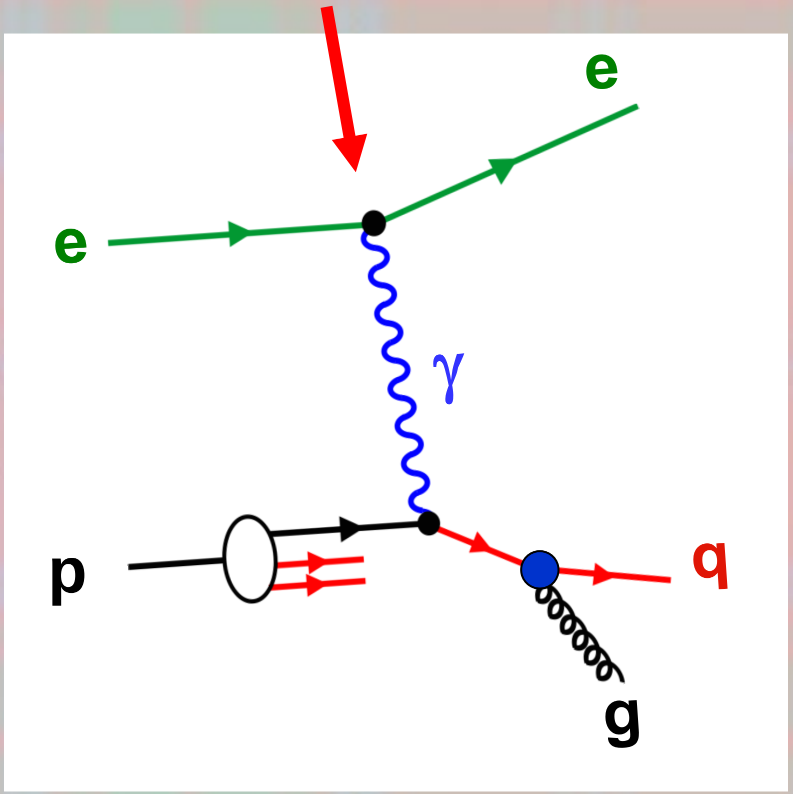
$$\mathcal{L}_{QCD} = \sum_{q=u,d,s,c,b} \bar{q}\,(\,i\gamma_\mu D^\mu - m_q\,)\,q \;-\; \frac{1}{4}\,\mathcal{F}^{\mu\nu}\mathcal{F}_{\mu\nu}$$

QCD

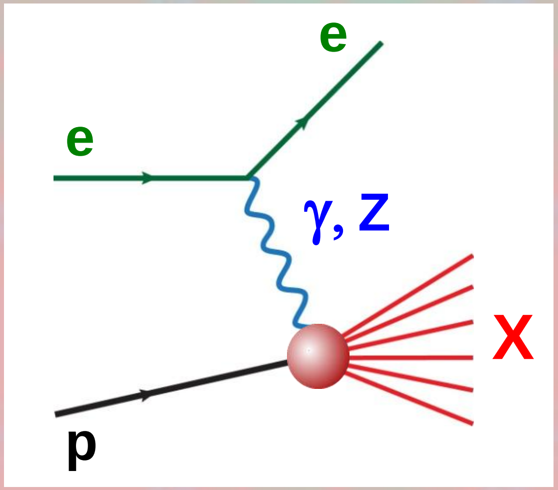
DIS, Renormalization Group & pQCD



$q^2 = -Q^2$



DIS, Renormalization Group & pQCD



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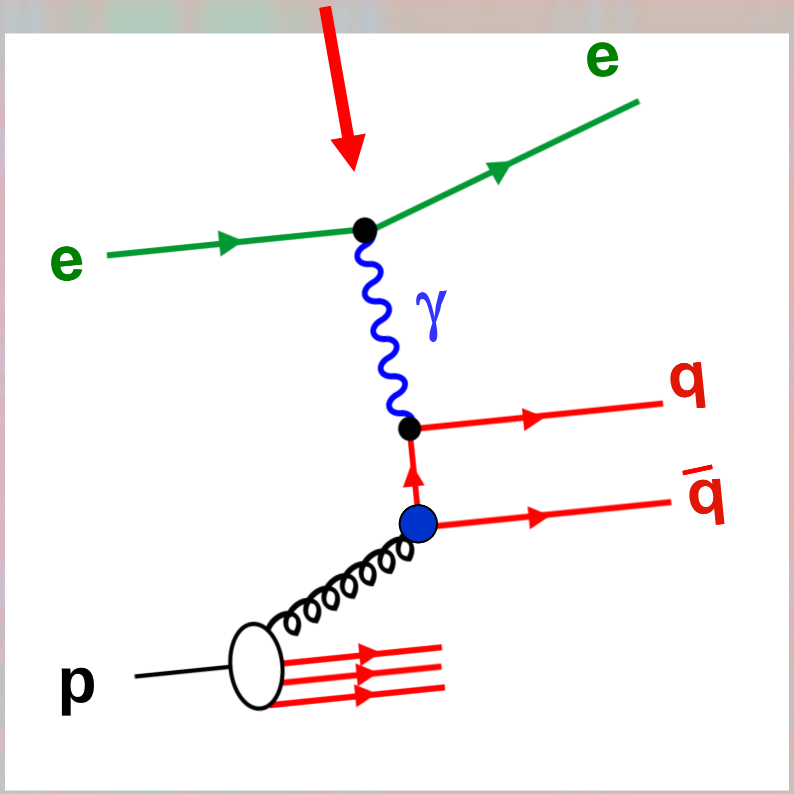
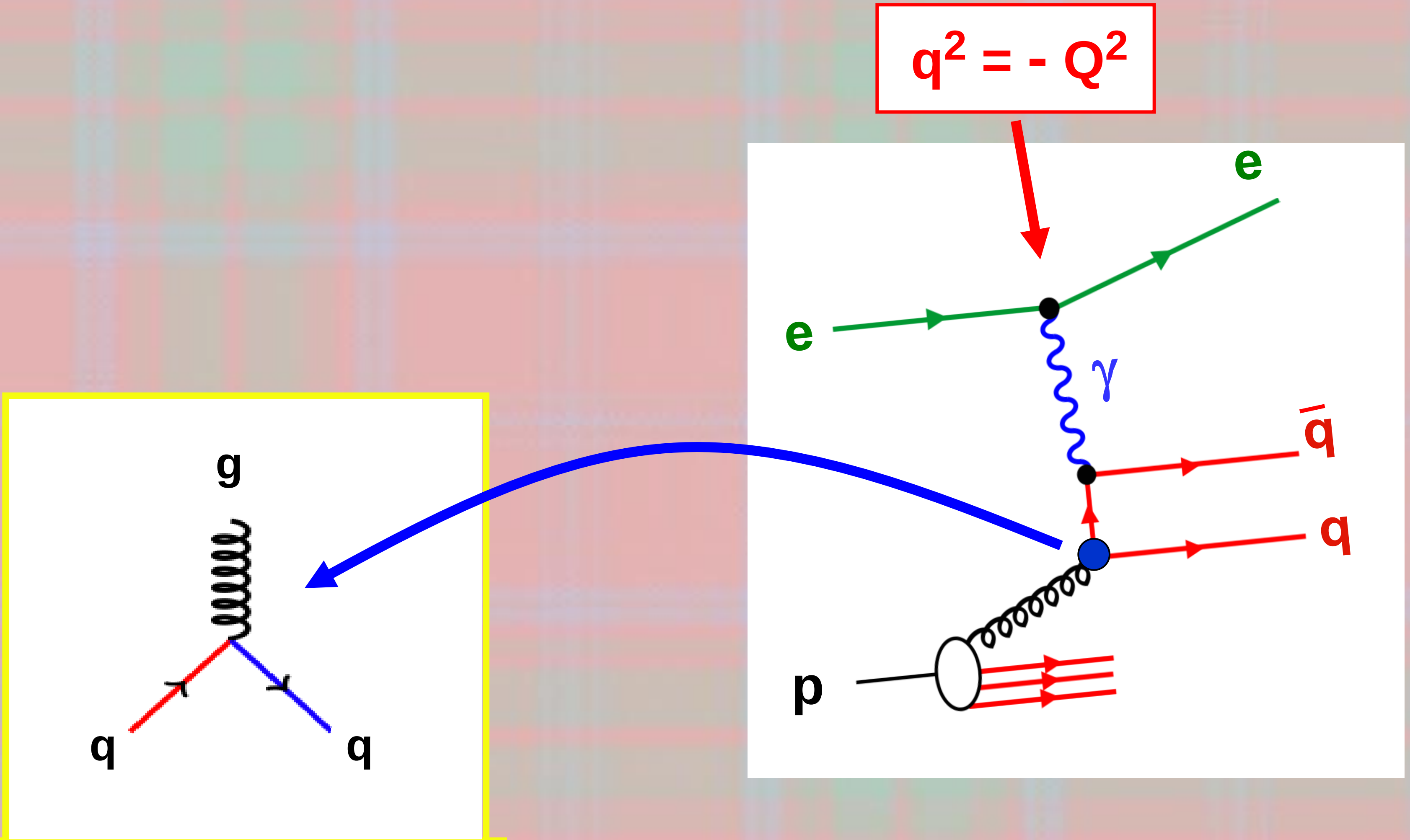
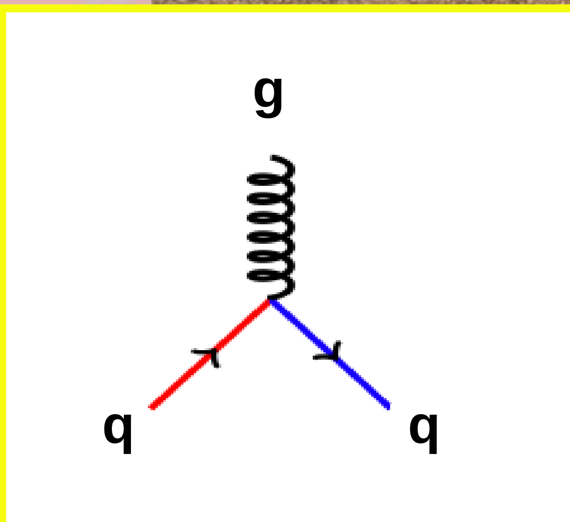


DIS, Renormalization Group & pQCD



$\alpha\,(p_1{}^2, p_2{}^2, p_3{}^2)$



$\alpha\,(p_1^2, p_2^2, p_3^2)$

Les Chemins de la Liberté

What can asymptotic freedom say about $e^+e^- \to$ hadrons ?

Nuclear Physics B124 (1977) 285–300

WHAT CAN ASYMPTOTIC FREEDOM SAY ABOUT $e^+e^- \to$ HADRONS? *

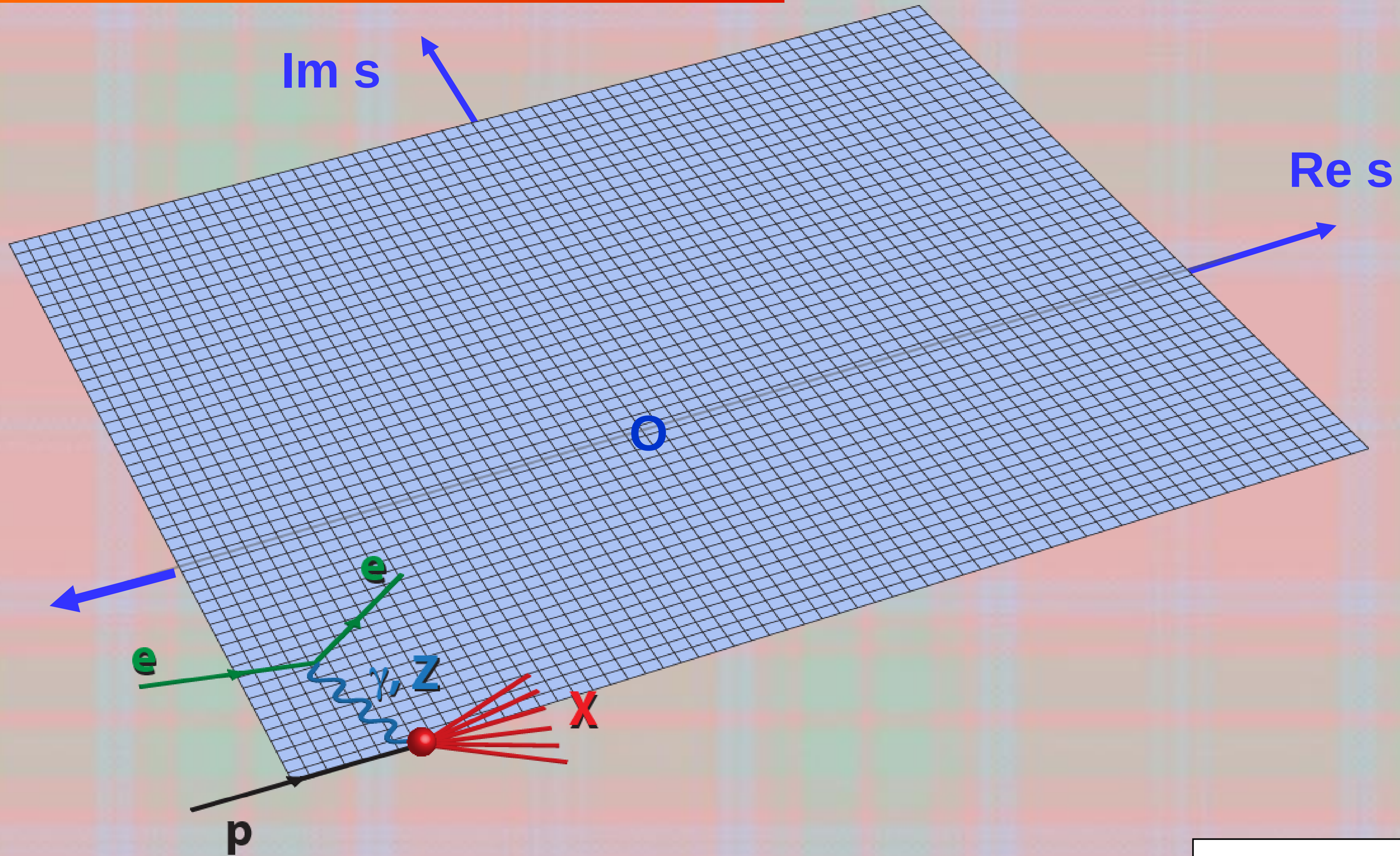
R.G. MOORHOUSE
University of Glasgow, Glasgow, Scotland

M.R. PENNINGTON **
University of Durham, Durham, England

G.G. ROSS
California Institute of Technology, Pasadena, California 91125

Received 25 January 1977

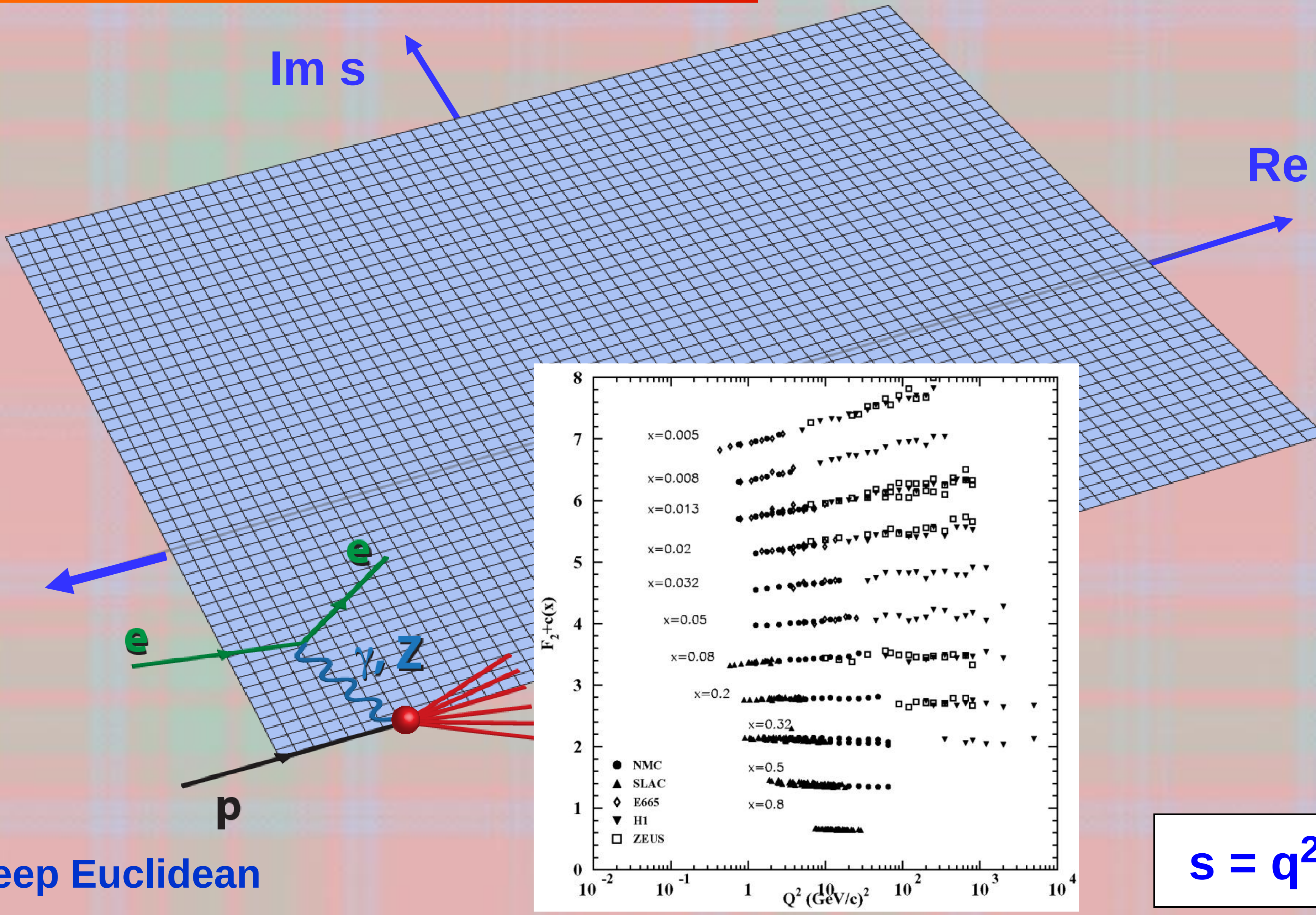
Where does pQCD apply?



deep Euclidean

$s = q^2$

Where does pQCD apply?



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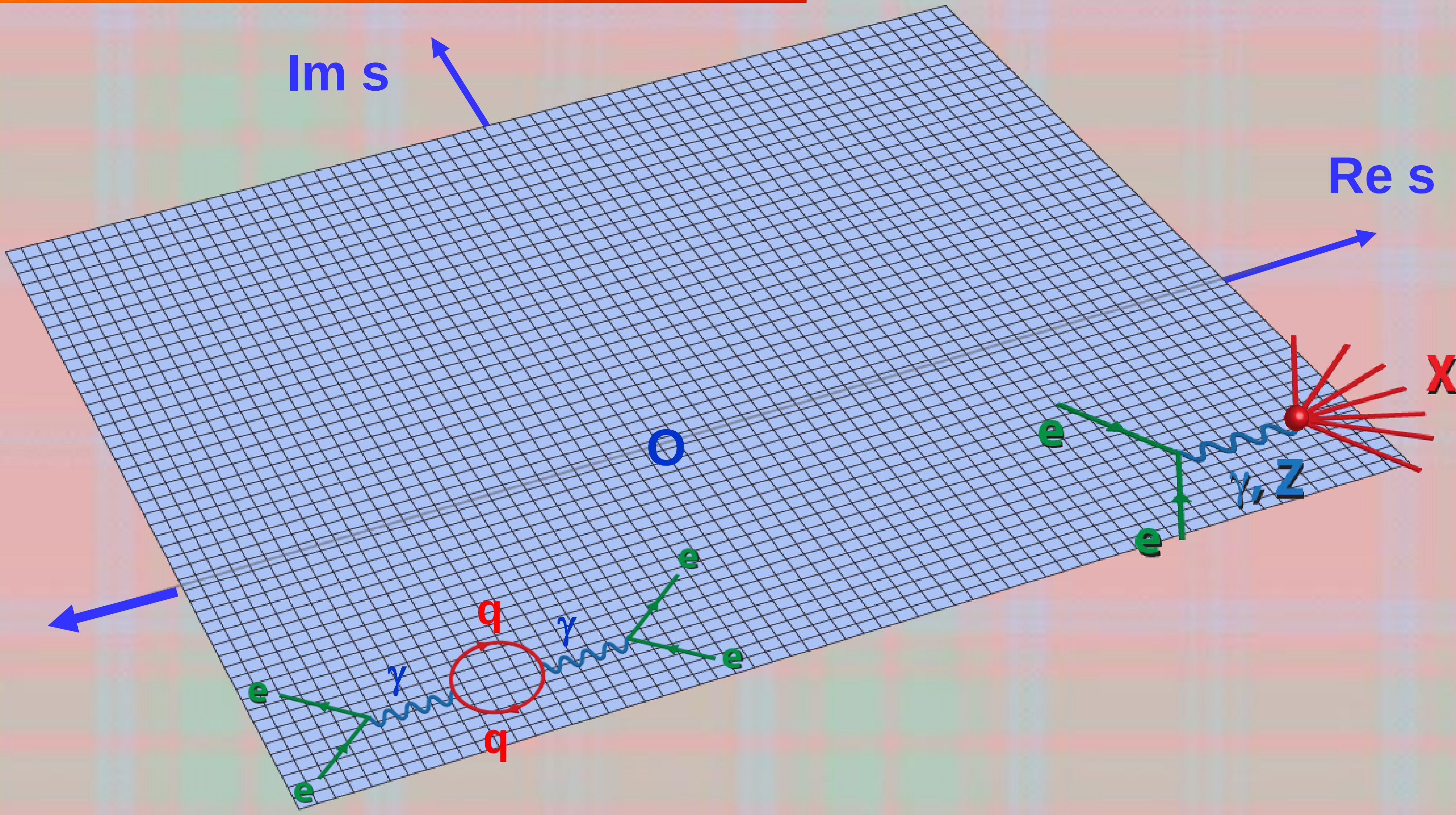

deep Euclidean

de Rujula, Georgi

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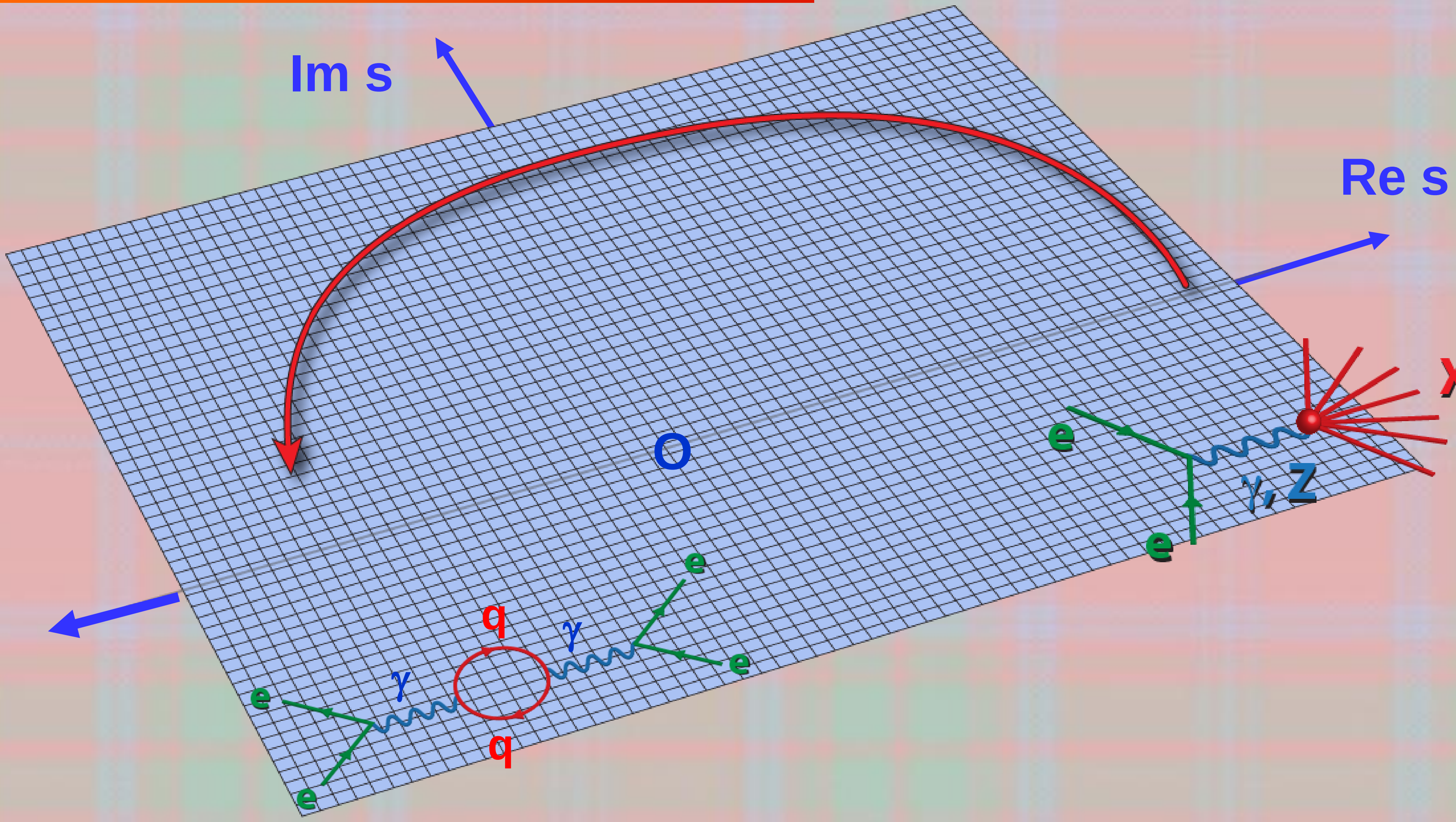

deep Euclidean

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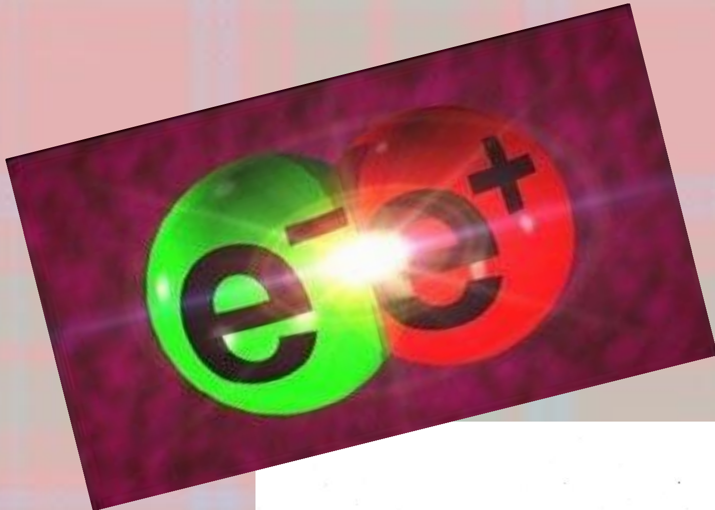
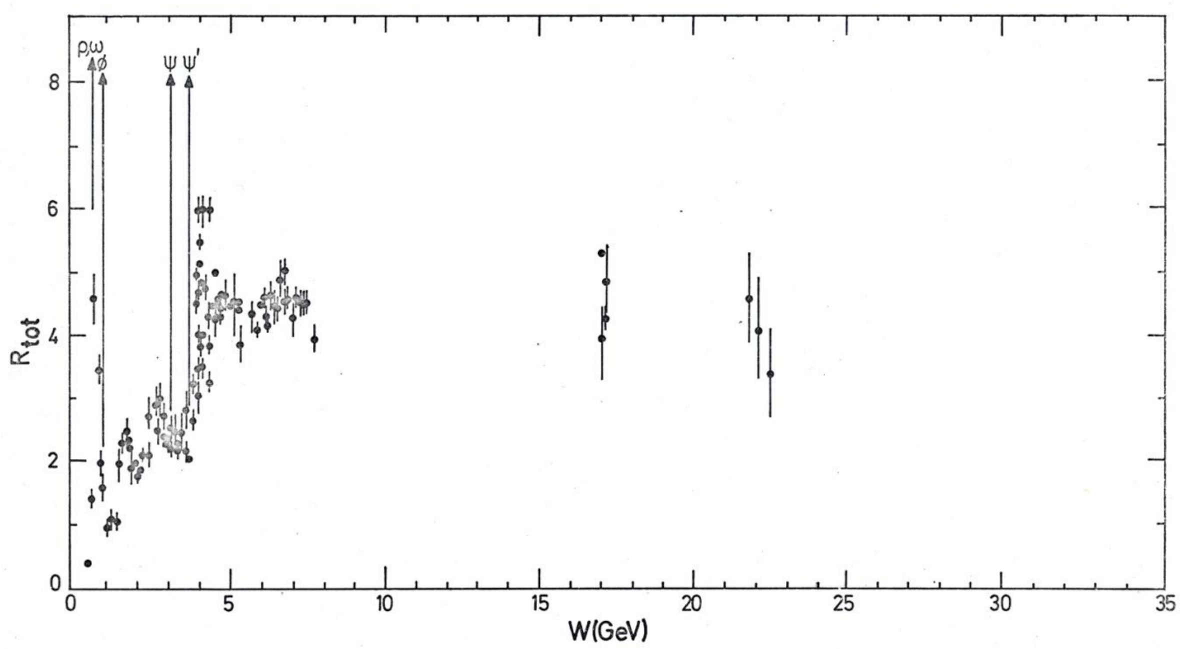
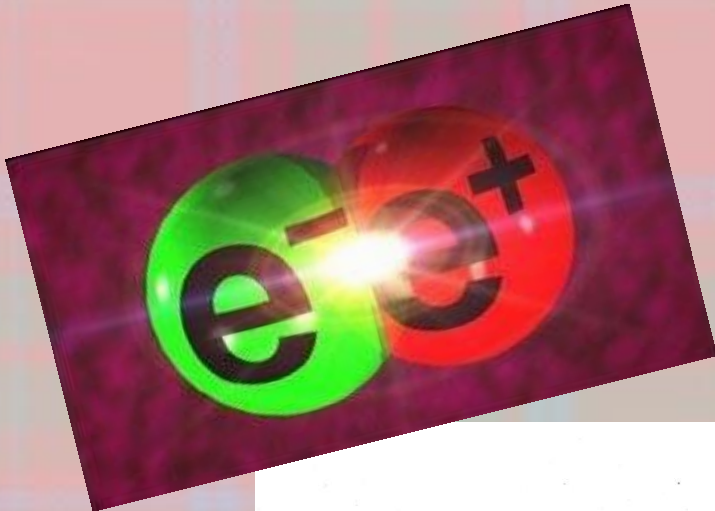


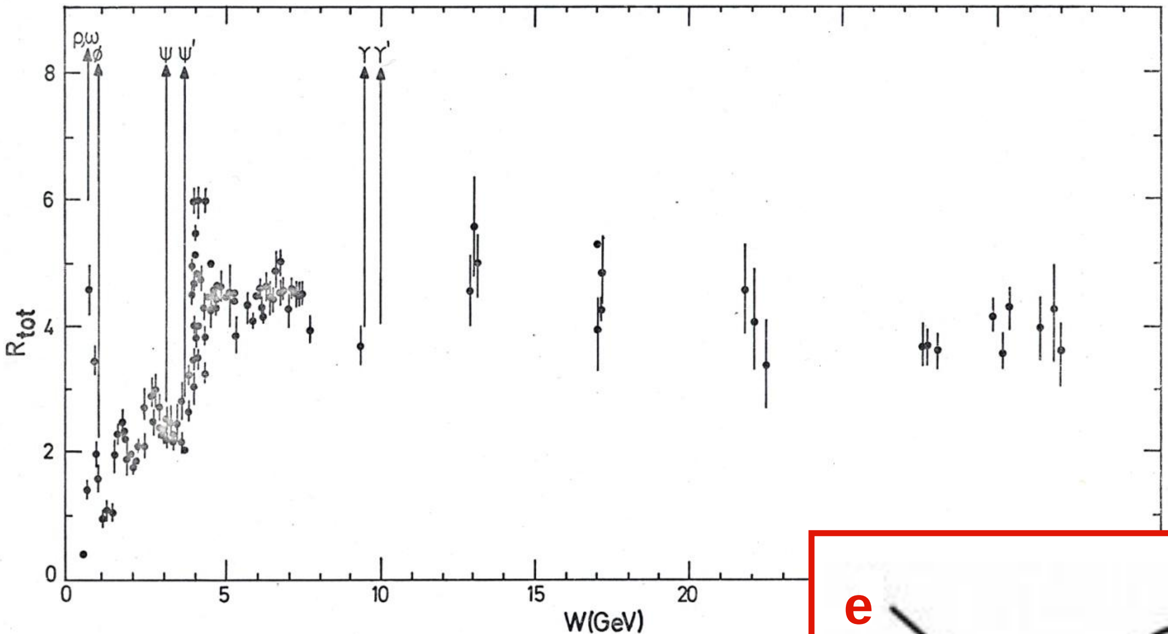
$$R(s) \equiv \frac{\sigma(e^+e^- \to \text{hadrons})}{\sigma(e^+e^- \to \mu^+\mu^-)}$$



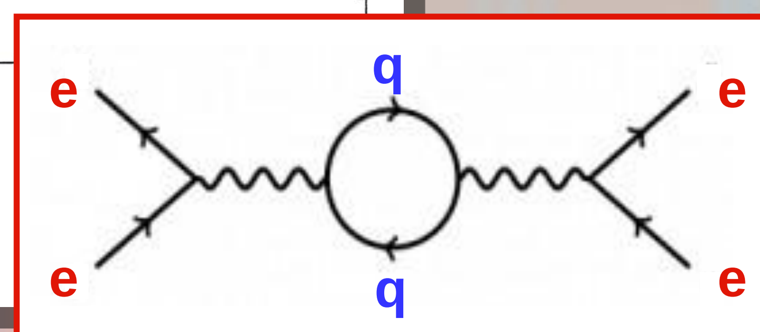
$s = W^2$

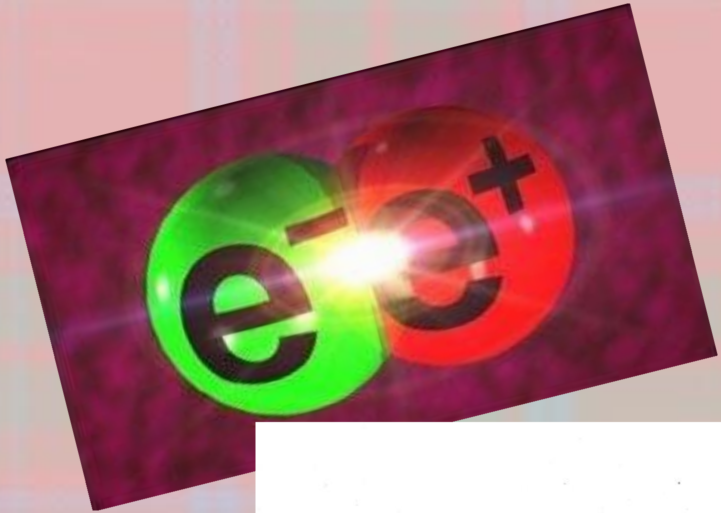


$$R(s) \equiv \frac{\sigma(e^+e^- \to \text{hadrons})}{\sigma(e^+e^- \to \mu^+\mu^-)}$$



s = W^2





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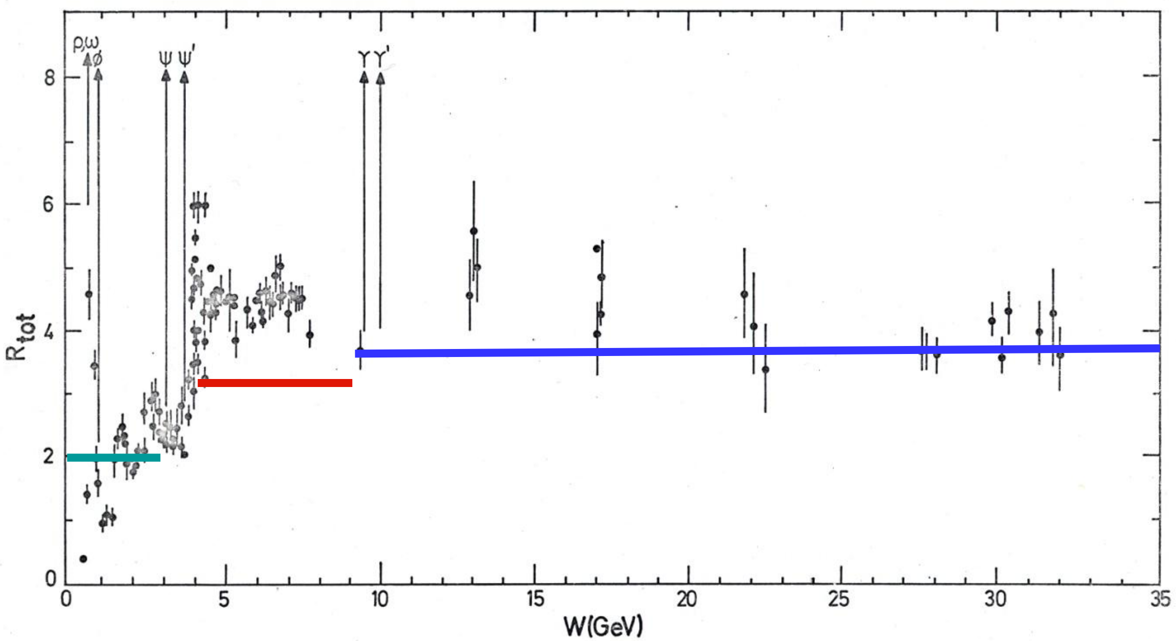
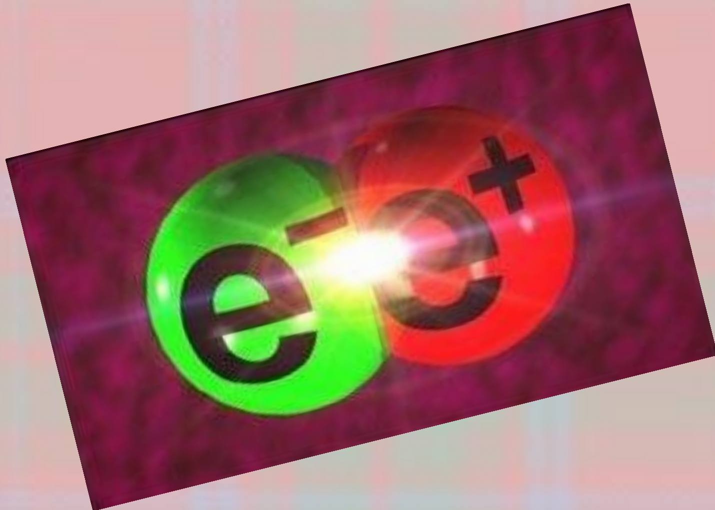
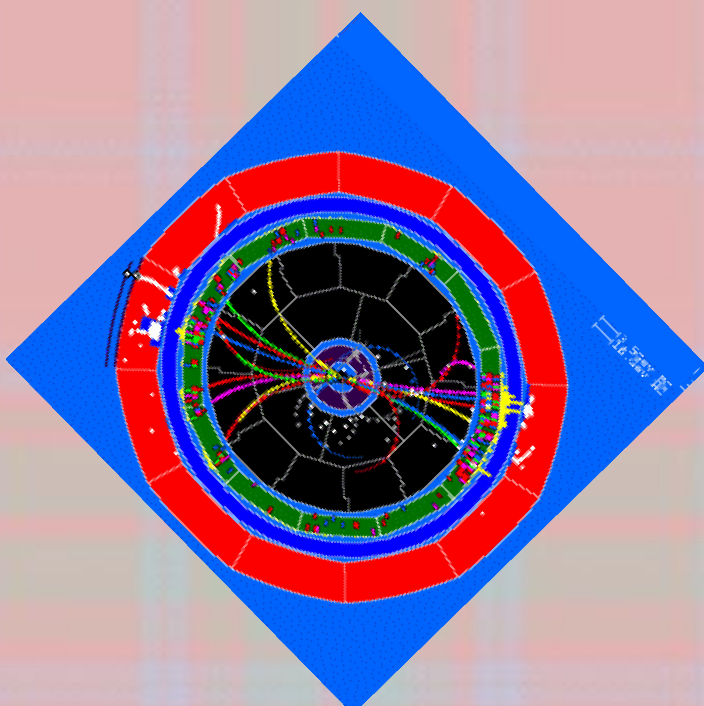
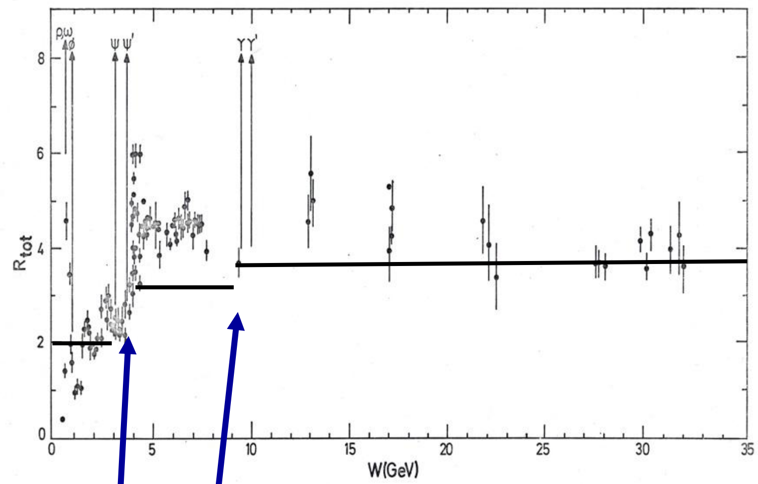


$$R(s) = N_c \sum_f e_f^2$$

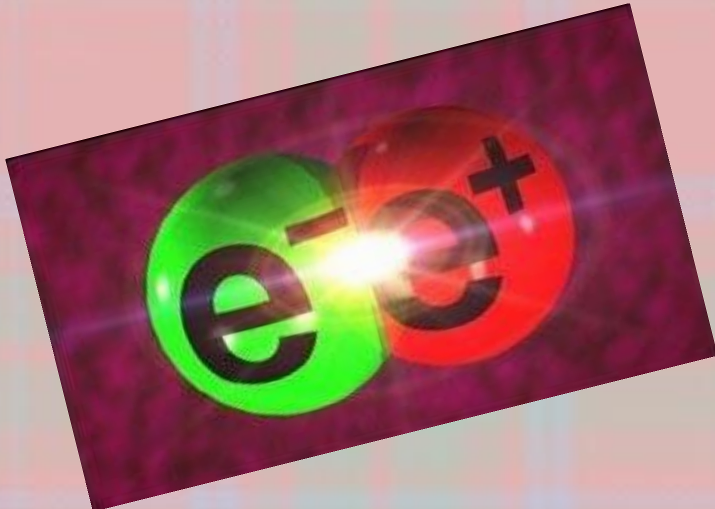


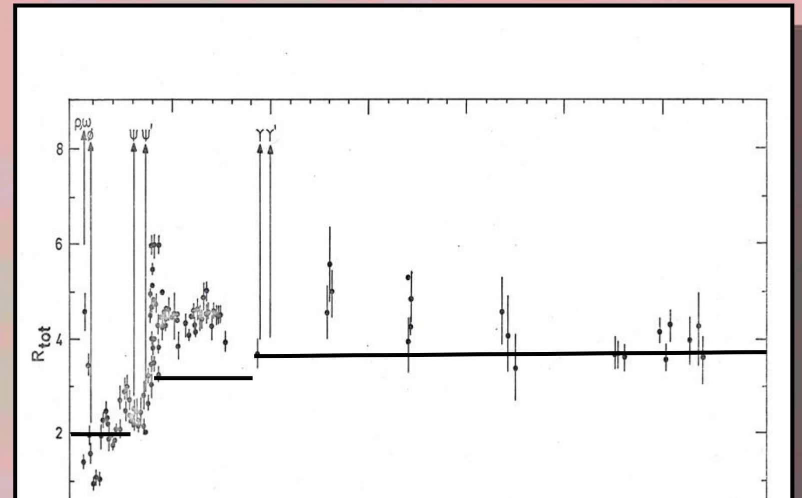


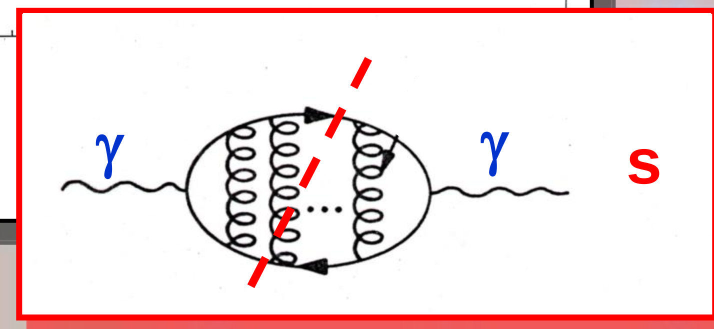


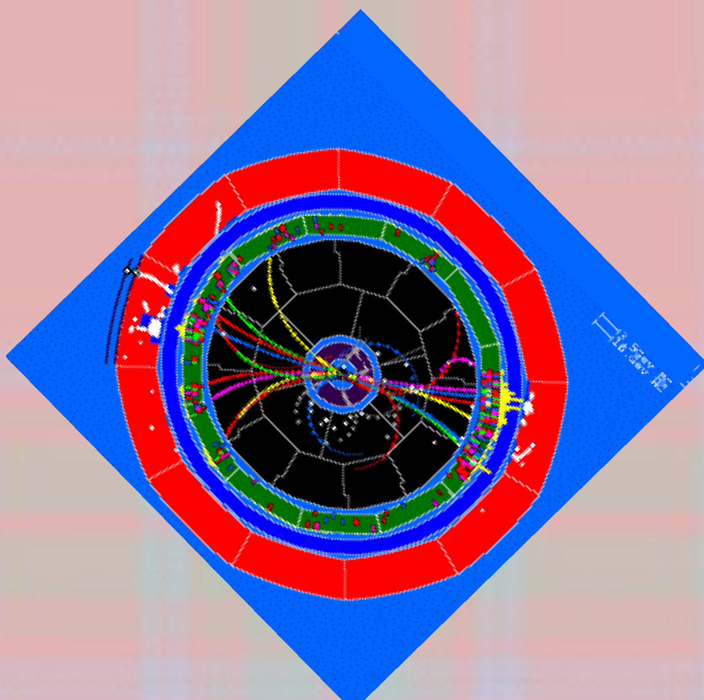
R(s)

$$S_F(p) = \frac{\mathcal{F}(p)}{\not p - \mathcal{M}(p)}$$



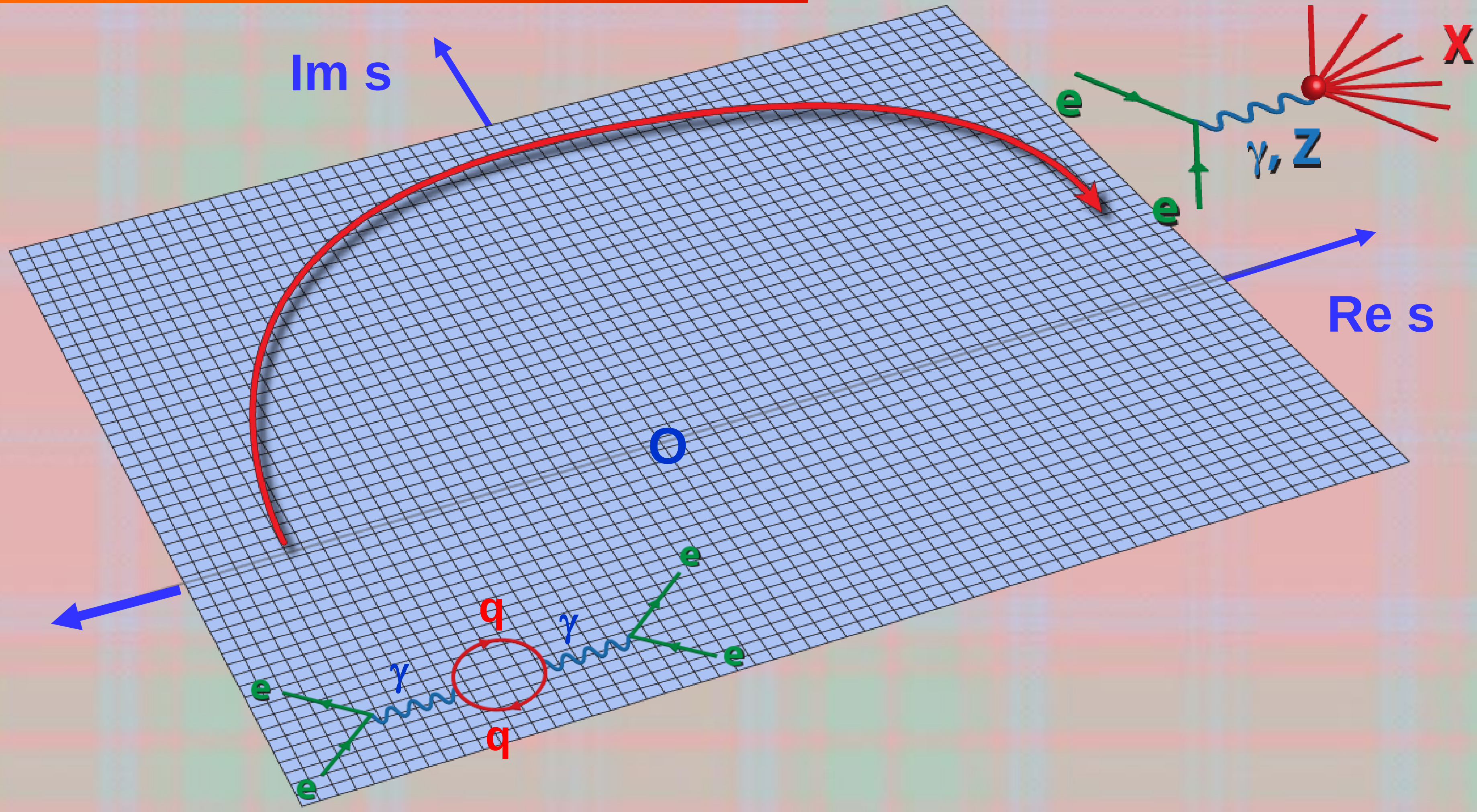






$$S_F(p) = \frac{\mathcal{F}(p)}{\not{p} - \mathcal{M}(p)}$$

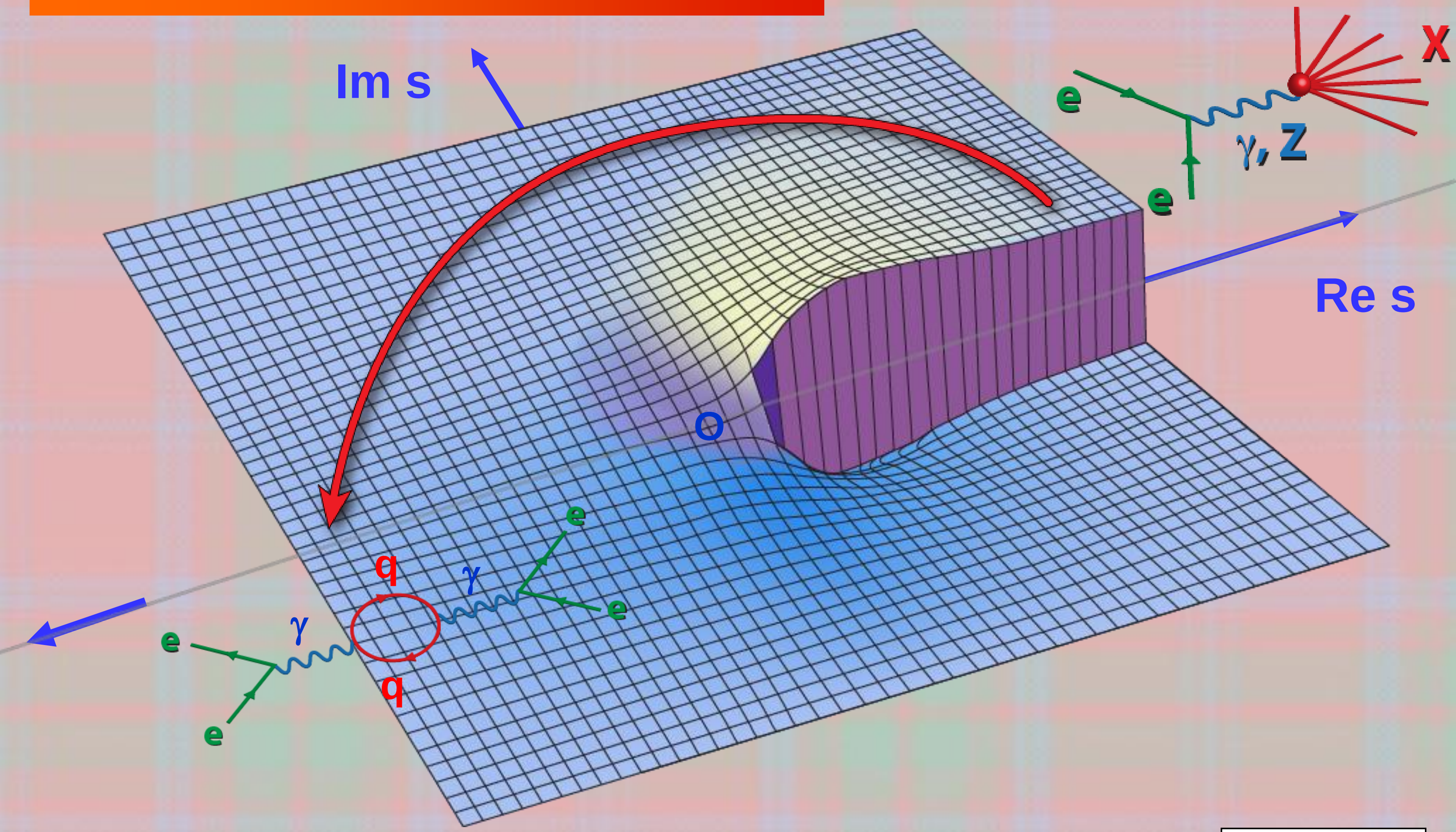
Where does pQCD apply?



deep Euclidean

$s = q^2$

Where does pQCD apply?



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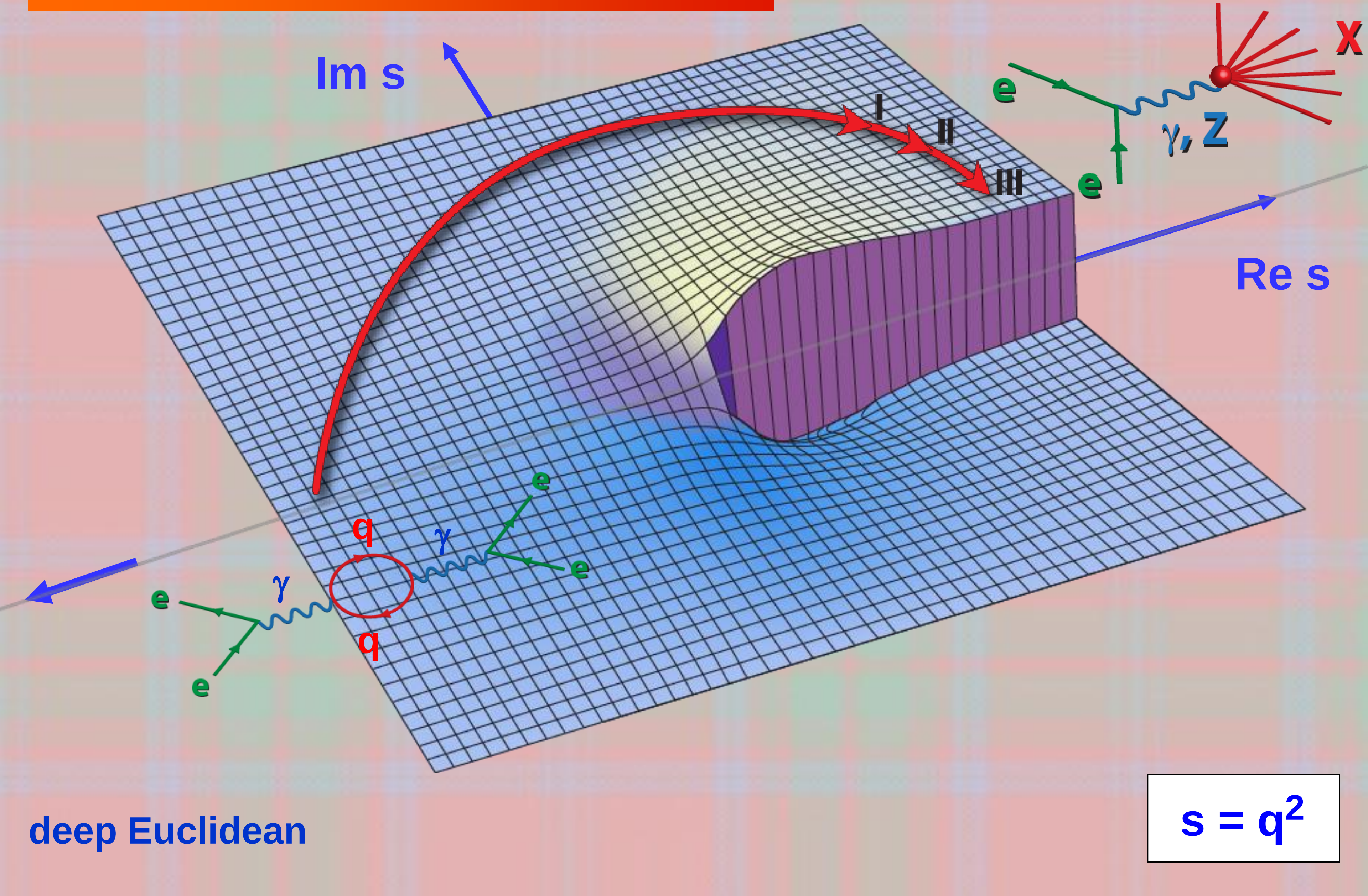
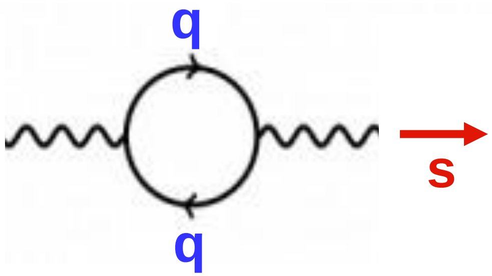
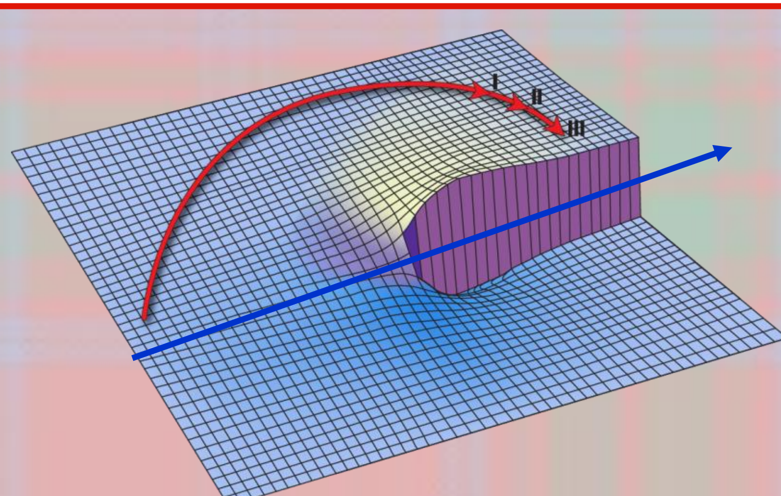


Adler $\mathcal{D}$ - function

$\Pi(s)$ 

$$\frac{1}{12\pi^3}\mathcal{D}(s) \equiv s\frac{\partial}{\partial s}\Pi(s)$$

$$\mathcal{D}\left(\frac{s}{\mu^2},\alpha(\mu^2)\right) = \mathcal{D}(1,\alpha(s)) = \sum_{c,f} e_f^2\left[1+\frac{\alpha(s)}{\pi}+\mathcal{O}(\alpha^2)\right]$$

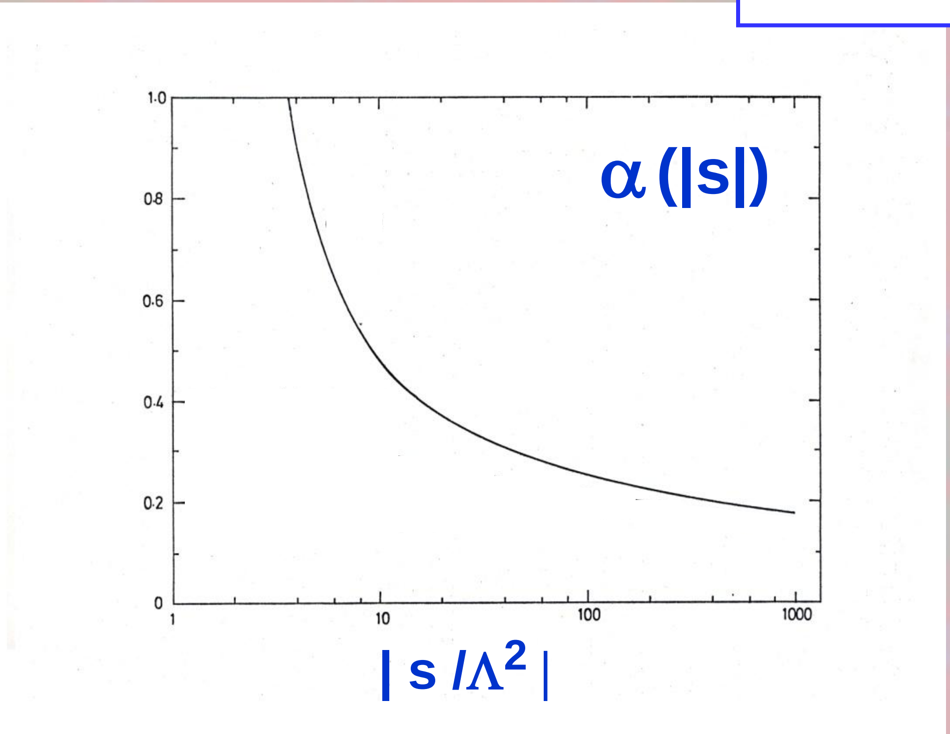


running coupling

$\mu^2 < 0$

$$\alpha(s) = \frac{\alpha(\mu^2)}{\left[1 + \frac{\beta_0}{4\pi}\alpha(\mu^2)\ln\frac{s}{\mu^2}\right]}$$

$$\beta_0 = \frac{11}{3}N_c - \frac{2}{3}n_f$$



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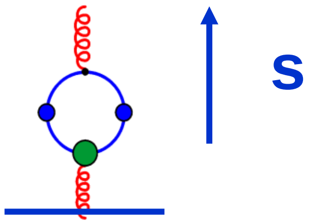
$$\beta_0 = \frac{11}{3}N_c - \frac{2}{3}n_f$$

timelike $s = q^2$

$s > 0$

$\mu^2 < 0$

$$\ln\left(\frac{s}{-\mu^2}\right) + i\pi$$



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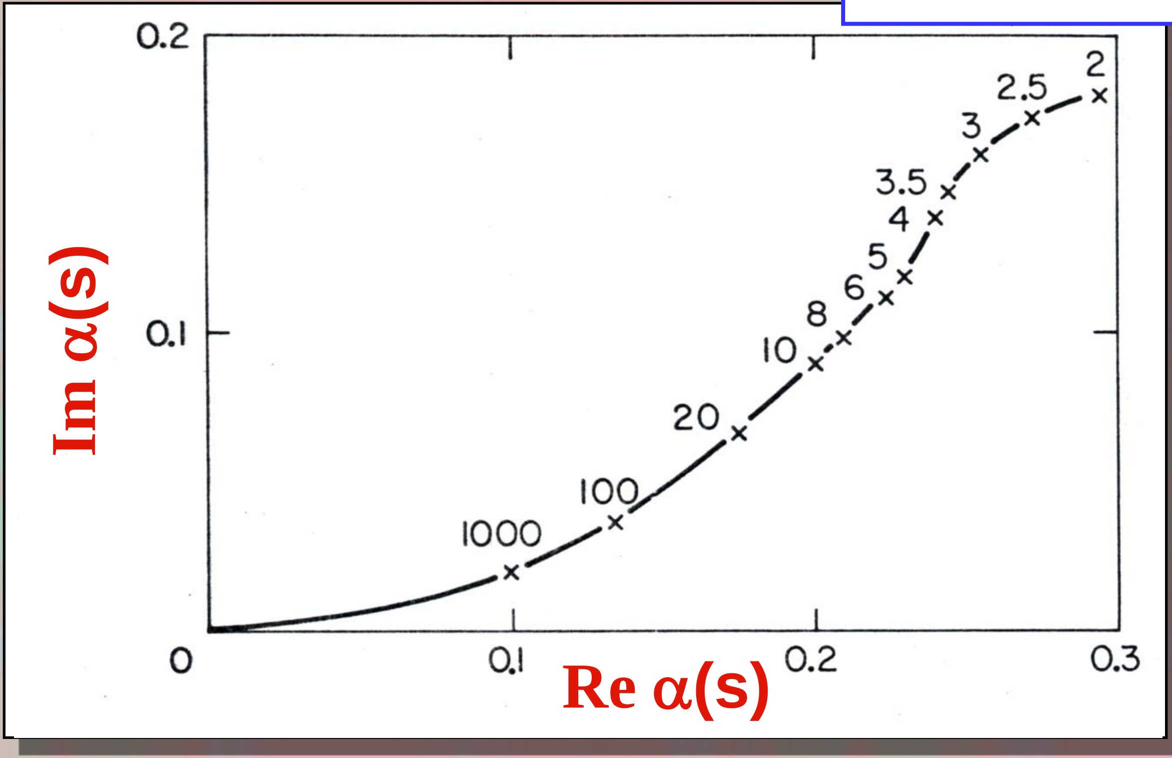


s > 0

$\mu^2 < 0$

$$S_F^{-1}(p,m)\Big|_{p^2=m^2} = \not{p} - m$$

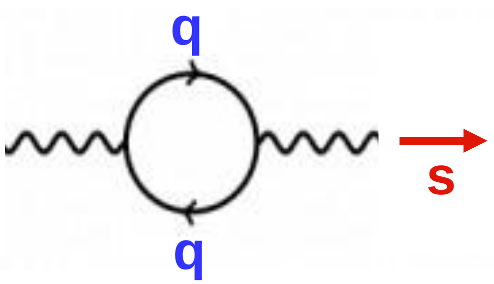
defining mass at pole

$$\left[\mu\frac{\partial}{\partial\mu} + \beta\left(g(\mu^2), m/\mu\right)\frac{\partial}{\partial g} + \sum_i \gamma_i\left(g(\mu^2), m/\mu\right)\right]\mathcal{D} \;=\; 0$$

$$\mathcal{D}\left(\frac{s}{\mu^2}, \frac{m^2}{\mu^2}, \alpha(\mu^2, m^2)\right) \;=\; \mathcal{D}\left(1, \frac{m^2}{s}, \alpha(s, m^2)\right)$$

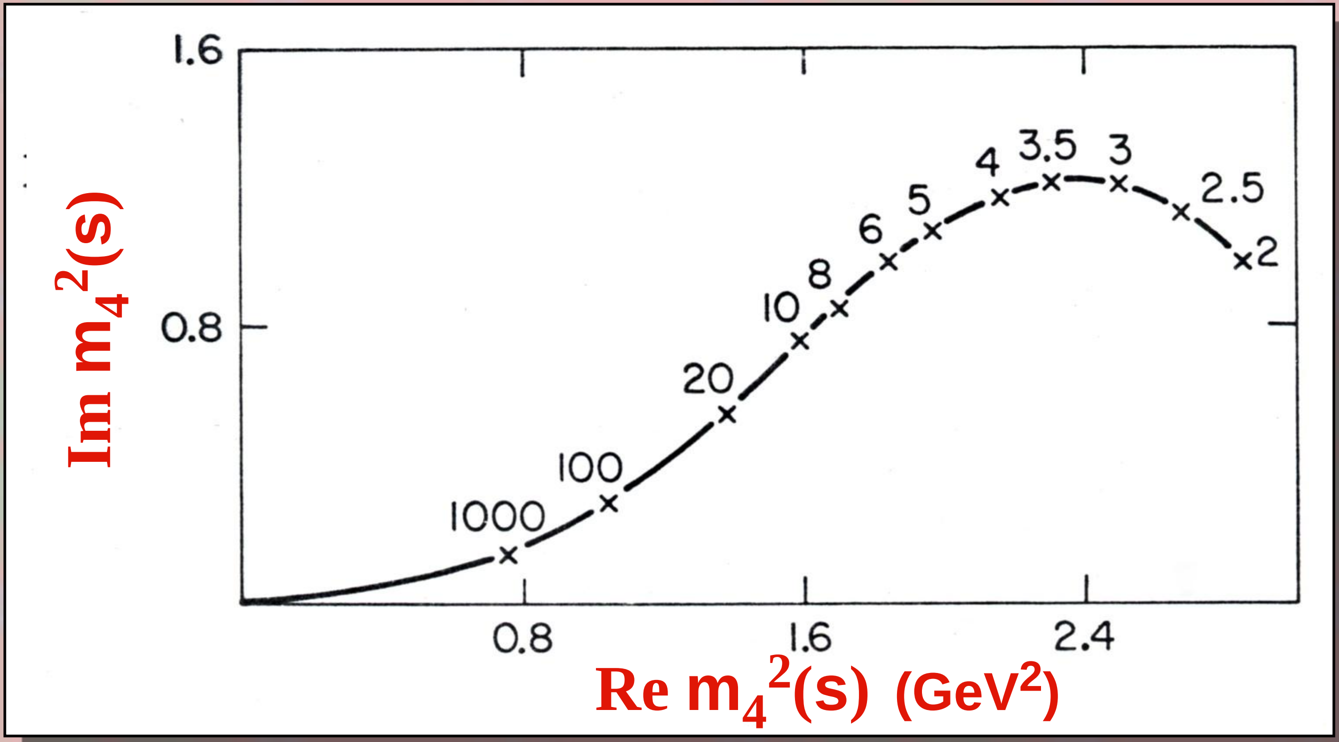
$$\frac{1}{\alpha(s,m^2)} \;=\; \frac{1}{\alpha(\mu^2,m^2)} + \frac{1}{4\pi}\left[11\,\ln\frac{s}{\mu^2} \;-\; -\frac{2}{3}\sum_j \int_{\mu^2}^{s}\frac{dz}{z}F_1\left(\frac{m_j^2}{z}\right)\right]$$

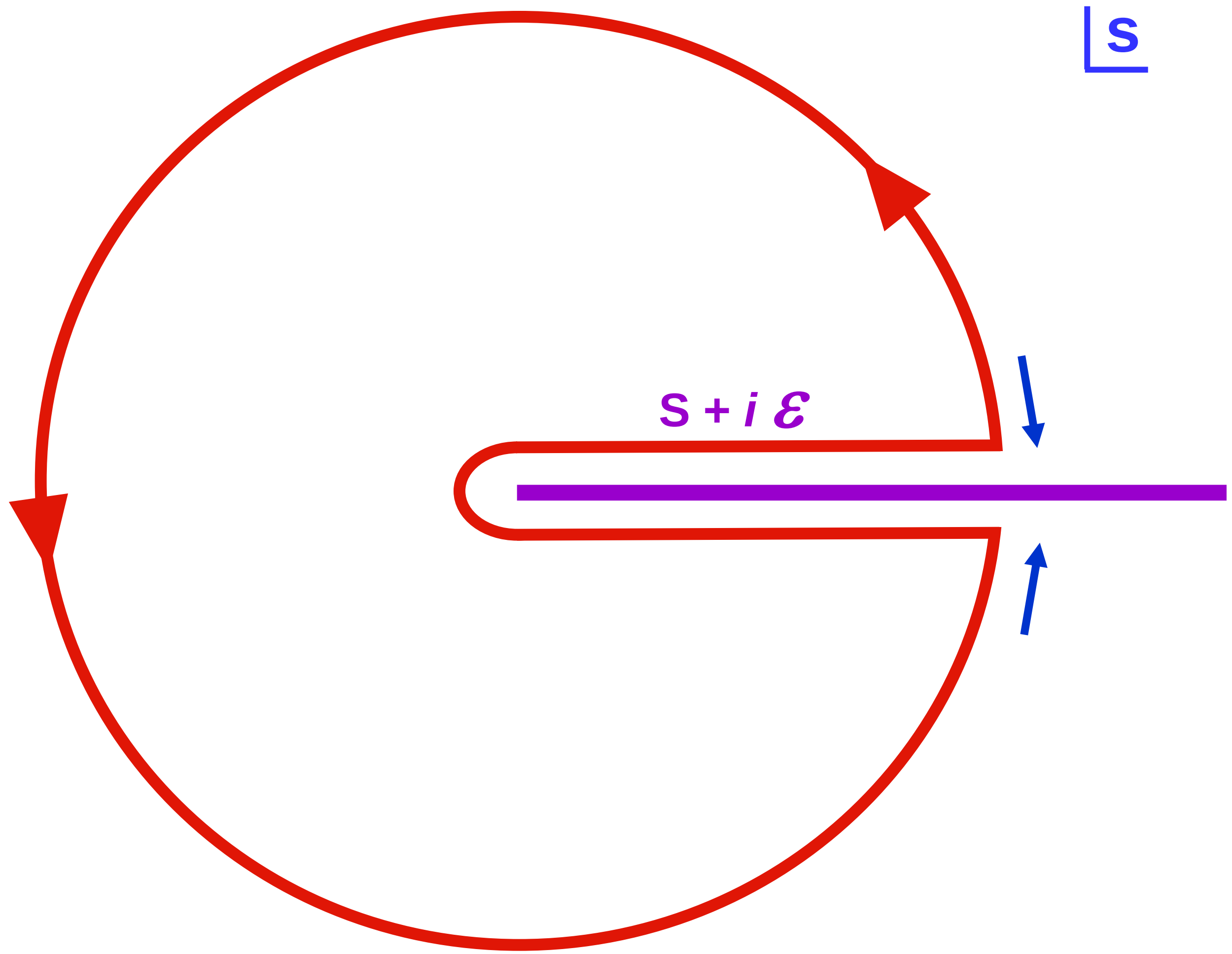
$$F_1(x) \;=\; 1 \;-\; 6x \;+\; \frac{12x^2}{\sqrt{1+4x}}\,\ln\left[\frac{\sqrt{1+4x}+1}{\sqrt{1+4x}-1}\right]$$

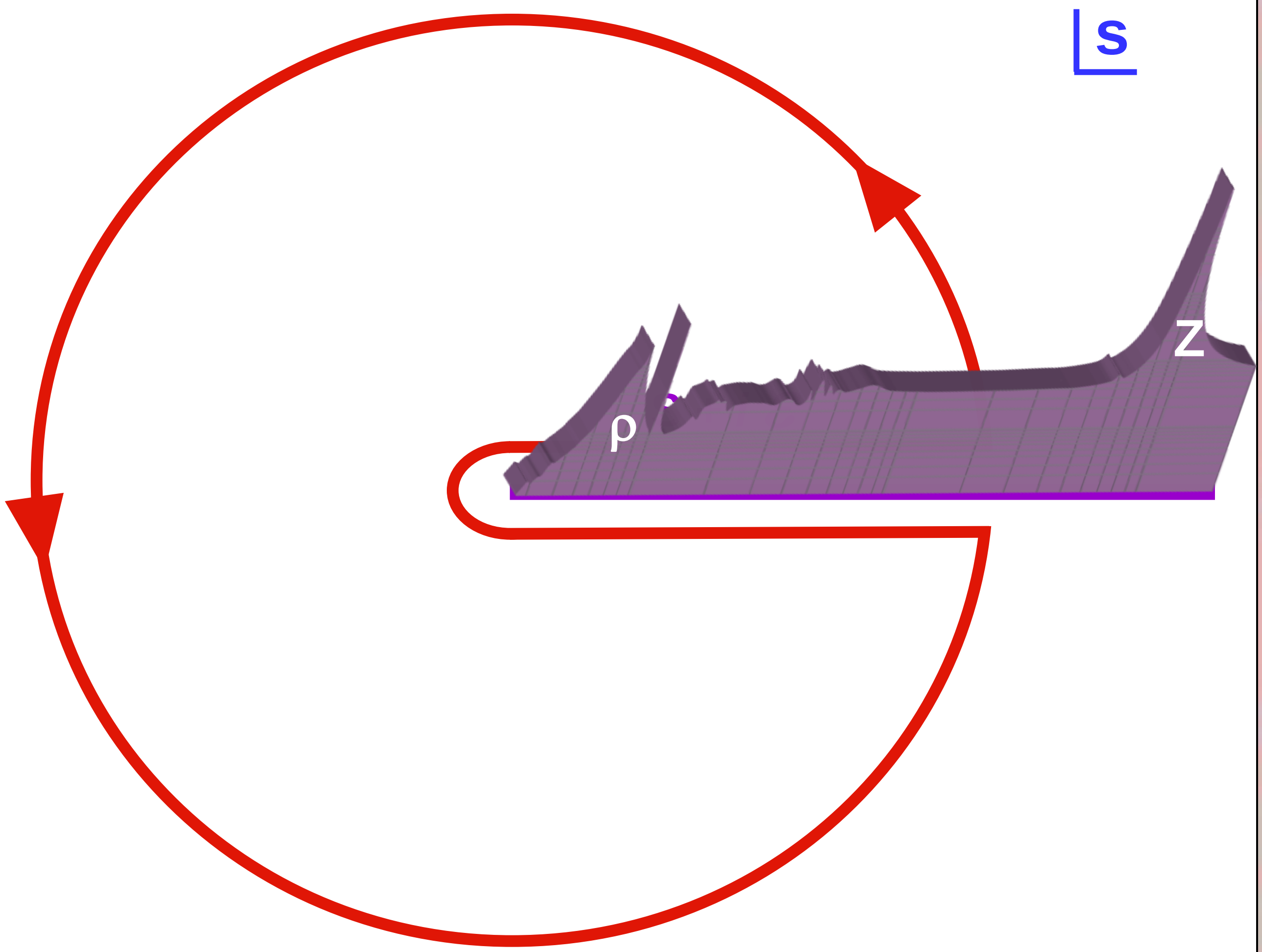


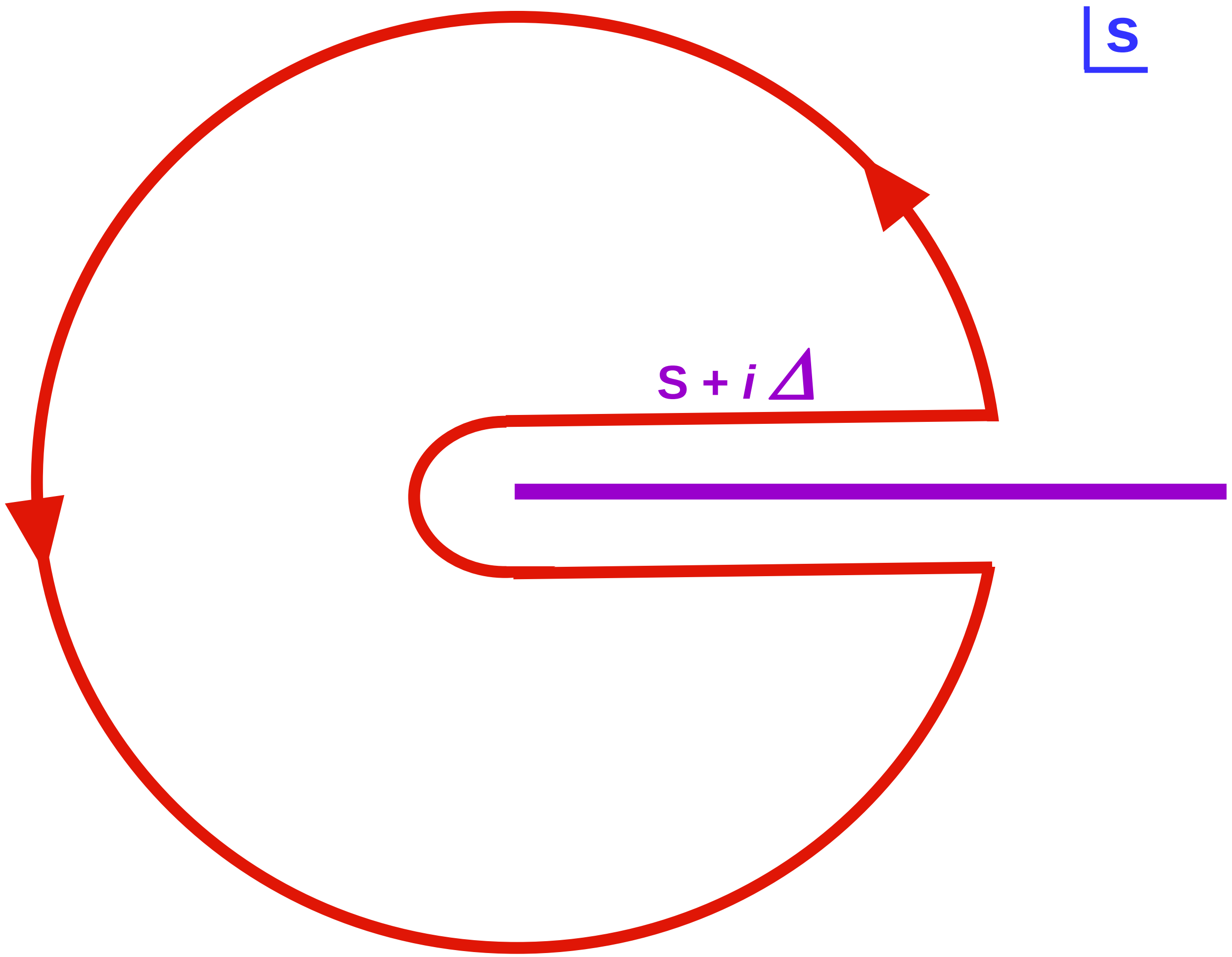
$$S_F^{-1}(p, m(\mu^2))\Big|_{p^2=\mu^2} = \not{p} - m(\mu^2)$$ **defining mass at renorm. pt**

$$m^2(s) \simeq m^2(\mu^2)\left(\frac{\alpha(s)}{\alpha(\mu^2)}\right)^{d_m}$$




s
s + i ε

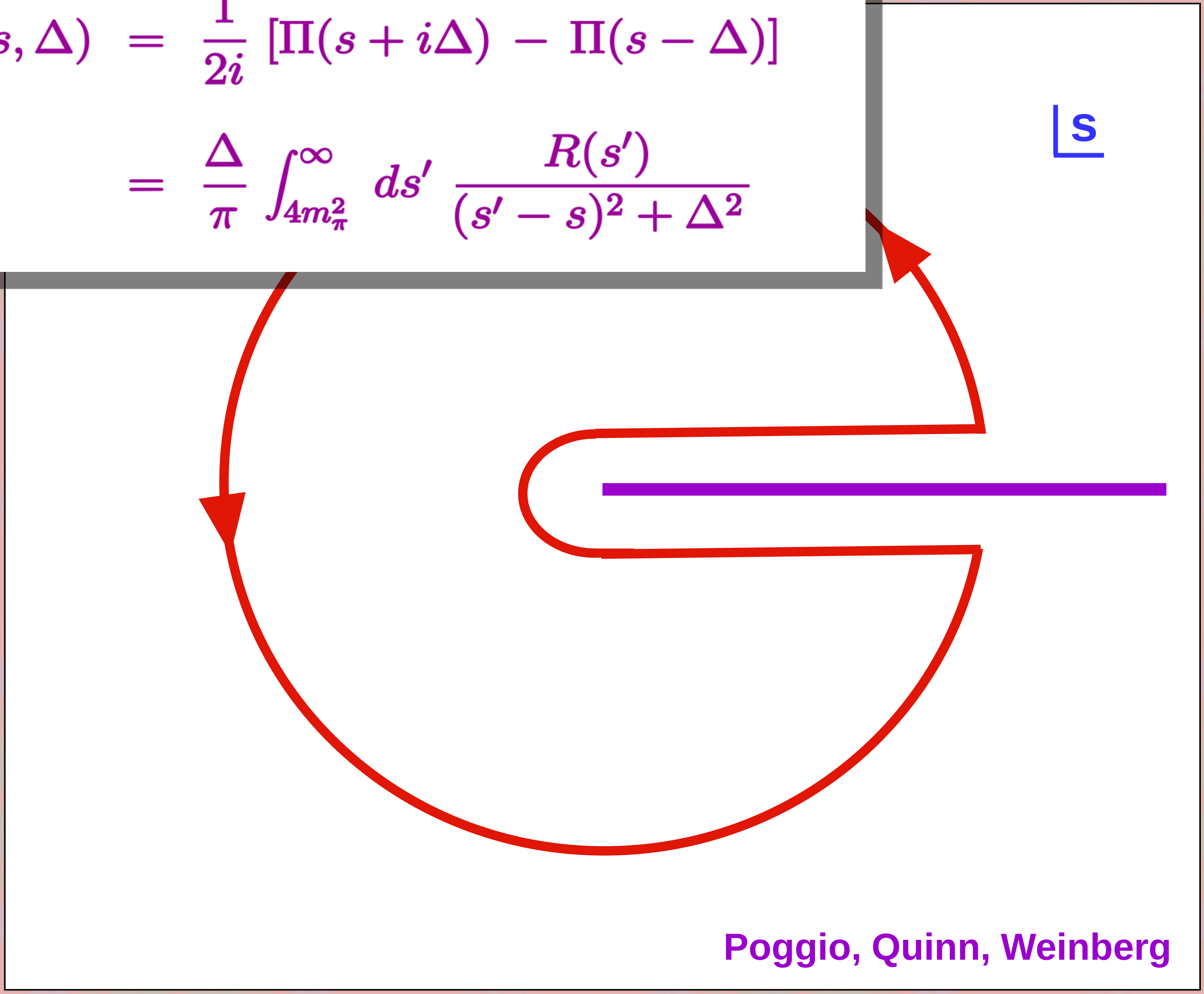

s
ρ
z

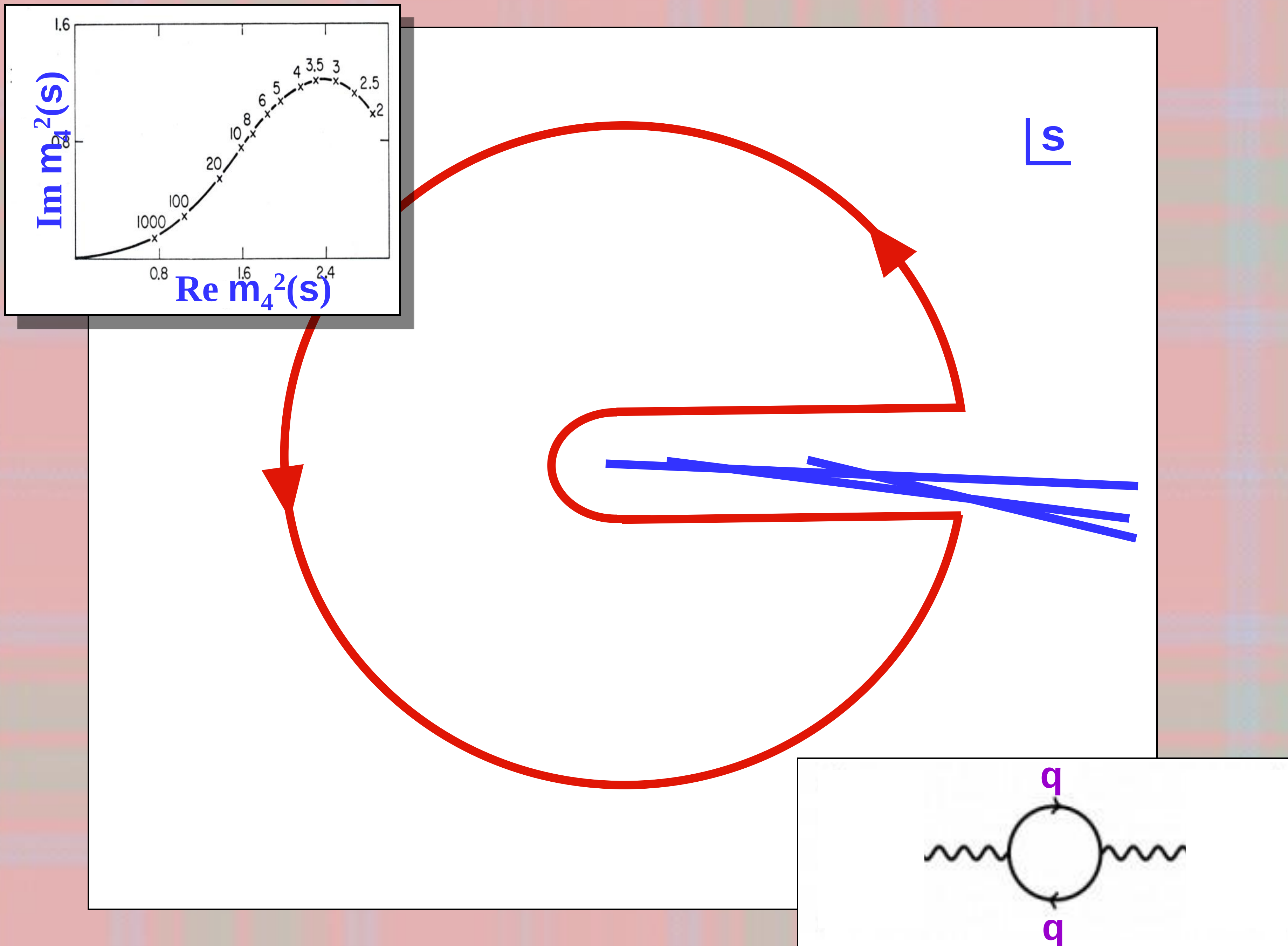


Poggio, Quinn, Weinberg

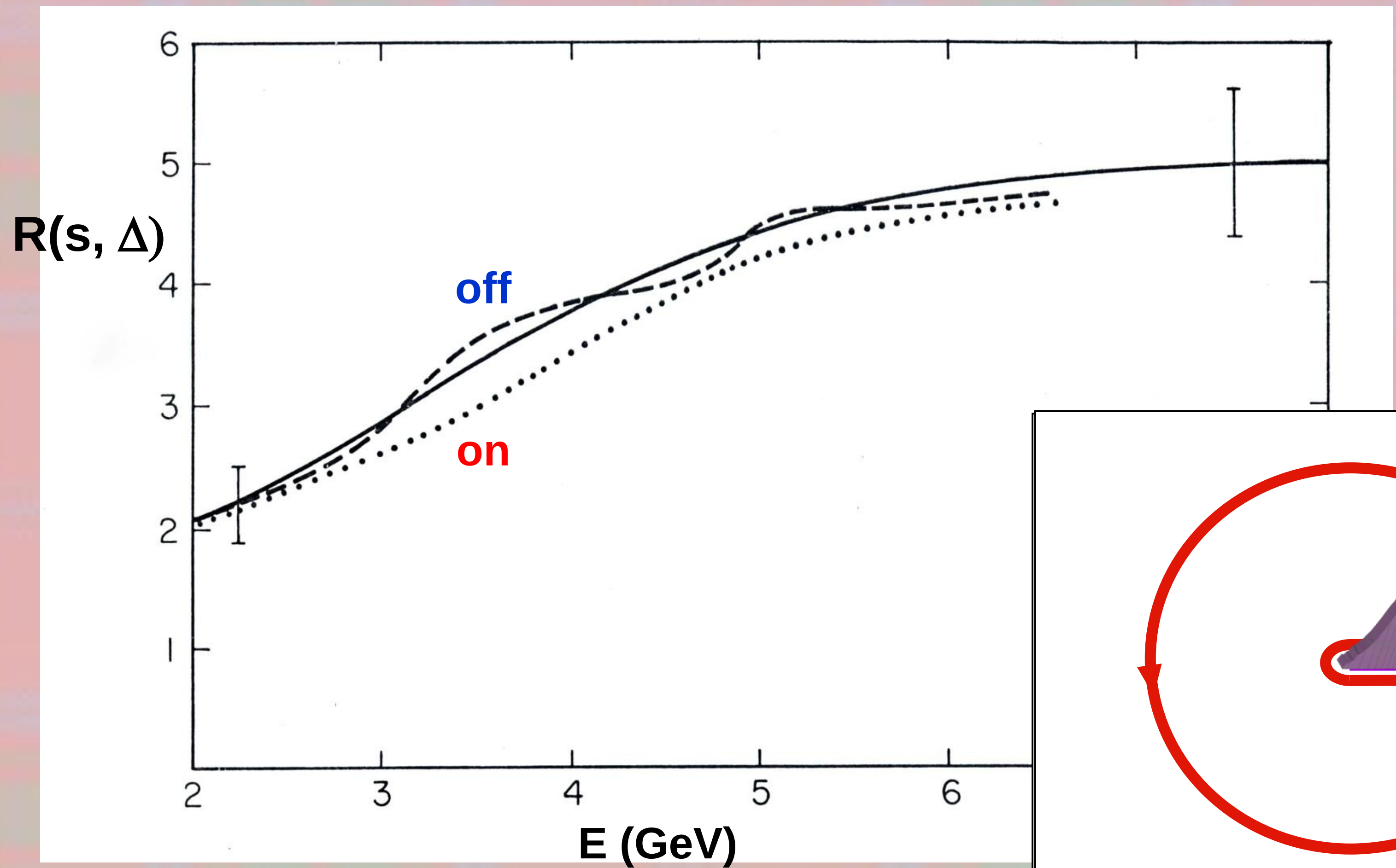
$$\mathcal{R}(s,\Delta) = \frac{1}{2i}\left[\Pi(s+i\Delta) - \Pi(s-\Delta)\right]$$

$$= \frac{\Delta}{\pi}\int_{4m_\pi^2}^{\infty} ds' \, \frac{R(s')}{(s'-s)^2+\Delta^2}$$

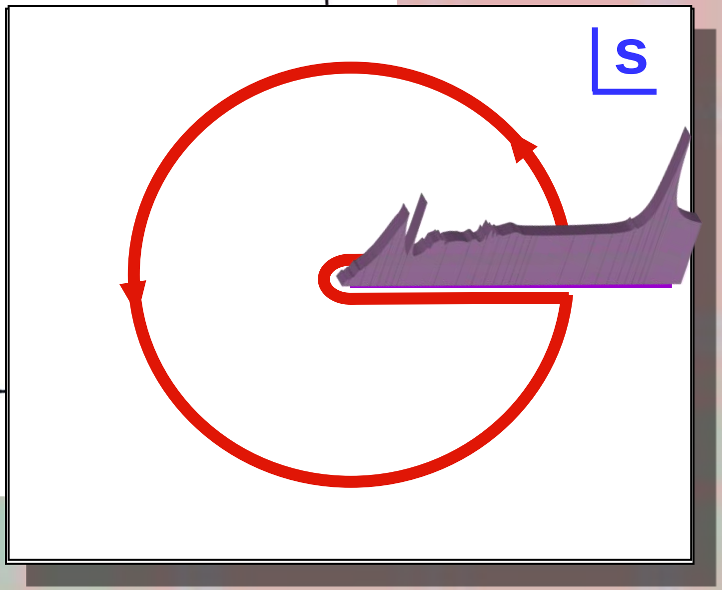




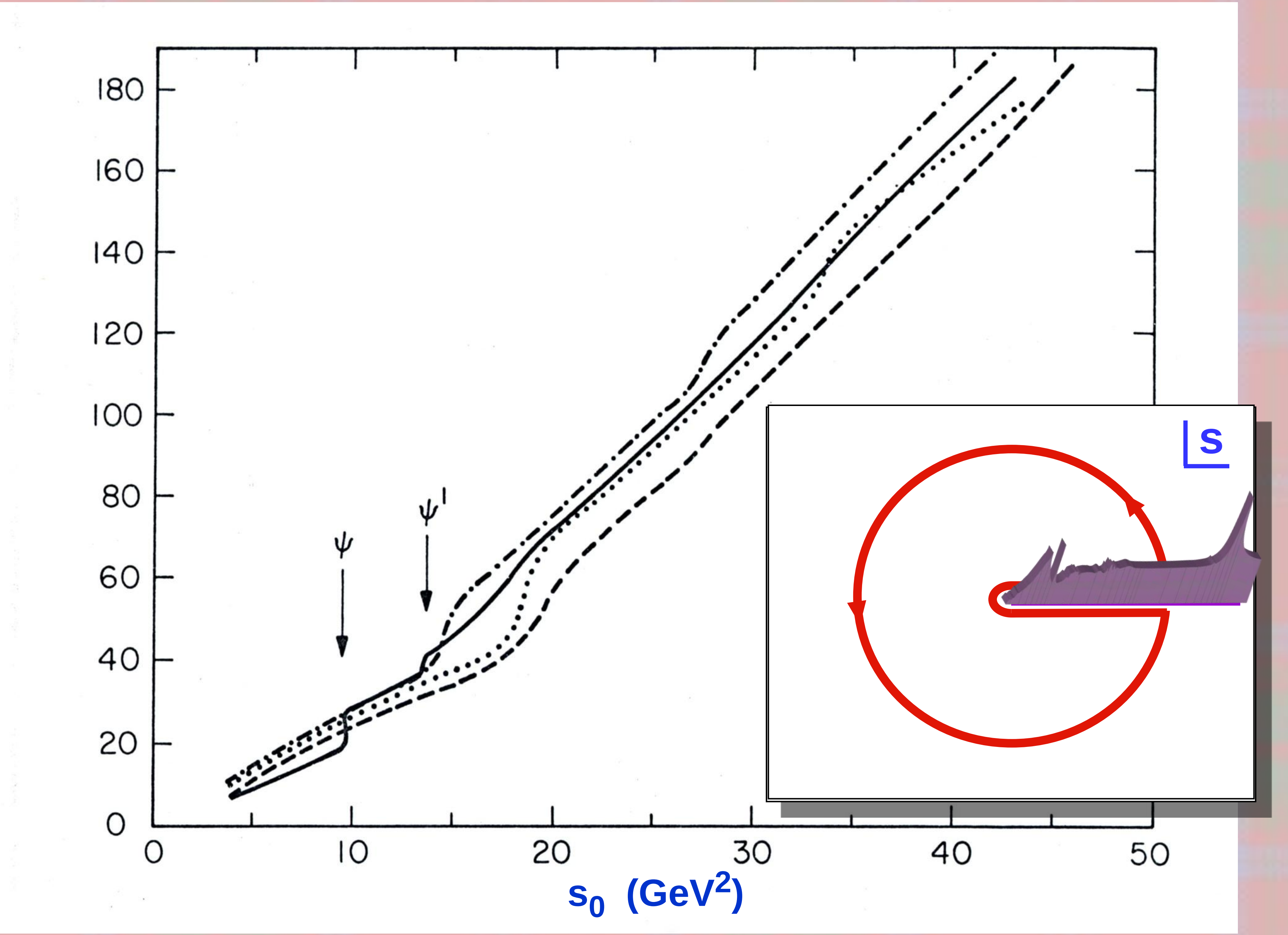
Im m4²(s)
Re m4²(s)
1.6
0.8
1.6
2.4
1000
100
20
10
8
6
5
4
3.5
3
2.5
2
s
q
q



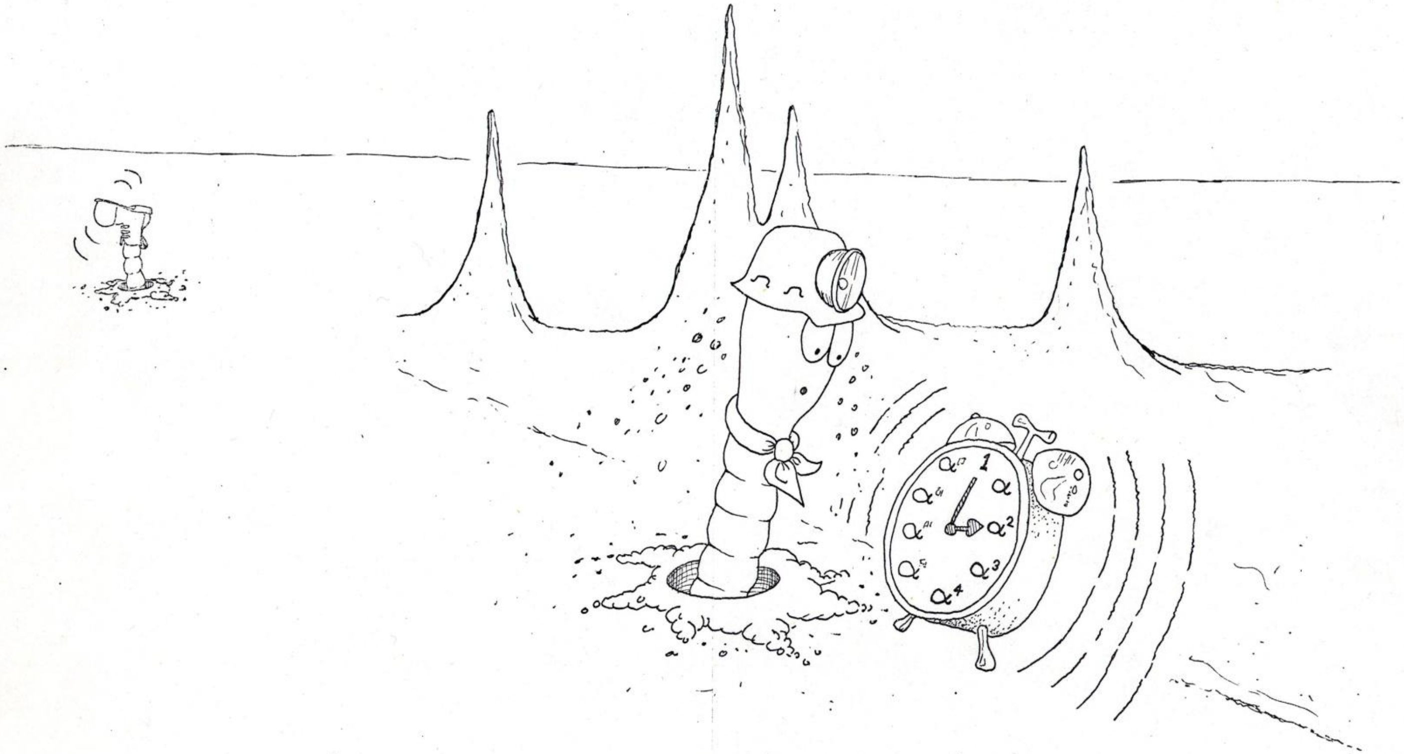
R(s, Δ)
6
5
4
3
2
1
2
3
4
5
6
off
on
E (GeV)



s

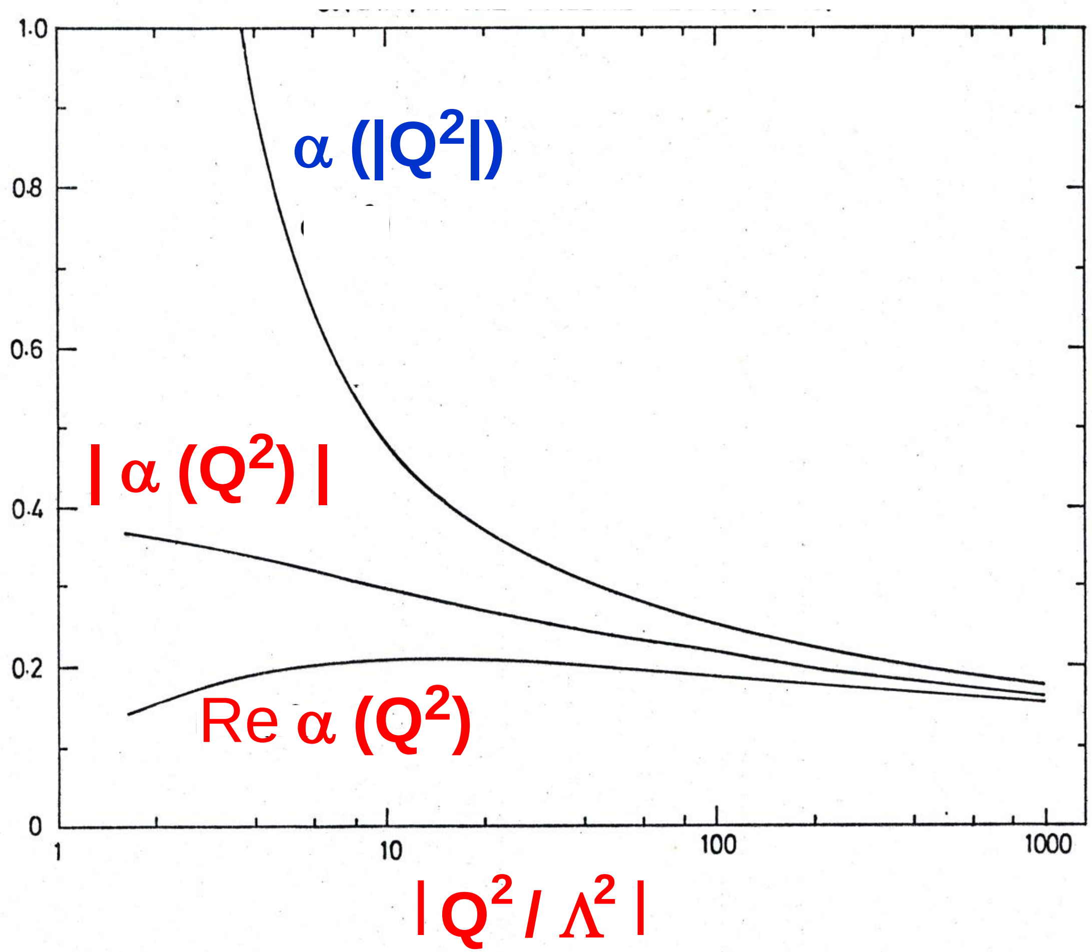


180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
ψ
ψ'
s
s_0 (GeV^2)

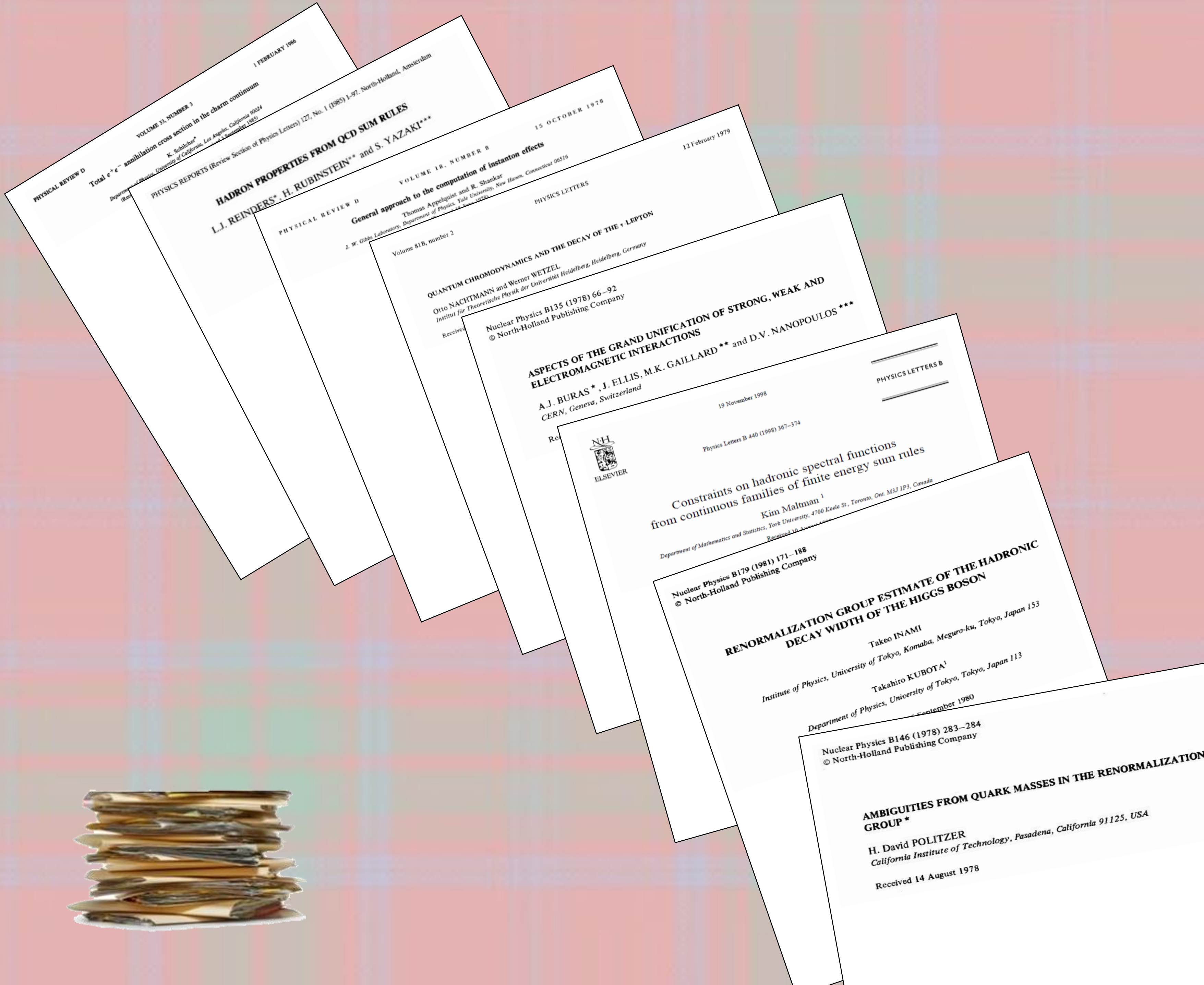


ANALYTIC CONTINUATION

$\alpha\,(Q^2/\Lambda^2)$ in timelike region $Q^2 < 0$



$$A\,\alpha(s) + B\,\pi^2\,\alpha^3(s) + \ldots \longrightarrow A\,\mathcal{a}(s)$$


PHYSICAL REVIEW D
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Otto NACHTMANN and Werner WETZEL
Institut für Theoretische Physik der Universität Heidelberg, Heidelberg, Germany
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A.J. BURAS, J. ELLIS, M.K. GAILLARD and D.V. NANOPOULOS
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Department of Mathematics and Statistics, York University, 4700 Keele St., Toronto, Ont. M3J 1P3, Canada
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RENORMALIZATION GROUP ESTIMATE OF THE HADRONIC DECAY WIDTH OF THE HIGGS BOSON
Takeo INAMI
Institute of Physics, University of Tokyo, Komaba, Meguro-ku, Tokyo, Japan 153
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AMBIGUITIES FROM QUARK MASSES IN THE RENORMALIZATION GROUP
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AMBIGUITIES FROM QUARK MASSES IN THE RENORMALIZATION GROUP *

H. David POLITZER

Renormalizability ensures that any consistent prescription will lead to the same physical predictions, whether the β functions are the same or not. More precisely, any discrepancies between two calculations carried out to a given order must be yet higher order in the coupling constant. One may still ask, in the spirit of Moorhouse, Pennington and Ross [4], whether one particular prescription is better than others in the following practical sense: if we compute to lowest order and ignore yet higher orders, may one prescription be closer to the complete theory than another? That is to ask: can choice of a particular prescription minimize the numerical coefficient of g^2 in the next correction? Typically the answer is yes, but it is impossible to prove without actually computing that next correction. However, for the bulk of phenomenological applications, the use of the light quark-gluon vertex to define g seems a likely candidate because it is precisely that vertex which occurs in lowest-order amplitudes and is subsequently renormalized by higher orders.

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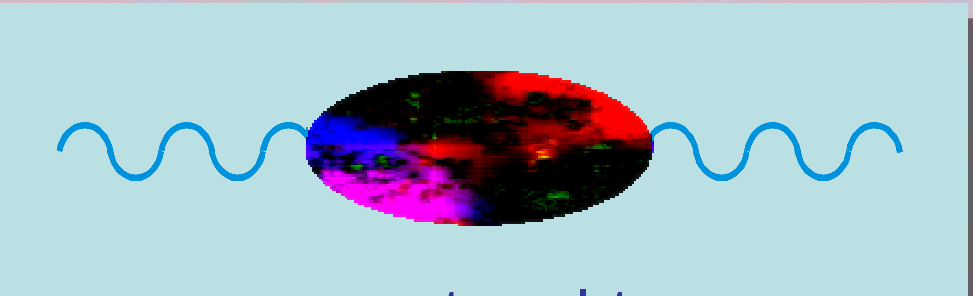
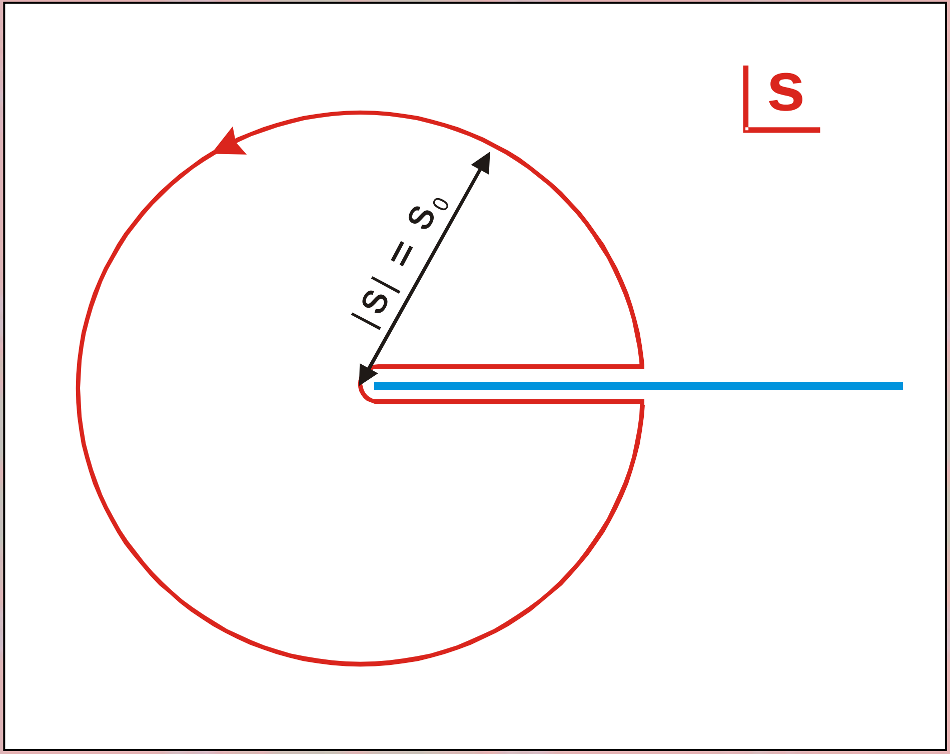
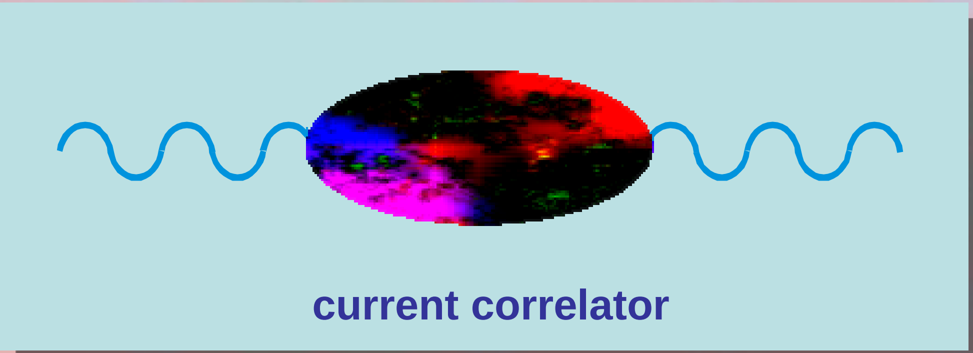
QCD Sum Rules

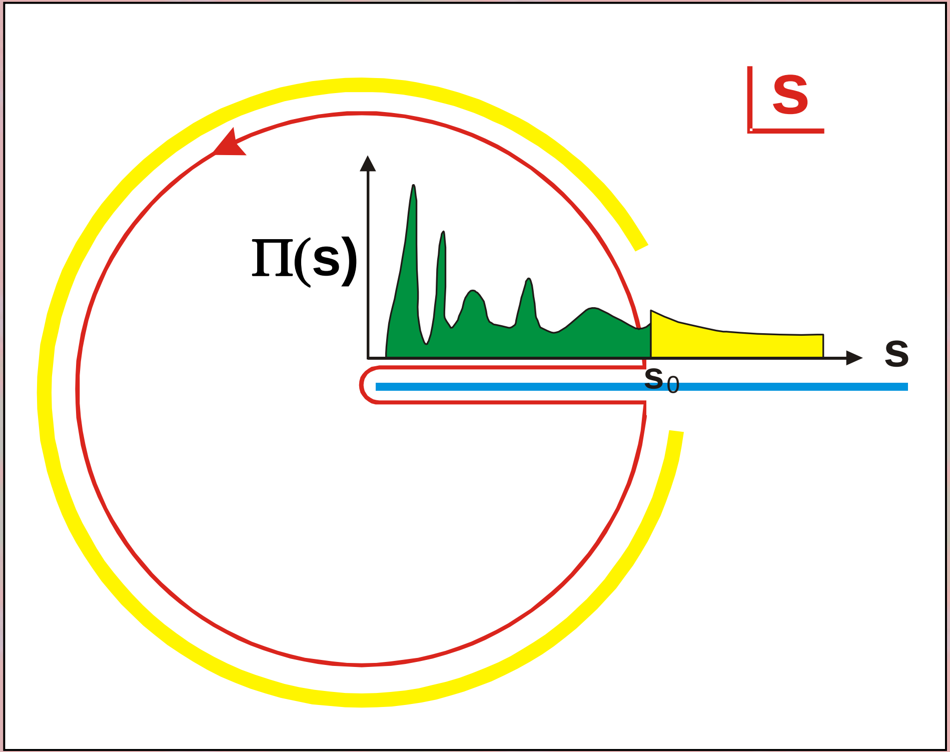




$$\oint ds\, \omega(s)\, \Pi(s) = 0$$

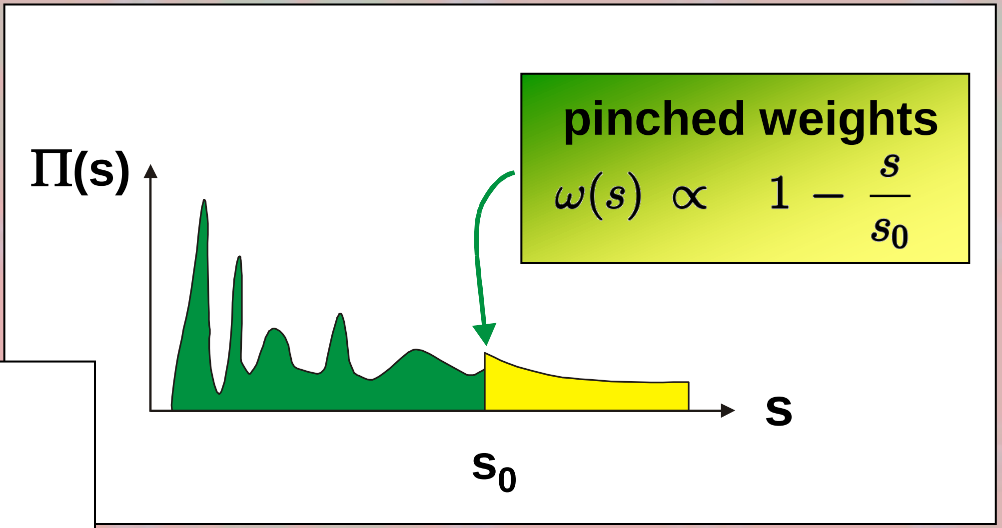
QCD Sum Rules

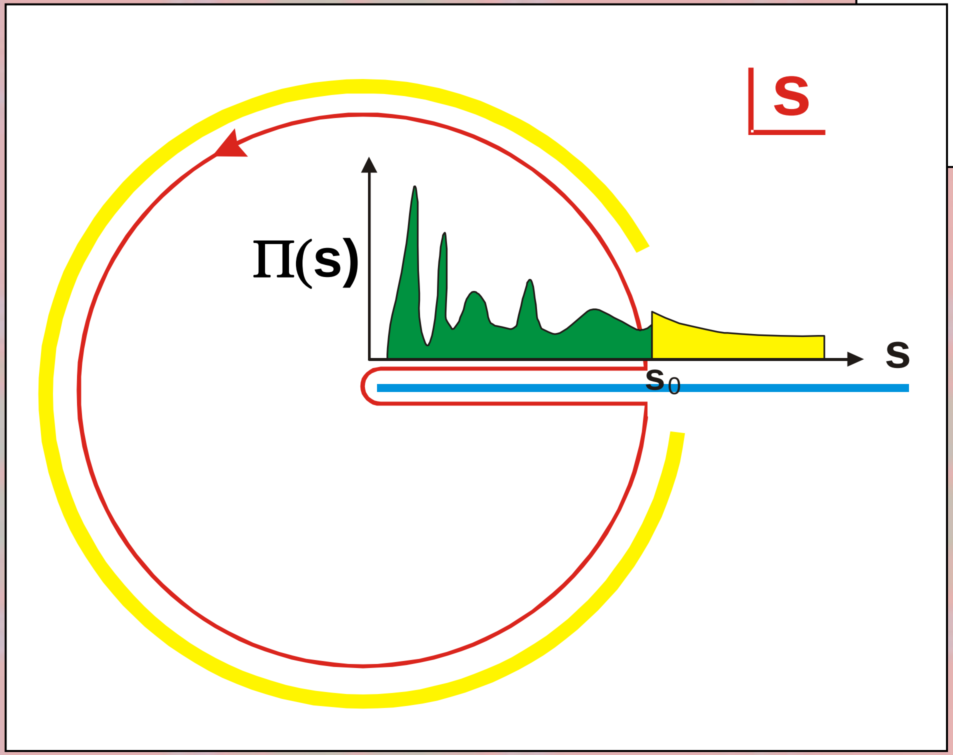




$< qq >_0 \;,\; < \alpha\, GG >_0 \;, \ldots$

$$2i \int_0^{s_0} ds\, \omega(s)\, \mathrm{Im}\,\Pi(s) = -\oint_C ds\, \omega(s)\, \Pi(s)$$





working with Graham Ross 1974-1984