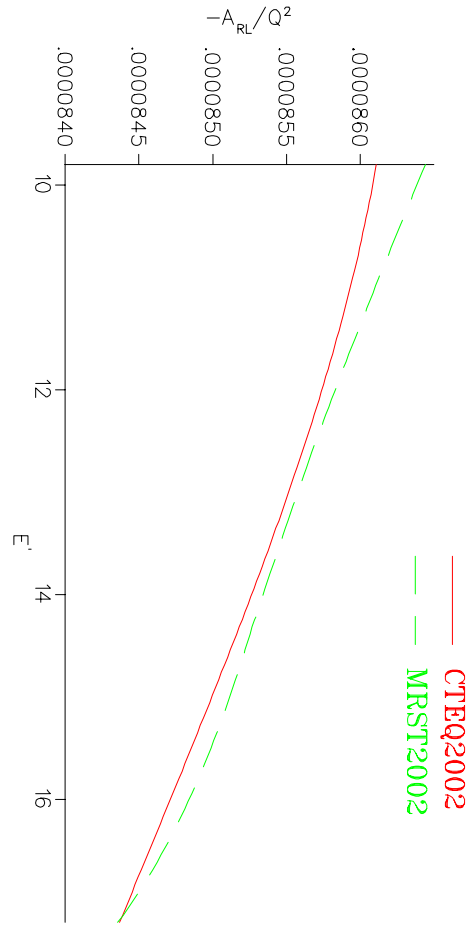
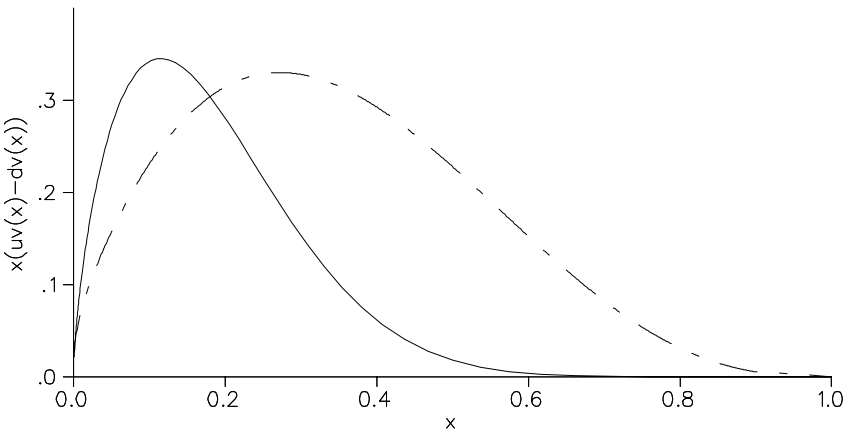
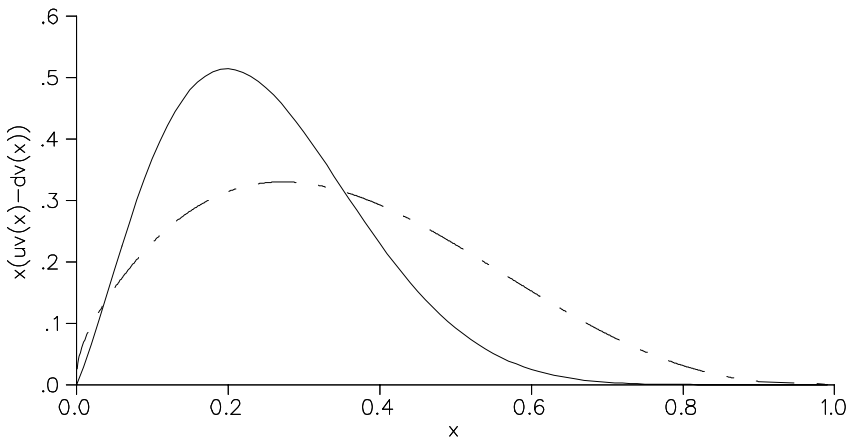
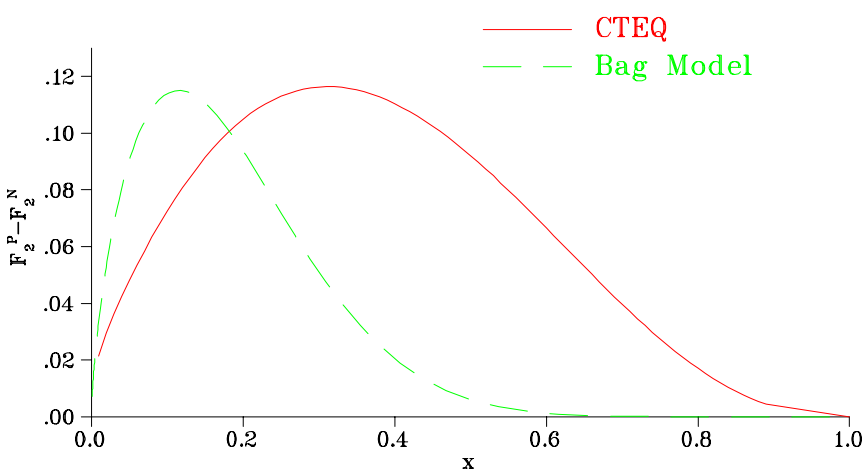
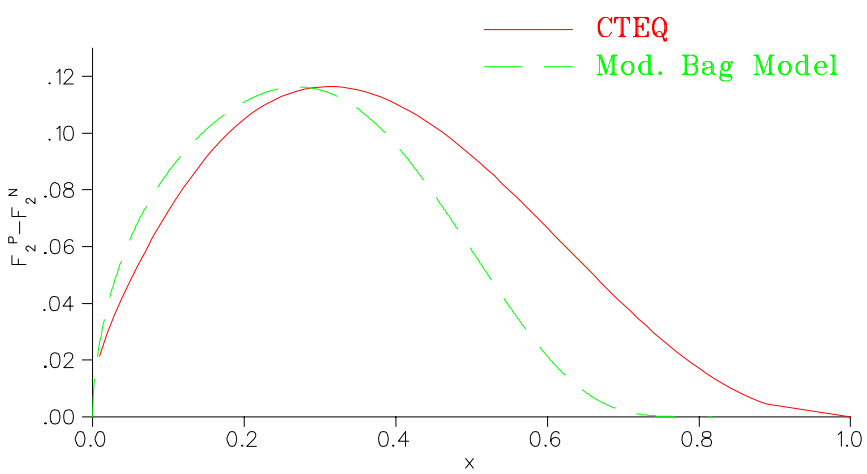
arXiv:0902.1285v1 [hep-ph] 8 Feb 2009 fig

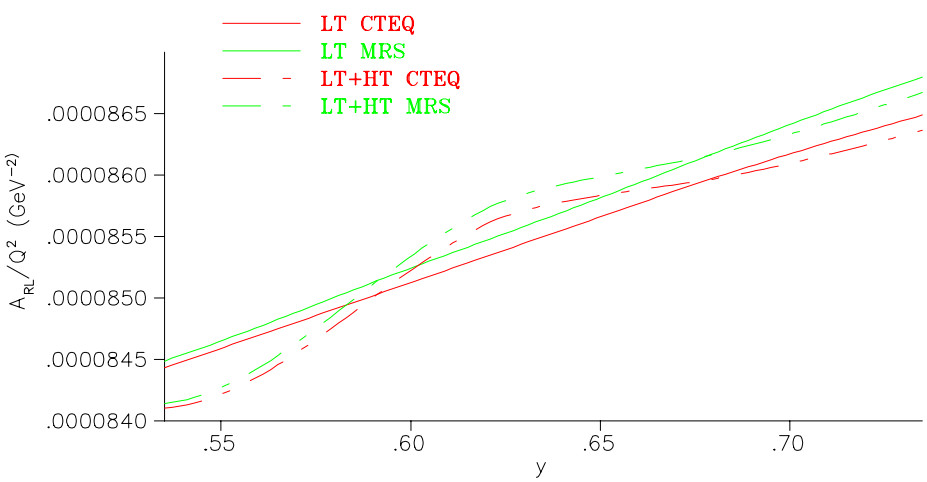


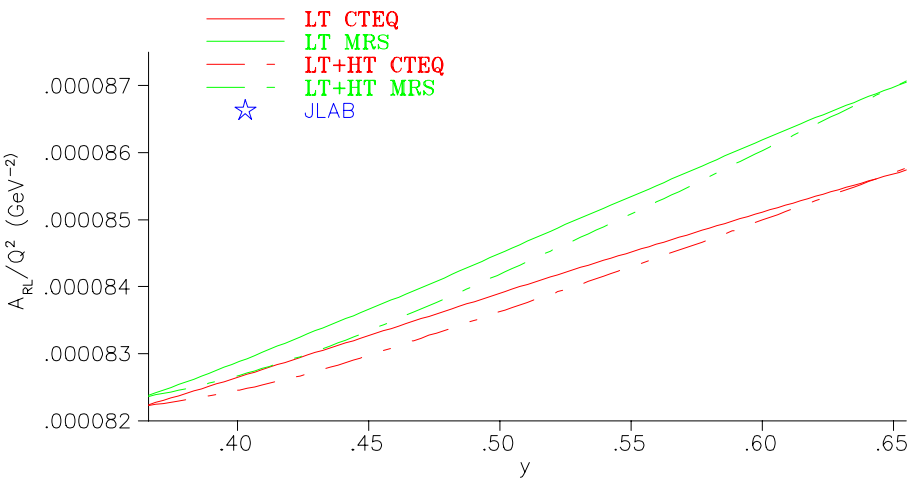

x(uv(x)−dv(x))
.3
.2
.1
.0
0.0
0.2
0.4
0.6
0.8
1.0
x

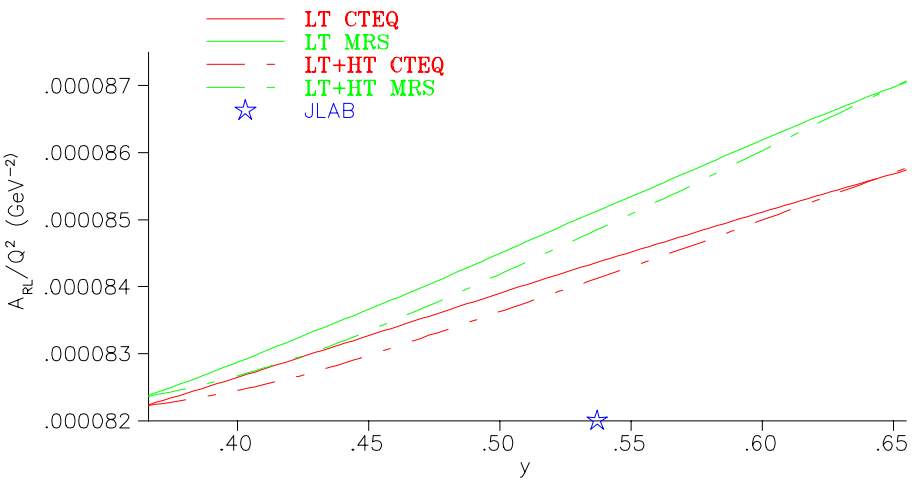

.6
.5
.4
.3
.2
.1
.0
x(uv(x)−dv(x))
0.0
0.2
0.4
0.6
0.8
1.0
x

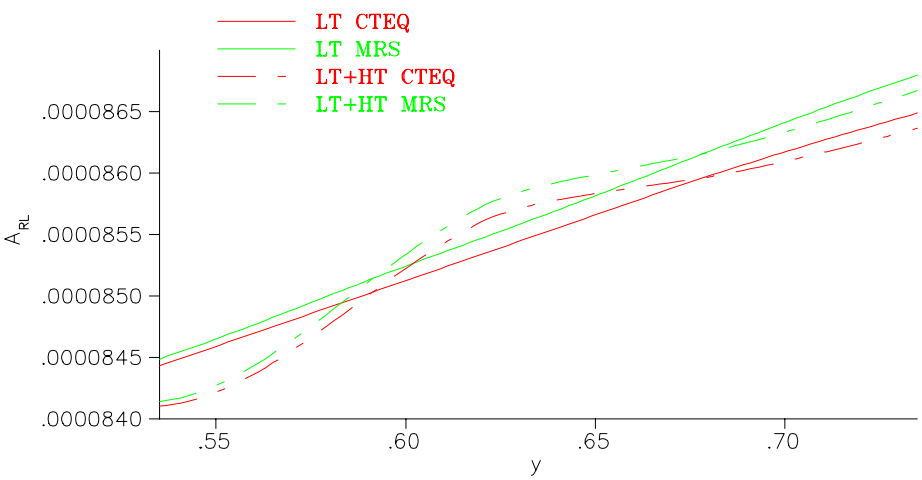

CTEQ
Bag Model
.12
.10
.08
.06
.04
.02
.00
0.0
0.2
0.4
0.6
0.8
1.0
x
F2P−F2N


CTEQ
Mod. Bag Model
.12
.10
.08
.06
.04
.02
.00
$F_2^P - F_2^N$
0.0
0.2
0.4
0.6
0.8
1.0
x


LT CTEQ
LT MRS
LT+HT CTEQ
LT+HT MRS
.0000865
.0000860
.0000855
.0000850
.0000845
.0000840
A_{RL}/Q^2 (GeV^{-2})
.55
.60
.65
.70
y


LT CTEQ
LT MRS
LT+HT CTEQ
LT+HT MRS
JLAB
.000087
.000086
.000085
.000084
.000083
.000082
A_{RL}/Q^2 (GeV^{-2})
.40
.45
.50
.55
.60
.65
y


LT CTEQ
LT MRS
LT+HT CTEQ
LT+HT MRS
JLAB
.000087
.000086
.000085
.000084
.000083
.000082
A_{RL}/Q^2 (GeV^{-2})
.40
.45
.50
.55
.60
.65
y


LT CTEQ
LT MRS
LT+HT CTEQ
LT+HT MRS
.0000865
.0000860
.0000855
.0000850
.0000845
.0000840
A_RL
.55
.60
.65
.70
y

the photon splitting to quark/anti-quark pairs (which then exchange the Pomeron with the nucleon).

Clearly a better treatment of the electroweak coupling at low Q^2 is needed. At present there is no universally accepted description of the interactions at low Q^2 (where perturbative QCD cannot be readily applied due to values of $\alpha_s(Q^2)$ approaching unity), but perhaps progress can be made if a complete multipole description is obtained from a phase shift analysis of all available electron scattering and photoproduction data. Even then, the treatment of the strange quark mass can be problematic. Ideally, measurements of the inelastic asymmetry should be made near the E158 kinematics.

Given these uncertainties, I assume $A)LR = (1.0 \times 10^{-4})Q^2$ at all values of ν, which is the value for the $\Delta(3,3)$ resonance, and about 10% above the average of the DIS, Pomeron, and VDM predictions. At present, it is hard to assign an error to this assumption.

Similar to the case of elastic scattering, a scattering probability P_I is evaluated using

$$P_I = (d\sigma/d\Omega de')2\pi t(e - P_{min})[\cos(\theta_{min}) - \cos(\theta_{max})]$$

and scattering takes place if a random number $R < P_I E_I$, where the enhancement factor E_I is by default the same as E_M and E_E. The final results do not depend on E_I for $E_I < 200$.

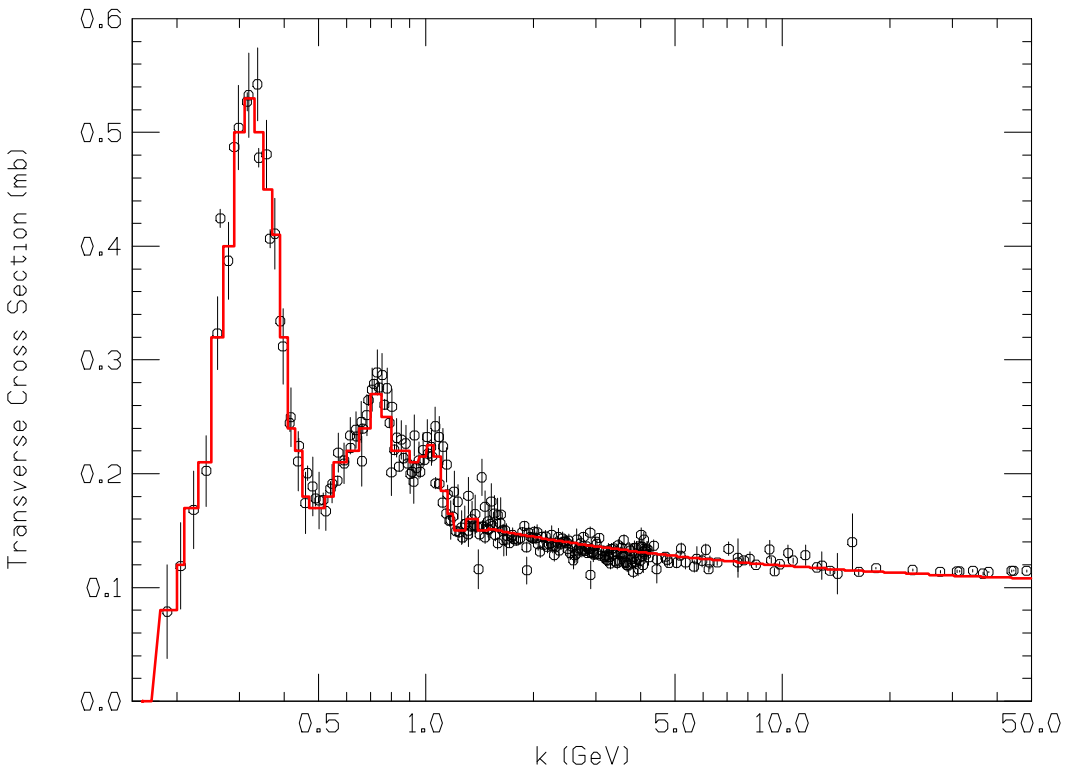


Figure 2: The data points are a compilation of the world data on σ_T as measured with real photons. The red curve is the simple fit used in the E158 modeling.

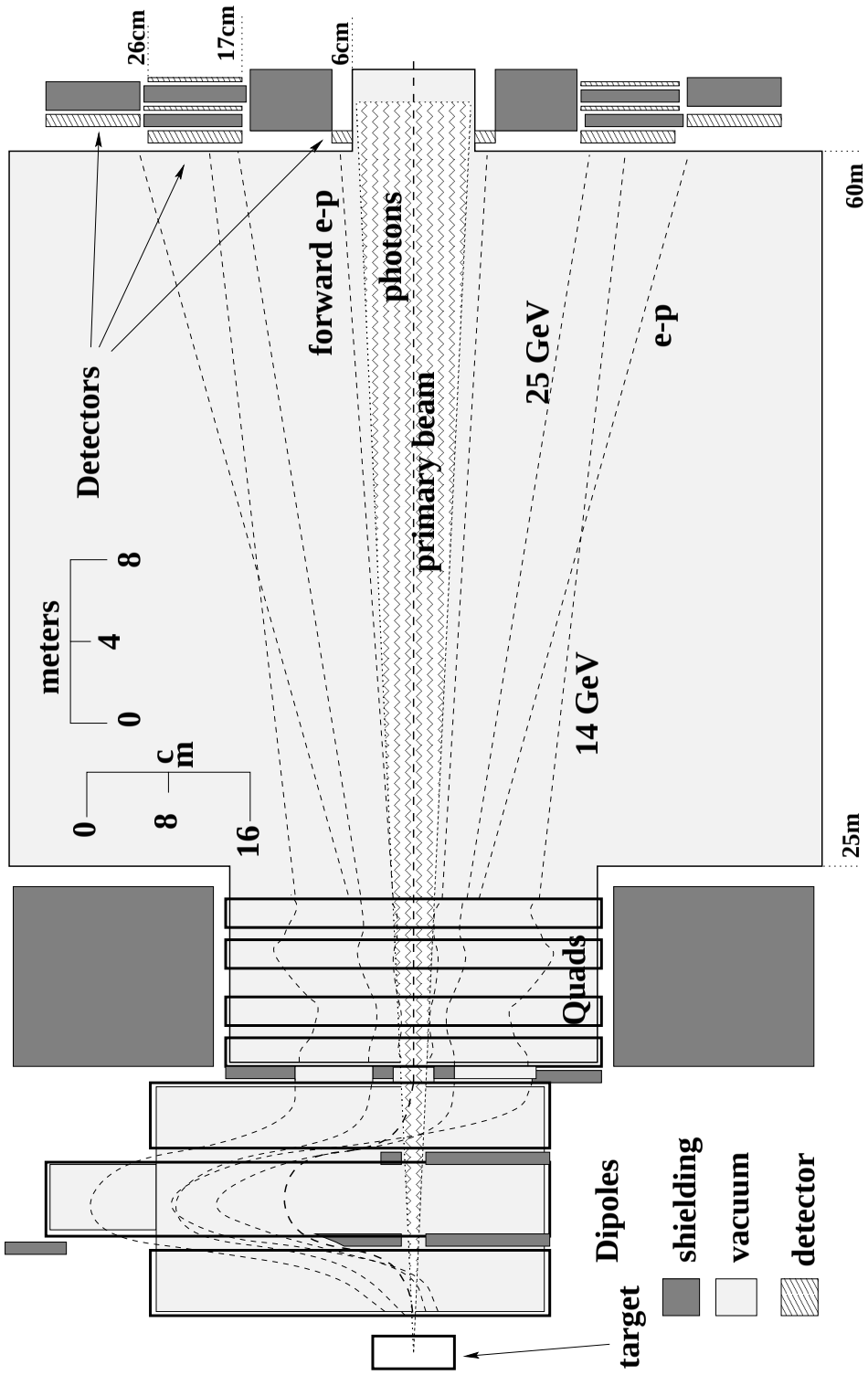


Figure 7: Schematic of the Spectrometer and Detector Layout in End Station A. Note the vastly different X and Z scales. Approximate horizontal ray traces of a few select electron trajectories are also shown.

DISSERTATION PROPOSAL FOR THE Ph.D. DEGREE

Hadronic Effects in Parity Violating Electron Scattering.

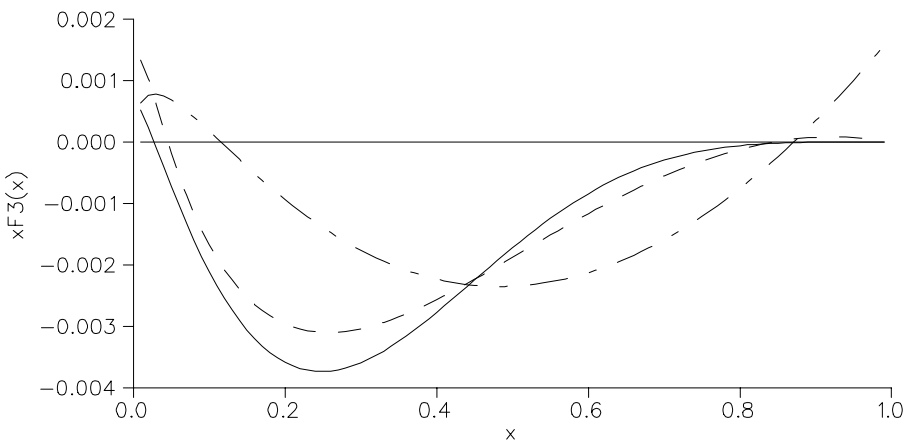
Gian Franco Sacco

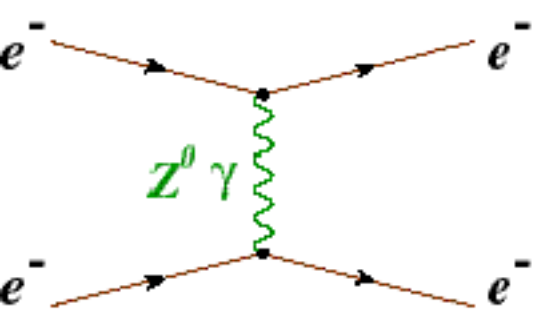
Abstract: Since their advent, Parity Violating experiments have played a crucial role in testing the standard model (SM) of electroweak interactions. In recent years, these experiments have reached such a high degree of accuracy that they might test for physics beyond the SM. When making high precision measurements, a recurrent problem is how to properly include hadronic corrections. In this study I consider possible hadronic effects that appear in such experiments.

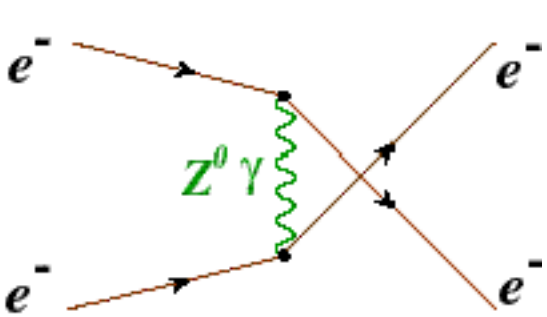
In the first part, I consider the possible hadronic corrections to the deep inelastic parity violating (PV) asymmetry, A_{RL} [1], stemming from sea quarks, perturbative QCD (PQCD), target mass (TM) and higher twist (HT) corrections. To estimate the first three effects I use available parametrizations of the leading twist parton distribution functions (PDF). For the HT, which are not well known, I suggest using the MIT bag model to give some reasonable estimate. HT corrections could be relevant at the kinematics in the proposed experiments [2,3] where the weak mixing angle θ_W may be measured by using A_{RL}. In this part of the study I consider the implications of these corrections for the extraction of $\sin^2\theta_W$.

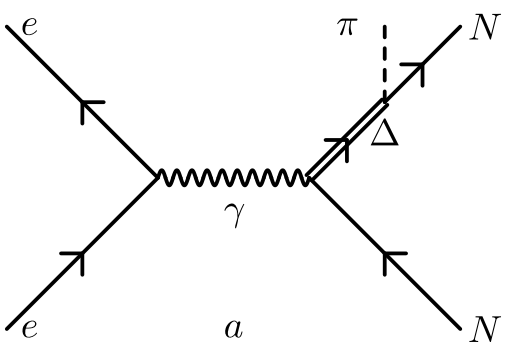
In the second part I study the contribution to A_{RL} of the bremsstrahlung radiation in electron-proton scattering. Such a process constitutes a background in the SLAC experiment E-158. In the experiment, which uses polarized Møller scattering to measure A_{RL} at the 8% level, it was noticed that the inelastic electron-proton (EP) scattering background amounted for 40% of the total asymmetry, which implies that, in order to reach the prescribed precision in the A_{RL}, one has to know the EP background to a 20% level. I suggest to use a simple model, consisting in only two resonances, to investigate which fraction of the bremmstrahlung radiation in the proton electro-excitation contributes to the total background and if the lack of knowledge in the resonance form factors might spoil the prescribed accuracy of the experiment.

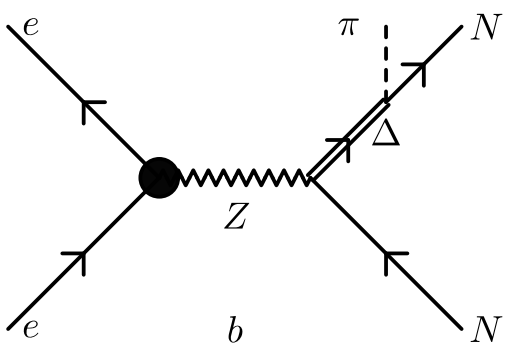
In the last part of the study I estimate the contribution to A_{RL} in the electro-excitation of the $\Delta(1232)$ resonance in chiral perturbation theory. I specifically focus on the chiral corrections of the terms stemming from the electric-dipole, the anapole and the d-wave chiral effective lagrangian and give some reasonable range of values for their contribution to A_{RL} in the low Q^2 region. In particular the dipole (or Siegert) contribution assumes great importance at very low Q^2 since it does not vanish at the photon point, while all the other contributions do.

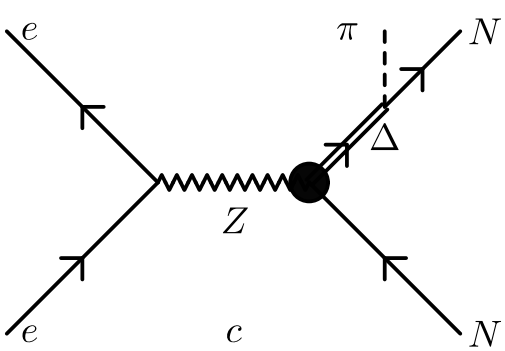

0.002
0.001
0.000
−0.001
−0.002
−0.003
−0.004
xF3(x)
0.0
0.2
0.4
0.6
0.8
1.0
x

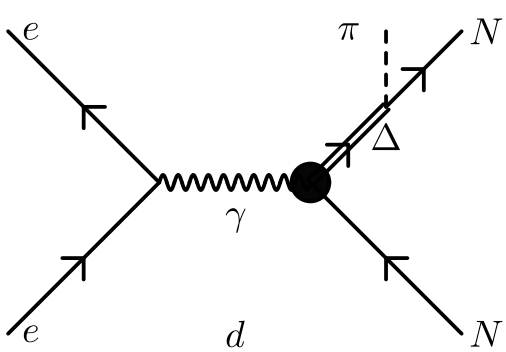

e-
e-
Z0 γ
e-
e-

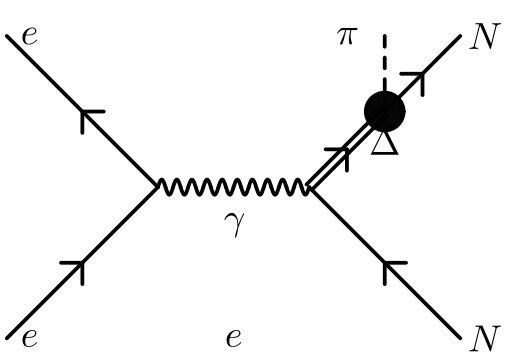

e-
e-
Z0 γ
e-
e-

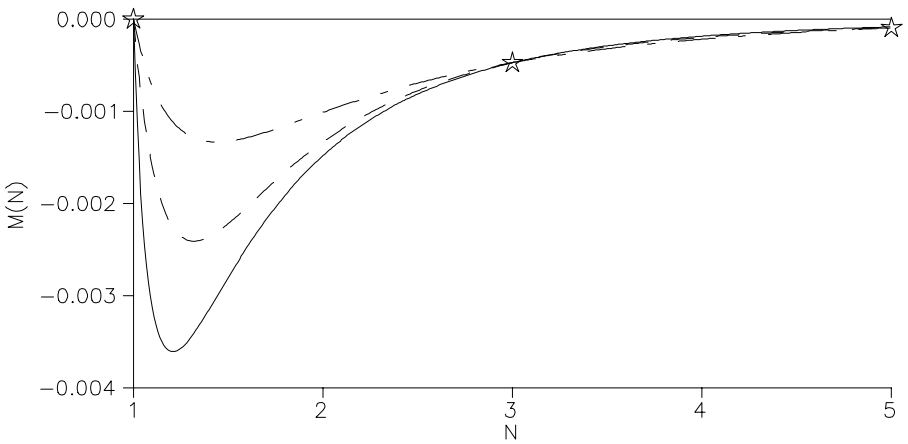

e
π
N
Δ
γ
e
N
a

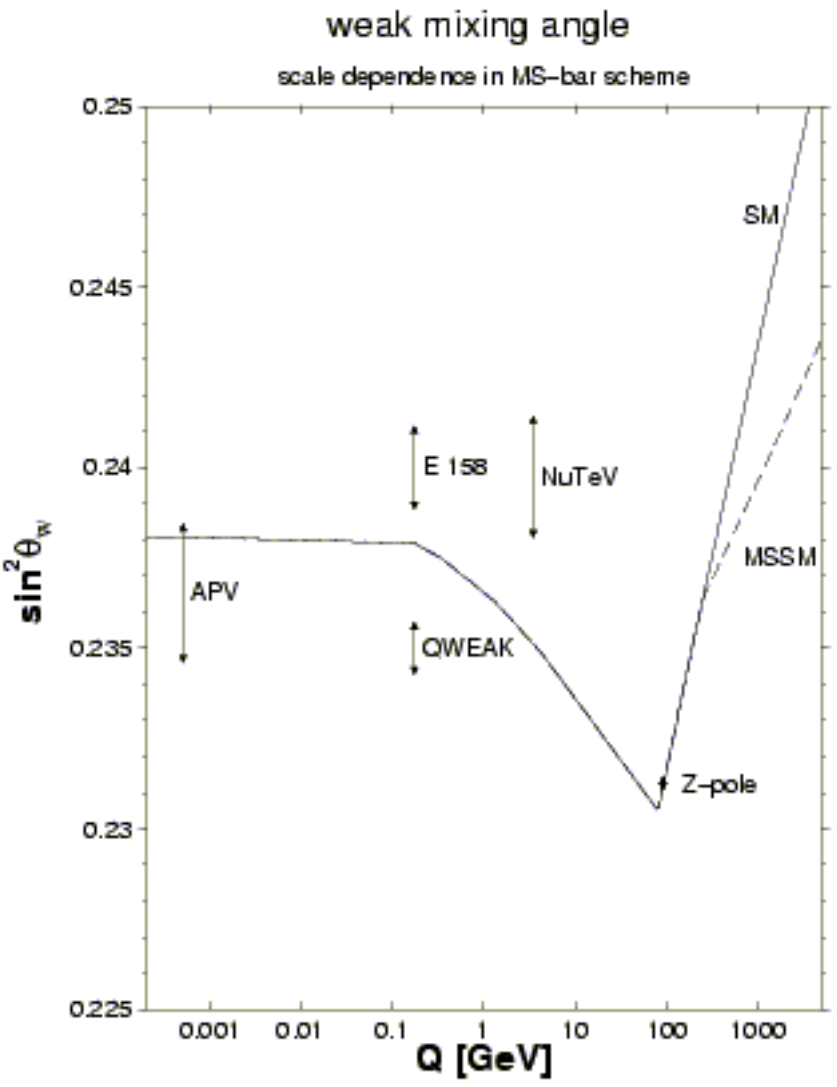

e
π
N
Δ
Z
e
N
b

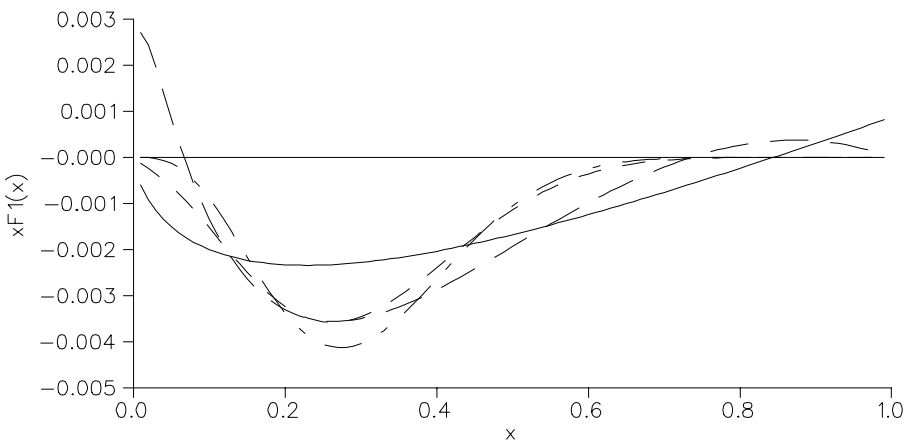

e
π
N
Δ
Z
e
N
c

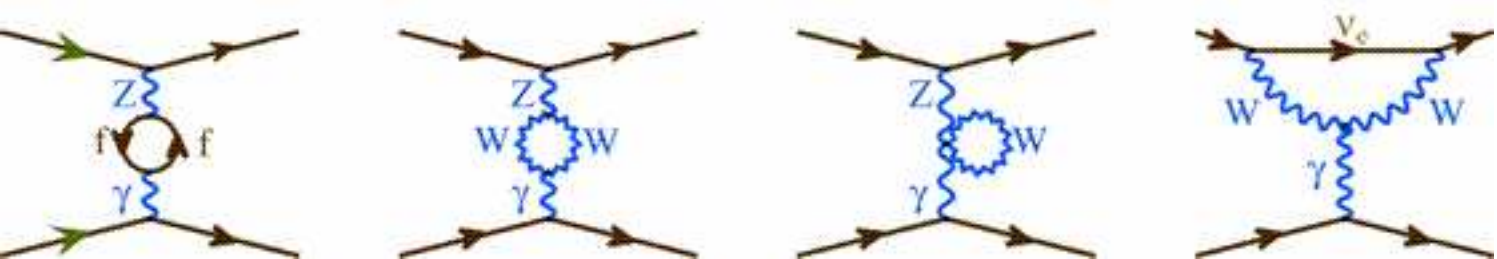

e
π
N
Δ
γ
e
N
d

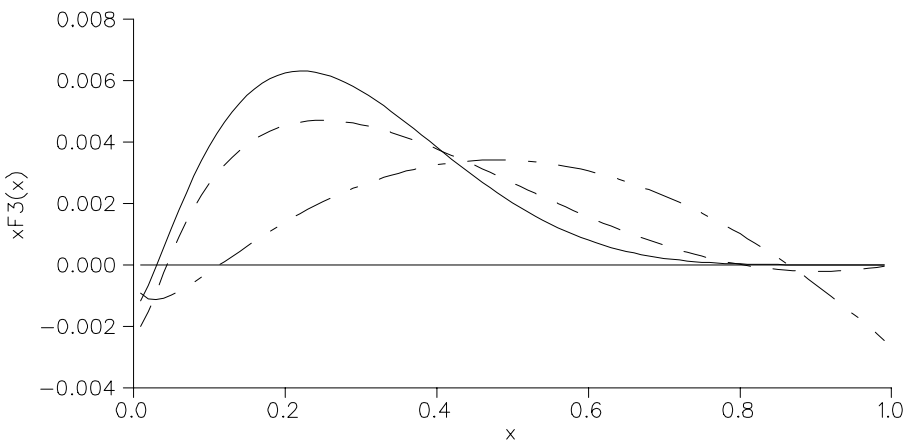

e
π
N
Δ
γ
e
N
e

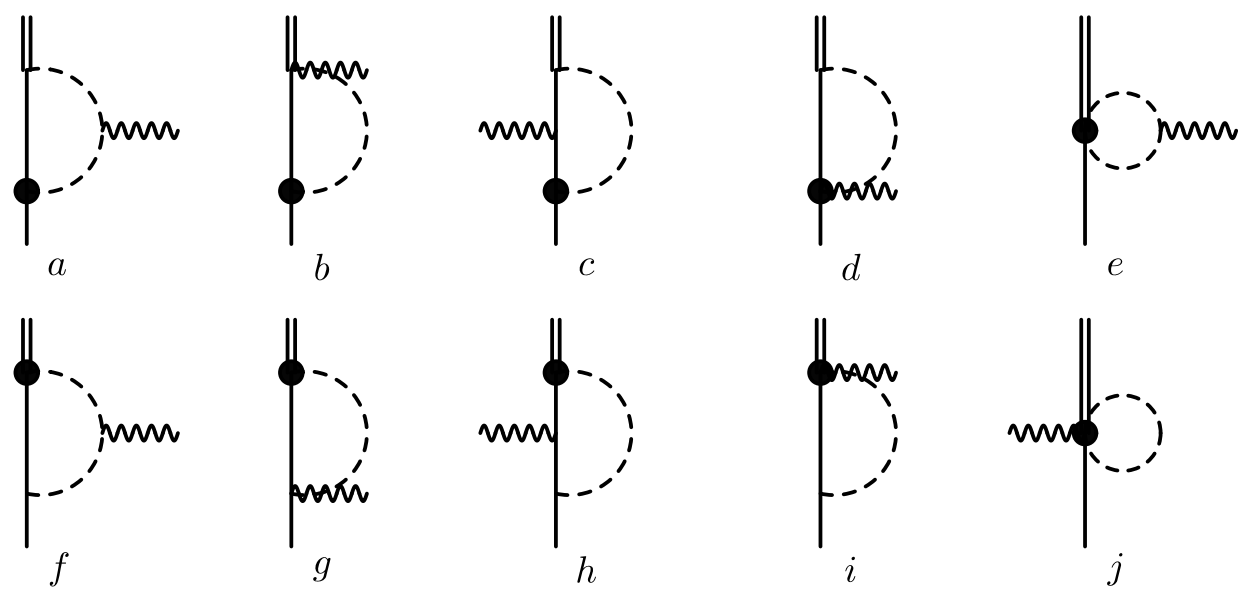

0.000
−0.001
−0.002
−0.003
−0.004
M(N)
1
2
3
4
5
N

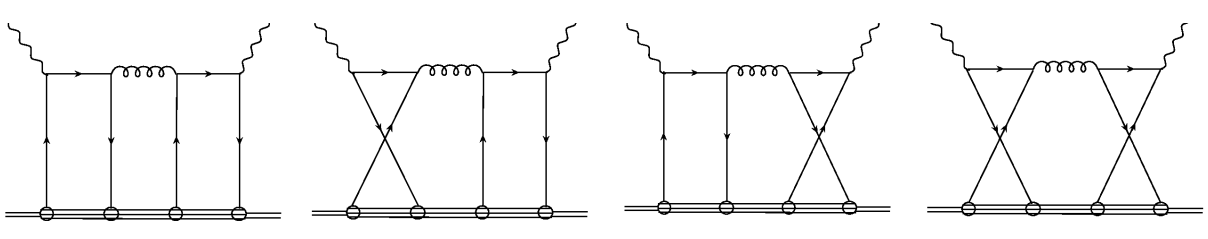

weak mixing angle
scale dependence in MS–bar scheme
0.25
0.245
0.24
0.235
0.23
0.225
$\sin^2\theta_W$
SM
MSSM
E 158
NuTeV
APV
QWEAK
Z–pole
0.001
0.01
0.1
1
10
100
1000
Q [GeV]

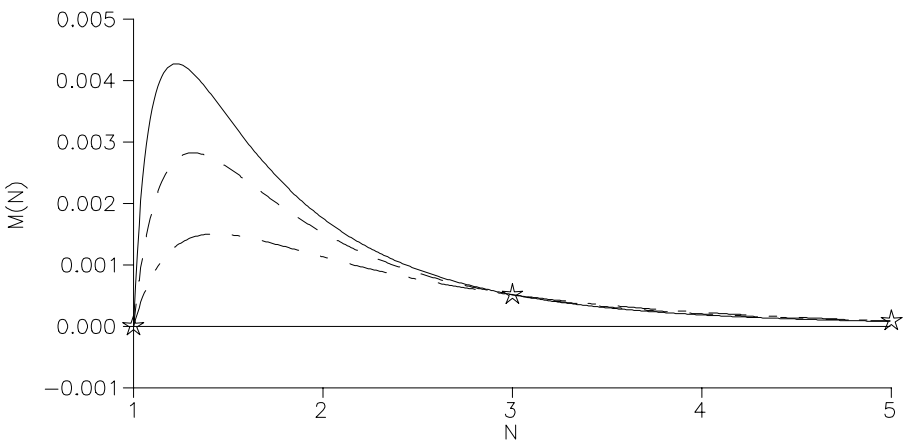

0.003
0.002
0.001
−0.000
−0.001
−0.002
−0.003
−0.004
−0.005
xF1(x)
0.0
0.2
0.4
0.6
0.8
1.0
x

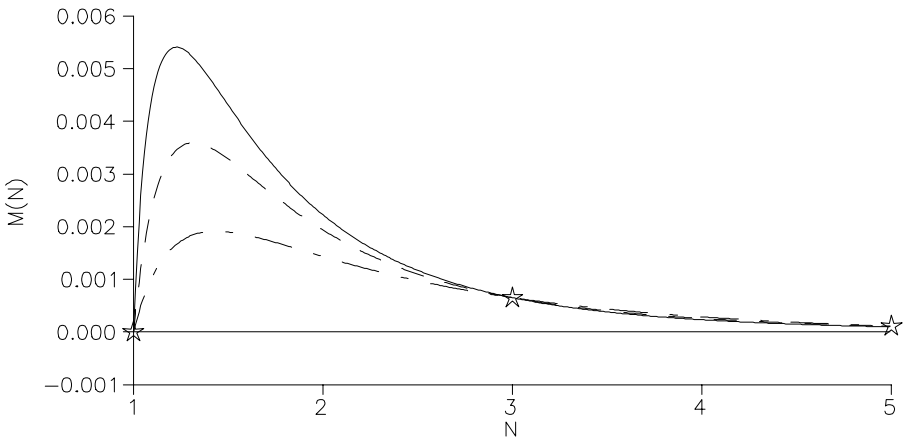

Z
f
f
γ
Z
W
W
γ
Z
W
γ
ν_e
W
W
γ

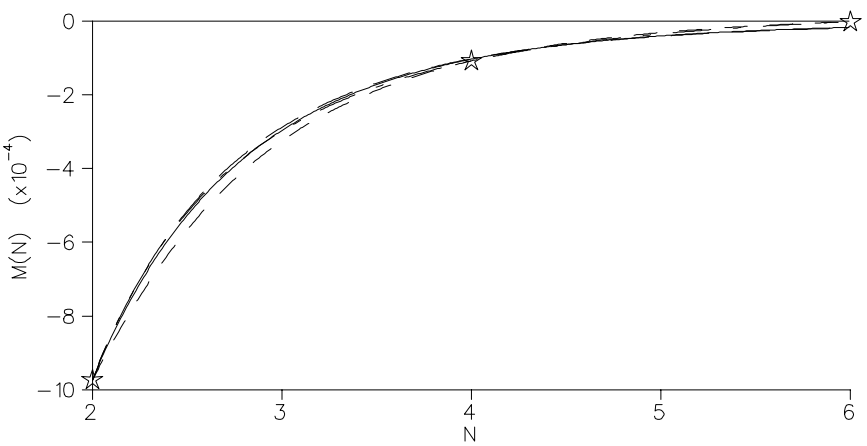

0.008
0.006
0.004
0.002
0.000
−0.002
−0.004
xF3(x)
0.0
0.2
0.4
0.6
0.8
1.0
x

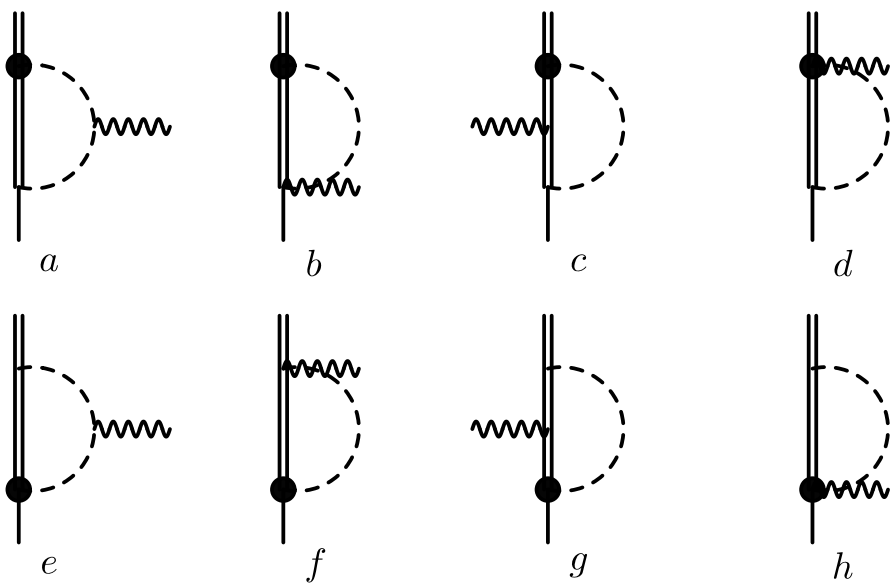

a
b
c
d
e
f
g
h
i
j

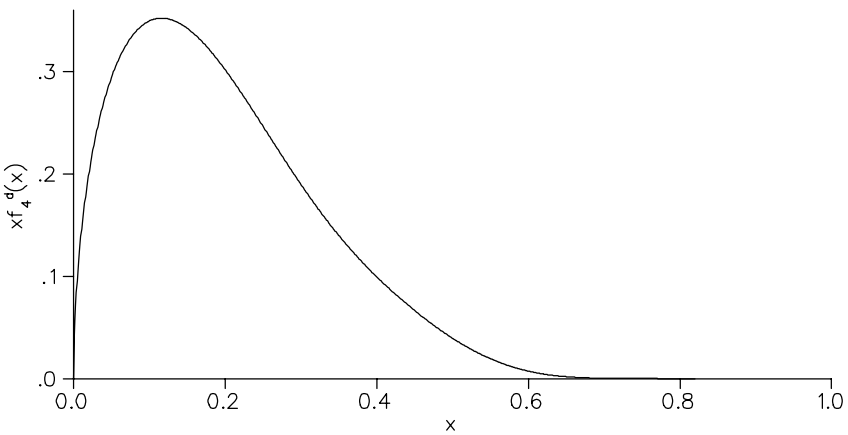


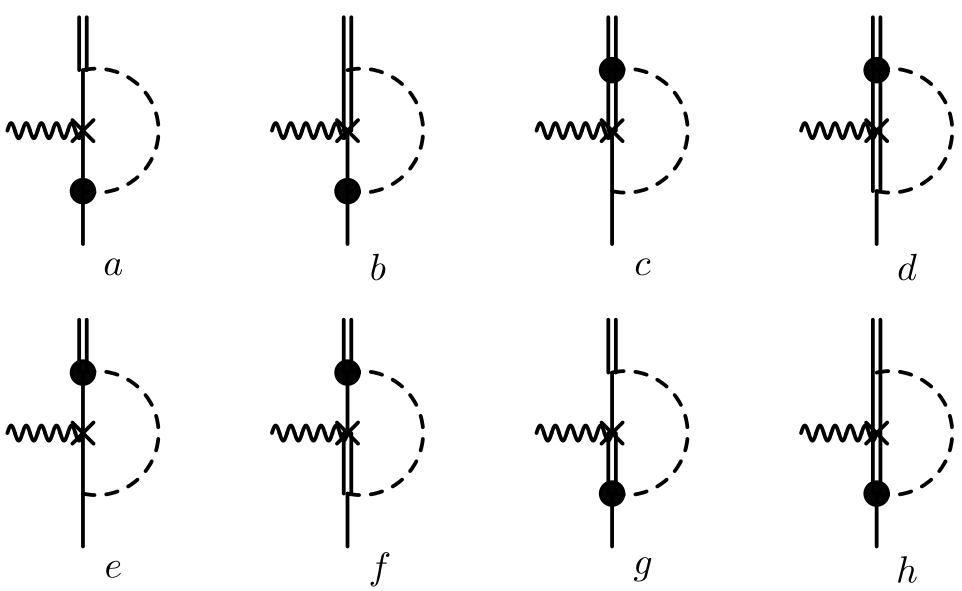

0.005
0.004
0.003
0.002
0.001
0.000
−0.001
M(N)
1
2
3
4
5
N

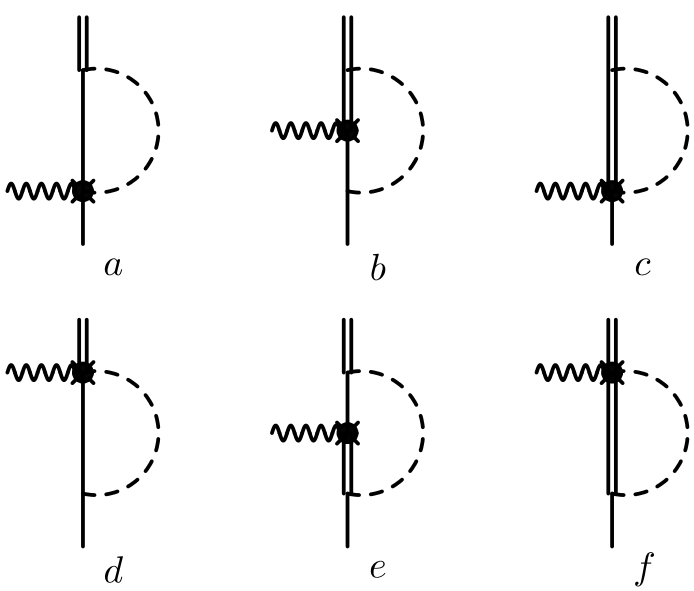

0.006
0.005
0.004
0.003
0.002
0.001
0.000
−0.001
M(N)
1
2
3
4
5
N

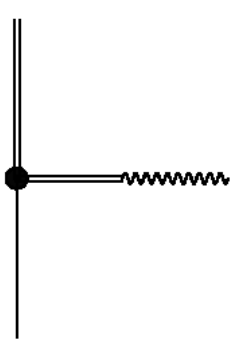

0
−2
−4
−6
−8
−10
M(N) (×10⁻⁴)
2
3
4
5
6
N

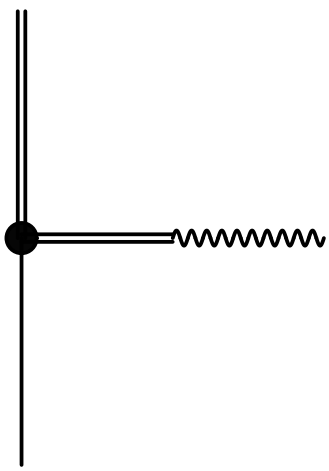

a
b
c
d
e
f
g
h


.3
.2
.1
.0
0.0
0.2
0.4
0.6
0.8
1.0
x
xf 4 d(x)


a
b
c
d
e
f
g
h

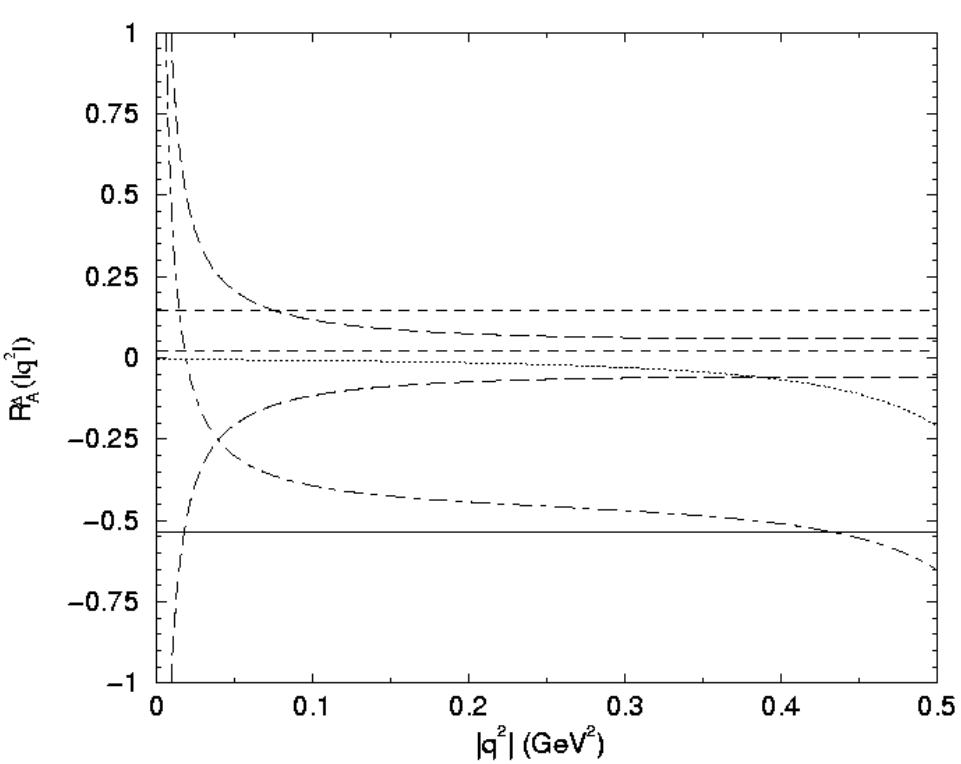

a
b
c
d
e
f

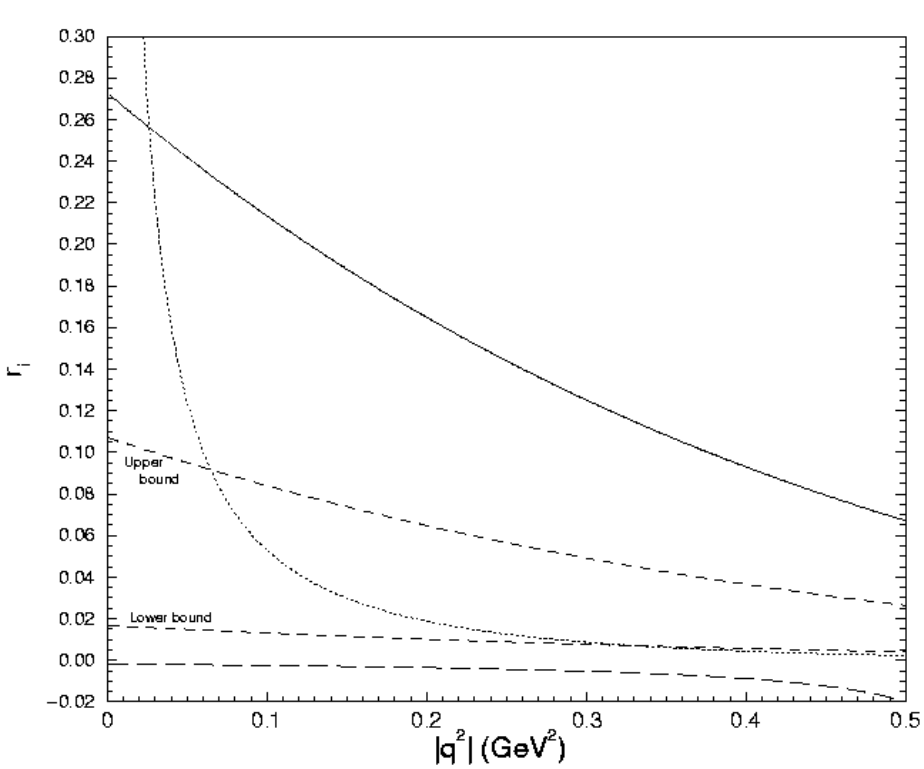


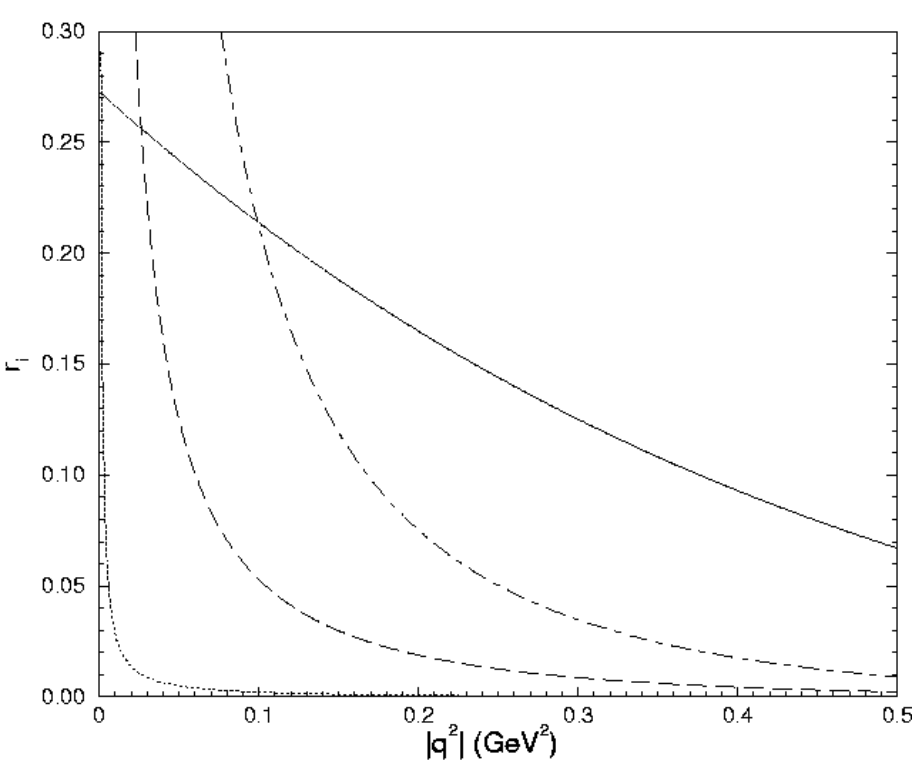


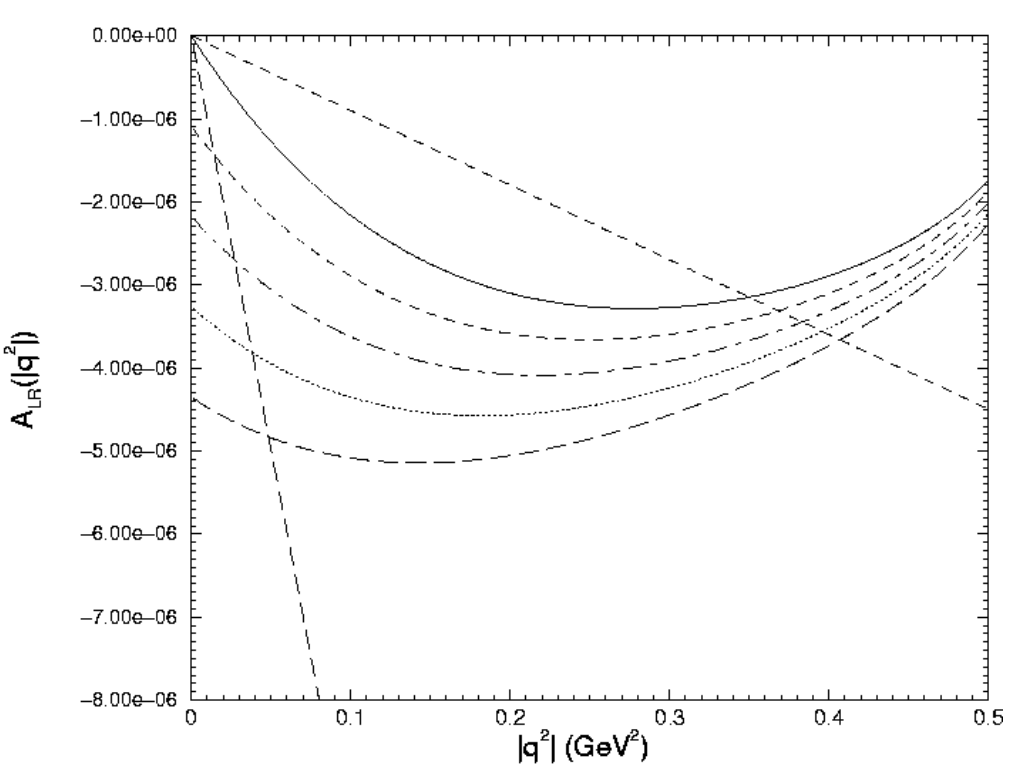
a *b*

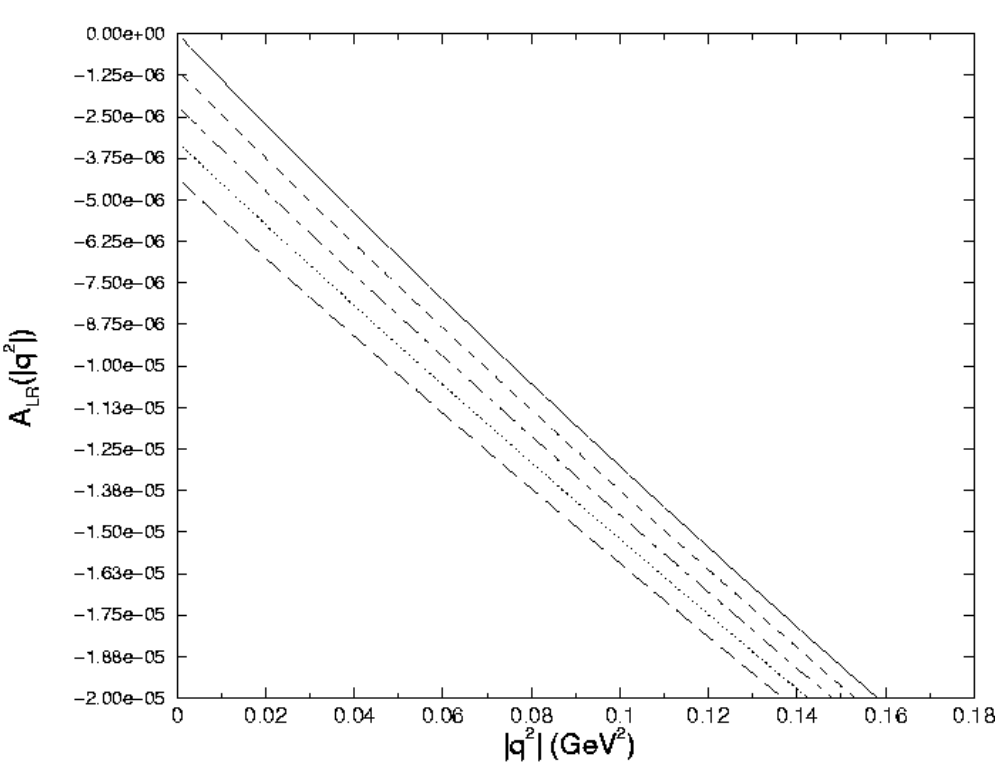
a b

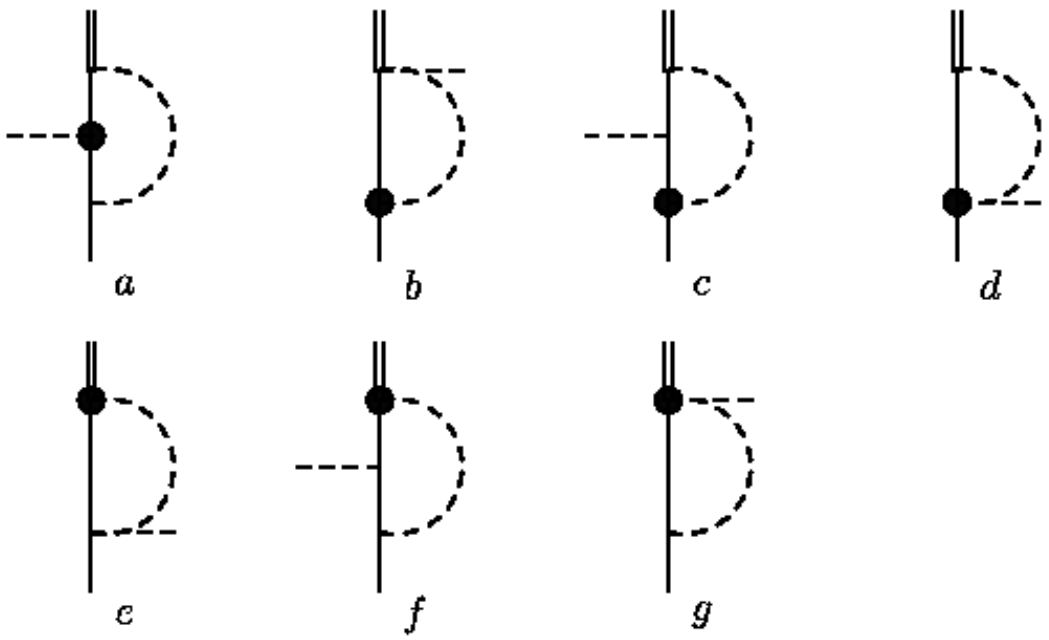

1
0.75
0.5
0.25
0
−0.25
−0.5
−0.75
−1
0
0.1
0.2
0.3
0.4
0.5
$R^{\Lambda}_{A}(|q^2|)$
$|q^2|$ (GeV^2)

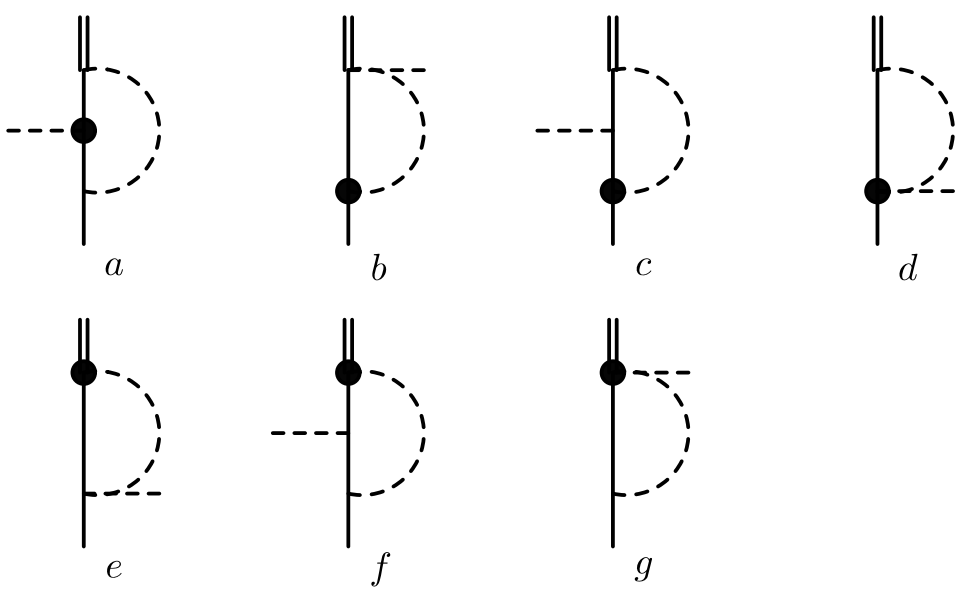

0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
−0.02
r_i
Upper bound
Lower bound
0
0.1
0.2
0.3
0.4
0.5
$|q^2|$ (GeV^2)


0.30
0.25
0.20
0.15
0.10
0.05
0.00
r_i
0
0.1
0.2
0.3
0.4
0.5
$|q^2|$ (GeV^2)


0.00e+00
−1.00e−06
−2.00e−06
−3.00e−06
−4.00e−06
−5.00e−06
−6.00e−06
−7.00e−06
−8.00e−06
0
0.1
0.2
0.3
0.4
0.5
$A_{LR}(|q^2|)$
$|q^2|$ (GeV^2)


0.00e+00
−1.25e−06
−2.50e−06
−3.75e−06
−5.00e−06
−6.25e−06
−7.50e−06
−8.75e−06
−1.00e−05
−1.13e−05
−1.25e−05
−1.38e−05
−1.50e−05
−1.63e−05
−1.75e−05
−1.88e−05
−2.00e−05
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
$A_{LR}(|q^2|)$
$|q^2|$ (GeV^2)


a
b
c
d
e
f
g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b
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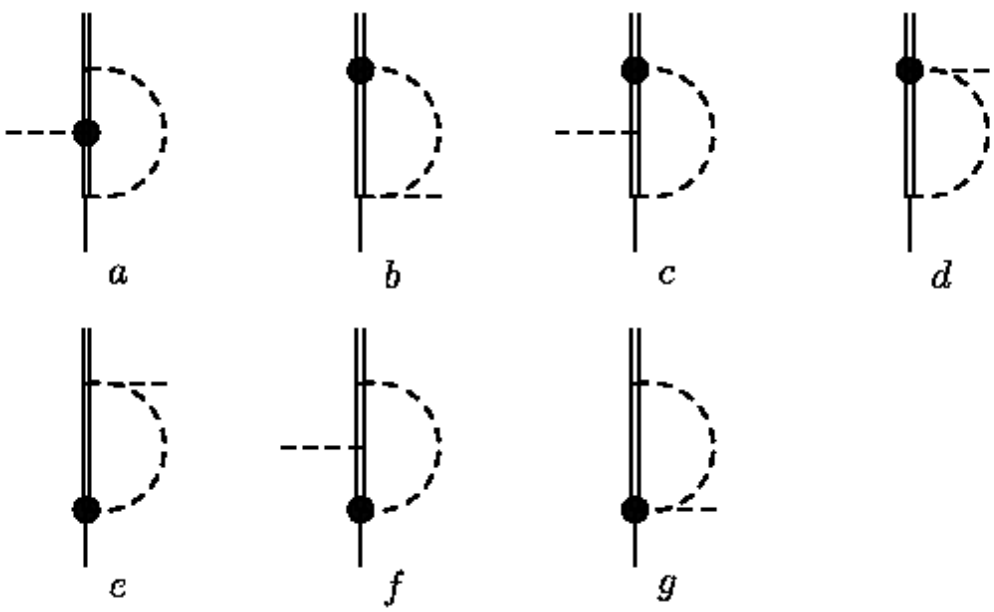
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b
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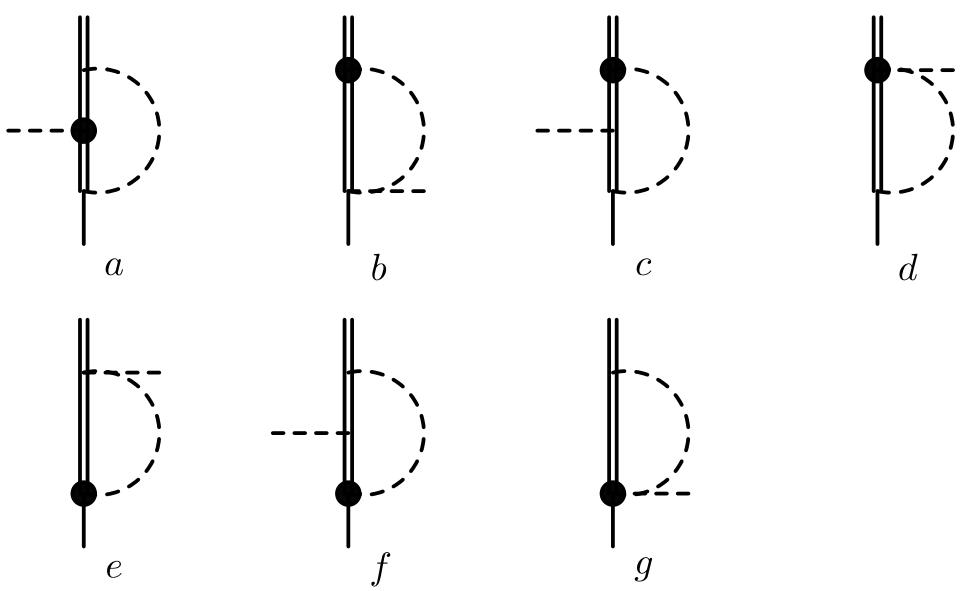
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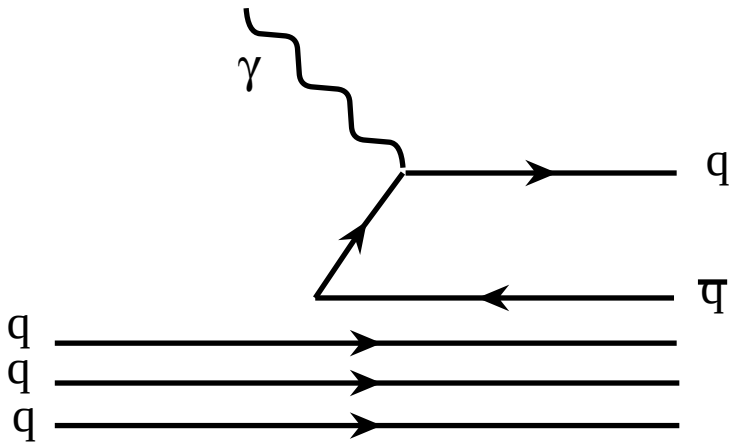
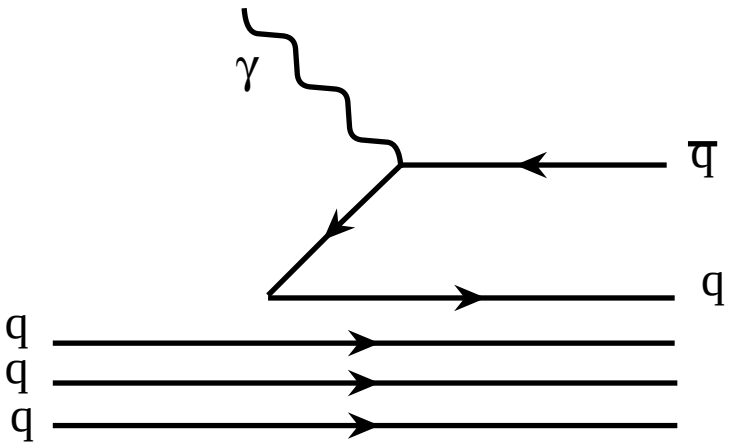
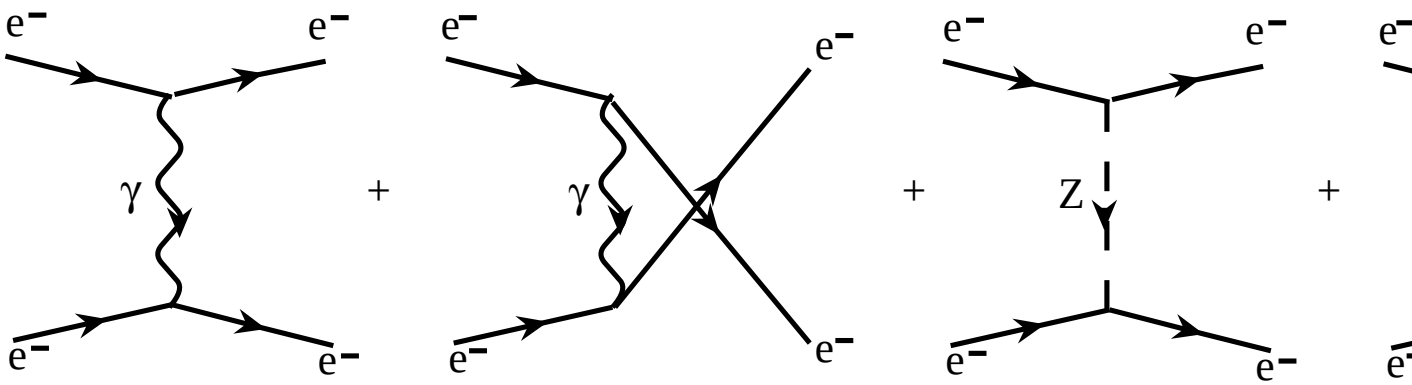
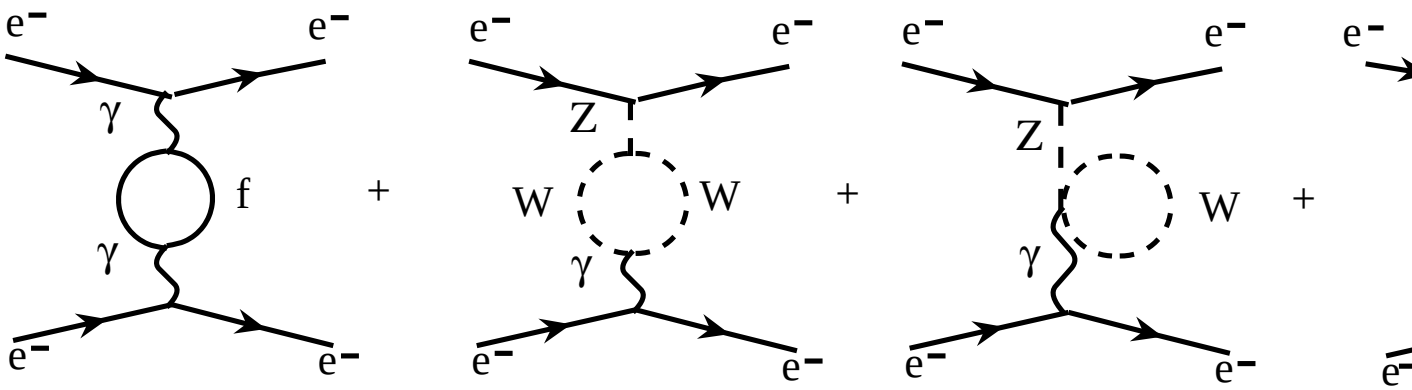
e
f
g


γ
q
q̄
q
q
q


γ
q̄
q
q
q
q


e⁻
e⁻
γ
e⁻
e⁻
+
e⁻
e⁻
γ
e⁻
e⁻
+
e⁻
e⁻
Z
e⁻
e⁻
+
e⁻
e⁻


e⁻
e⁻
γ
f
γ
e⁻
e⁻
+
e⁻
e⁻
Z
W
W
γ
e⁻
e⁻
+
e⁻
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Z
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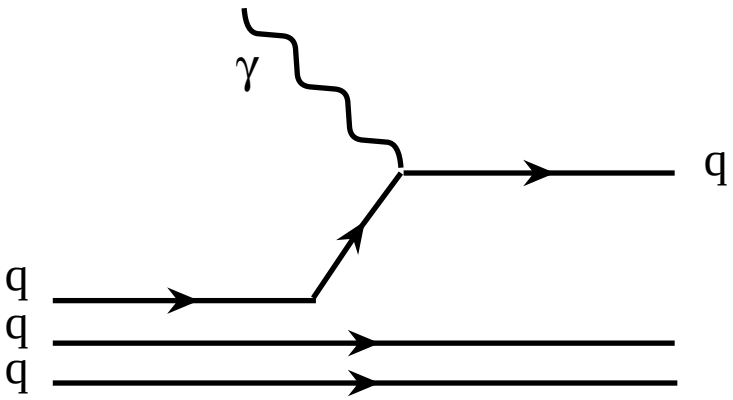
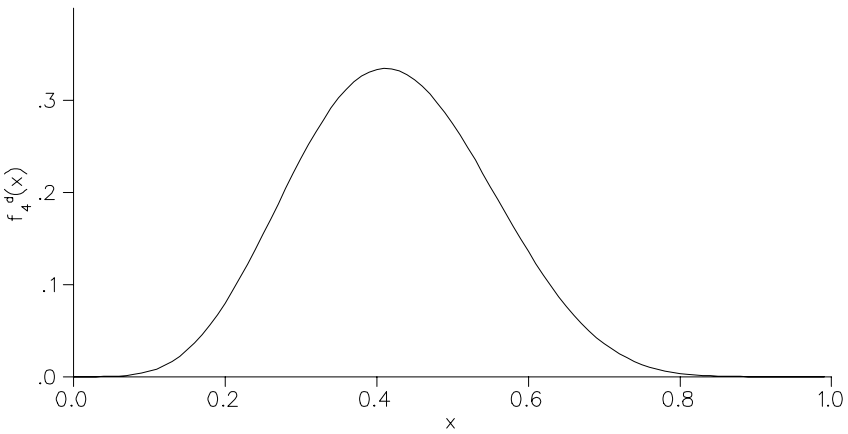
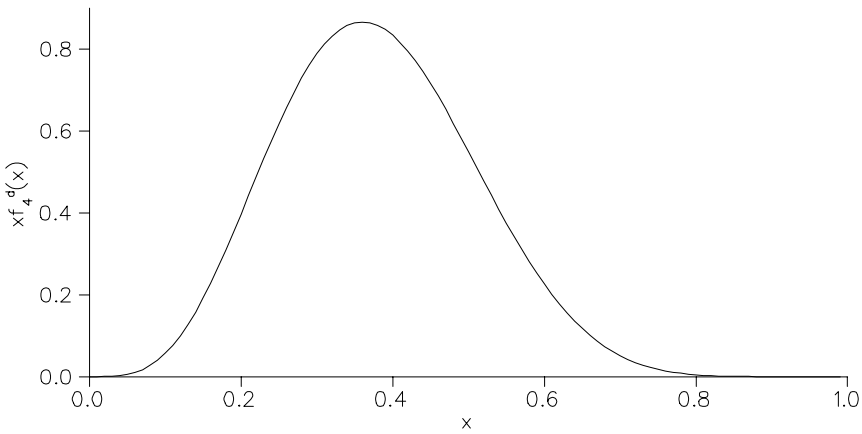
γ
e⁻
e⁻
+
e⁻
e⁻


γ
q
q
q
q


.3
.2
.1
.0
$f_4^d(x)$
0.0
0.2
0.4
0.6
0.8
1.0
x


0.8
0.6
0.4
0.2
0.0
$xf_4^d(x)$
0.0
0.2
0.4
0.6
0.8
1.0
x