Light-by-light contribution of pseudoscalar and scalar mesons to (g-2) of the muon.

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5 October 2010
XX International Baldin Seminar

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Plan

1. Motivation
2. Pseudoscalar meson contribution
3. Scalar mesons contribution
4. Conclusions

Motivation

1. Anomalous magnetic momentum of muon $a_\mu = (g-2)_\mu$ is measured in experiment E821(BNL) with high precision

$$a_\mu^{\text{exp}} = 11\,659\,208.0(6.3) \cdot 10^{-10}.$$

Prediction of Standard Model

$$a_\mu^{\text{theory}} = 11\,659\,179.0(6.5) \cdot 10^{-10}.$$

2. Difference between experiment and prediction of Standard Model is 3 standard deviation

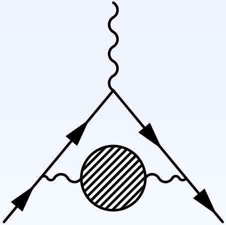
$$a_\mu^{\text{exp}} - a_\mu^{\text{theory}} = 29.0(9.0) \cdot 10^{-10}.$$

3. The main theoretical error in a_μ^{theory} is due to strong interaction (~ 97 %).

Anomalous magnetic momentum. Hadron polarization of vacuum

4. Contribution of strong interactions can be divided into two parts

- contribution of hadronic polarization of vacuum (which can be extracted from experimental data for process $e^+e^- \to$ in hadrons)



Value of contribution of hadronic polarization of vacuum estimated as:

$$a_\mu^{\mathrm{Had,LO}} = 690.9(4.4) \cdot 10^{-10}.$$

- light-by-light process

Lagrangian

The Lagrangian of the nonlocal model has the form

$$\mathcal{L} = \mathcal{L}_{free} + \mathcal{L}_{4q} + \mathcal{L}_{tH}$$

$$\mathcal{L}_{free} = \bar{q}(x)(i\hat{\partial} - m_c)q(x)$$

m_c is a current quark mass matrix with diagonal elements $m_c^u = m_c^d$, m_c^s.

$$\mathcal{L}_{4q} = \frac{G}{2}[J_S^a(x)J_S^a(x) + J_P^a(x)J_P^a(x)]$$

nonlocal quark currents are

$$J_M^a(x) = \int d^4(x_1x_2)\, f(x_1)f(x_2)\, \bar{q}(x - x_1)\, \Gamma_M q(x + x_2),$$

$$\Gamma_S = \lambda^a, \Gamma_P = i\gamma^5\lambda^a$$

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$$\mathcal{L}_{tH} = H[\mathrm{det}\bar{q}(1+\gamma_5)q + \mathrm{det}\bar{q}(1-\gamma_5)q]$$

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$$\mathcal{L}_{4q} = \frac{G}{2}[J_S^a(x)J_S^a(x) + J_P^a(x)J_P^a(x)]$$

$$\mathcal{L}_{tH} = -\frac{H}{4}T_{abc}[J_S^a(x)J_S^b(x)J_S^c(x) - 3J_P^a(x)J_P^b(x)J_P^c(x)]$$

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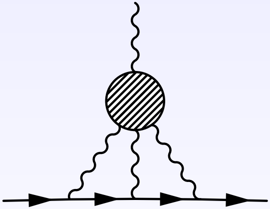
Anomalous magnetic momentum. Light-by-light.

Diagram of the light-by-light scattering process



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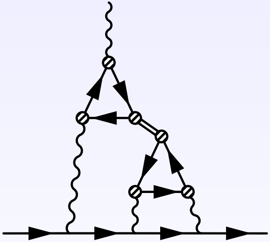
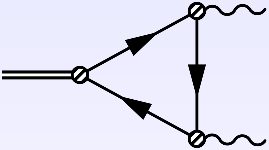


Form-factor $\pi^0\gamma\gamma$



$$A\left(\gamma^*\left(q_1,\epsilon_1\right)\gamma^*\left(q_2,\epsilon_2\right)\to\pi^0\left(q_3\right)\right) = -ie^2\varepsilon_{\mu\nu\rho\sigma}\epsilon_1^\mu\epsilon_2^\nu q_1^\rho q_2^\sigma\mathcal{F}_{\pi_0^*\gamma^*\gamma^*}(q_3^2;q_1^2,q_2^2),$$

where q_1 and q_2 – photon momentum, q_3 – neutral pion momentum. $\mathcal{F}_{\pi_0^*\gamma^*\gamma^*}(q_3^2;q_1^2,q_2^2)$ – form-factor of the decay of π^0 into two γ. In the chiral limit $m_c\to 0$ the form-factor is normalized to the chiral anomaly

$$\mathcal{F}_{\pi^0\gamma\gamma}\left(0;0,0\right) = \frac{N_c}{12\pi^2F_\pi}.$$

Pseudoscalar and scalar contributions

Estimations for light-by-light contribution

$a_\mu^{\mathrm{LbL}} \cdot 10^{-10}$	π^0	π^0, η, η'	$\sigma, a_0(980), f_0(980)$
HK	$+5.6$	$+8.27(0.64)$	
BPP	$+5.8(1.0)$	$+8.5(1.3)$	$-0.68(0.2)$
KN	$+5.8(1.0)$	$+8.3(1.2)$	
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BBDDKZ	$+8.18(1.65)$	$+9.5(1.94)$	$1.23(0.24)$
DB	$+6.5(0.2)$		
FGW	$+5.75(0.69)$	$+8.43(1.28)$	
This work	$+5.0(0.3)$	$+6.0(0.6)$	$0.43(0.1)$

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Conclusions

1. Light-by-light contribution to the anomalous magnetic moment of muon from diagrams with lightest pseudoscalar and scalar mesons is calculated.
2. Full kinematic dependence is taken into account.
3. It seems that full kinematic dependence of meson in two photon form-factors leads to lowering of mesonic contribution.

Future

Calculation quark diagram is planed.