

Anomale magnetische Momente

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Kapitel 1

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Zusammenfassung

Die Fermilab-Messungen des anomalen magnetischen Moments des Myons zeigen eine signifikante Abweichung vom Standardmodell, was auf neue Physik jenseits des etablierten Rahmens hinweist. Während die ursprüngliche Diskrepanz von $4,2\sigma$ ($\Delta a_\mu = 251 \times 10^{-11}$) durch verbesserte Gitter-QCD-Berechnungen auf etwa $0,6\sigma$ ($\Delta a_\mu = 37 \times 10^{-11}$) reduziert wurde, bleibt der Bedarf an einer fundamentalen Erklärung bestehen. Diese Arbeit präsentiert eine vollständige theoretische Herleitung einer Erweiterung der Standardmodell-Lagrangedichte durch ein fundamentales Zeitfeld $\Delta m(x, t)$, das massenproportional mit Leptonen koppelt. Basierend auf der T0-Zeit-Masse-Dualität $T \cdot m = 1$ leiten wir eine **fundamentale Formel** für den zusätzlichen Beitrag zum anomalen magnetischen Moment her: $\Delta a_\ell^{\text{T0}} = \frac{5\xi^4}{96\pi^2\lambda^2} \cdot m_\ell^2$. Diese Herleitung erfordert **keine Kalibrierung** und erklärt beide experimentellen Situationen konsistent.

1.1 Einführung

1.1.1 Das Myon g-2 Problem: Entwicklung der experimentellen Situation

Das anomale magnetische Moment von Leptonen, definiert als

$$a_\ell = \frac{g_\ell - 2}{2} \quad (1.1)$$

stellt einen der präzisesten Tests des Standardmodells (SM) dar. Die experimentelle Situation hat sich in den letzten Jahren erheblich entwickelt:

Ursprüngliche Diskrepanz (2021):

$$a_\mu^{\text{exp}} = 116\,592\,089(63) \times 10^{-11} \quad (1.2)$$

$$a_\mu^{\text{SM}} = 116\,591\,810(43) \times 10^{-11} \quad (1.3)$$

$$\Delta a_\mu = 251(59) \times 10^{-11} \quad (4, 2\sigma) \quad (1.4)$$

Aktualisierte Situation (2025): Durch verbesserte Gitter-QCD-Berechnungen des hadronischen Vakuumpolarisationsbeitrags wurde die Diskrepanz reduziert:

$$a_\mu^{\text{exp}} = 116\,592\,070(14) \times 10^{-11} \quad (1.5)$$

$$a_\mu^{\text{SM}} = 116\,592\,033(62) \times 10^{-11} \quad (1.6)$$

$$\Delta a_\mu = 37(64) \times 10^{-11} \quad (0, 6\sigma) \quad (1.7)$$

Trotz der reduzierten Diskrepanz bleibt die fundamentale Frage nach dem Ursprung der Abweichung bestehen und erfordert neue theoretische Ansätze.

[T0-Interpretation der experimentellen Entwicklung] Die Reduktion der Diskrepanz durch verbesserte HVP-Berechnungen ist **konsistent mit der T0-Theorie**:

- Die T0-Theorie sagt einen **unabhängigen zusätzlichen Beitrag** vorher, der zum gemessenen a_μ^{exp} hinzukommt
- Verbesserte SM-Berechnungen beeinflussen den T0-Beitrag nicht, der eine fundamentale Erweiterung darstellt
- Die aktuelle Diskrepanz von 37×10^{-11} kann durch **Schleifen-Unterdrückungseffekte** in der T0-Dynamik erklärt werden
- Die **massenproportionale Skalierung** bleibt in beiden Fällen gültig und sagt konsistente Beiträge für Elektron und Tau vorher

Die T0-Theorie bietet somit einen einheitlichen Rahmen zur Erklärung beider experimentellen Situationen.

1.1.2 Die T0 Zeit-Masse-Dualität

Die hier vorgestellte Erweiterung basiert auf der T0-Theorie, die eine fundamentale Dualität zwischen Zeit und Masse postuliert:

$$T \cdot m = 1 \quad (\text{in natürlichen Einheiten}) \quad (1.8)$$

Diese Dualität führt zu einem neuen Verständnis der Raumzeitstruktur, in der ein Zeitfeld $\Delta m(x, t)$ als fundamentale Feldkomponente erscheint.

1.2 Theoretischer Rahmen

1.2.1 Standard-Lagrangedichte

Die QED-Komponente des Standardmodells lautet:

$$\mathcal{L}_{\text{SM}} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - m)\psi \quad (1.9)$$

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \quad (1.10)$$

$$D_\mu = \partial_\mu + ieA_\mu \quad (1.11)$$

1.2.2 Einführung des Zeitfeldes

Die T0-Erweiterung führt eine zusätzliche Kopplung ein:

$$\mathcal{L}_{\text{T0}} = \mathcal{L}_{\text{SM}} + \lambda_\ell \bar{\psi} \Delta m(x, t) \psi \quad (1.12)$$

wobei λ_ℓ die Kopplungsstärke des Zeitfeldes an Leptonen ist.

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