Lorentz and CPT Violation in Muon g-2 Experiments

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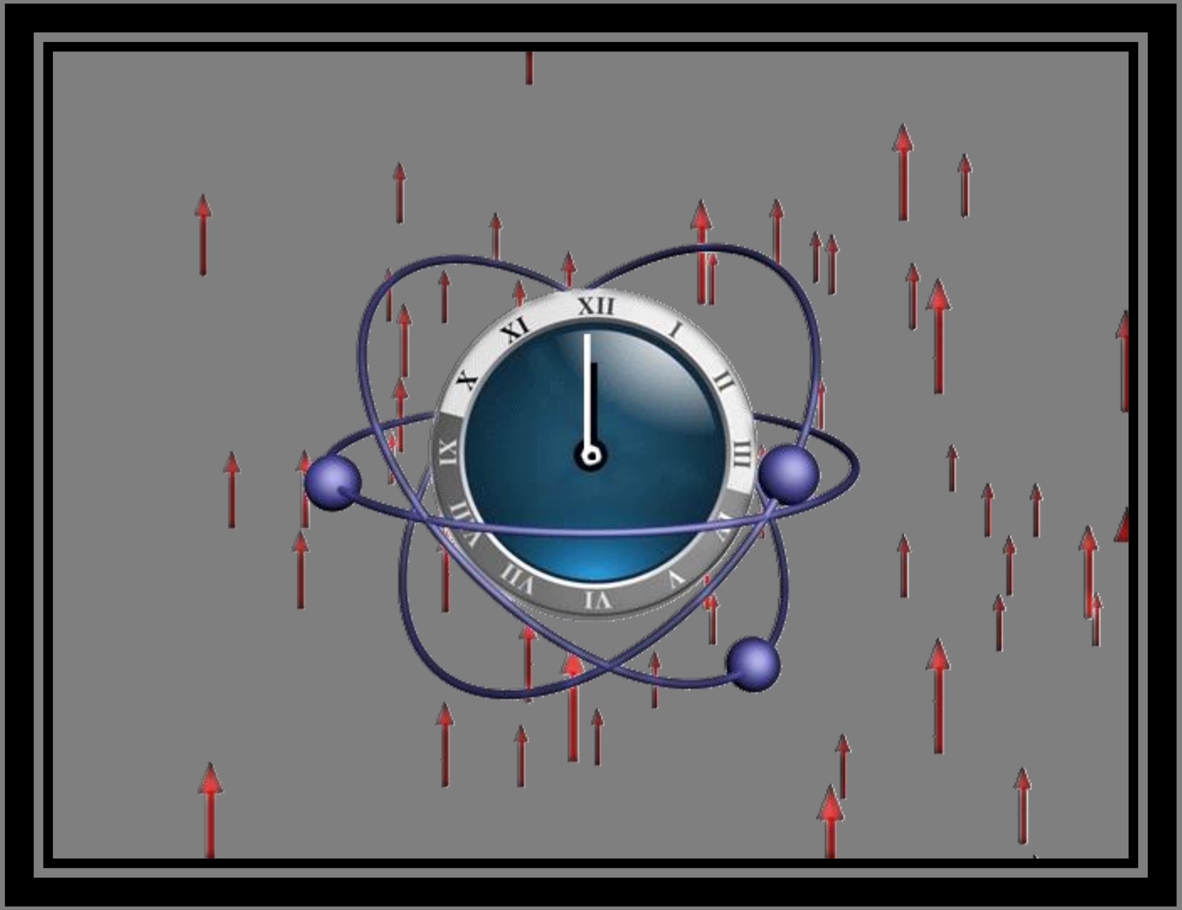
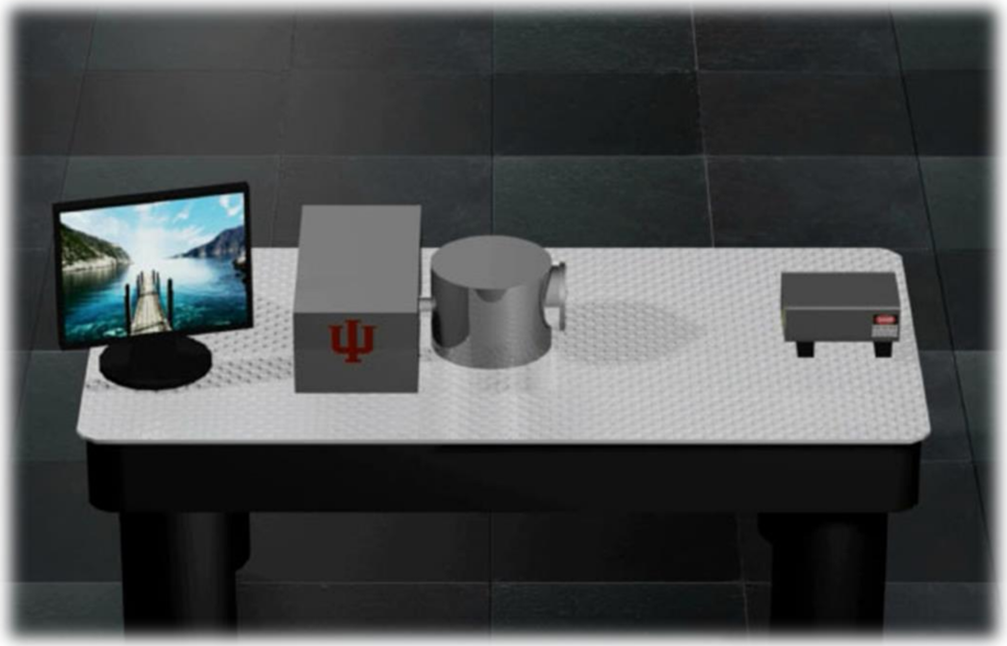
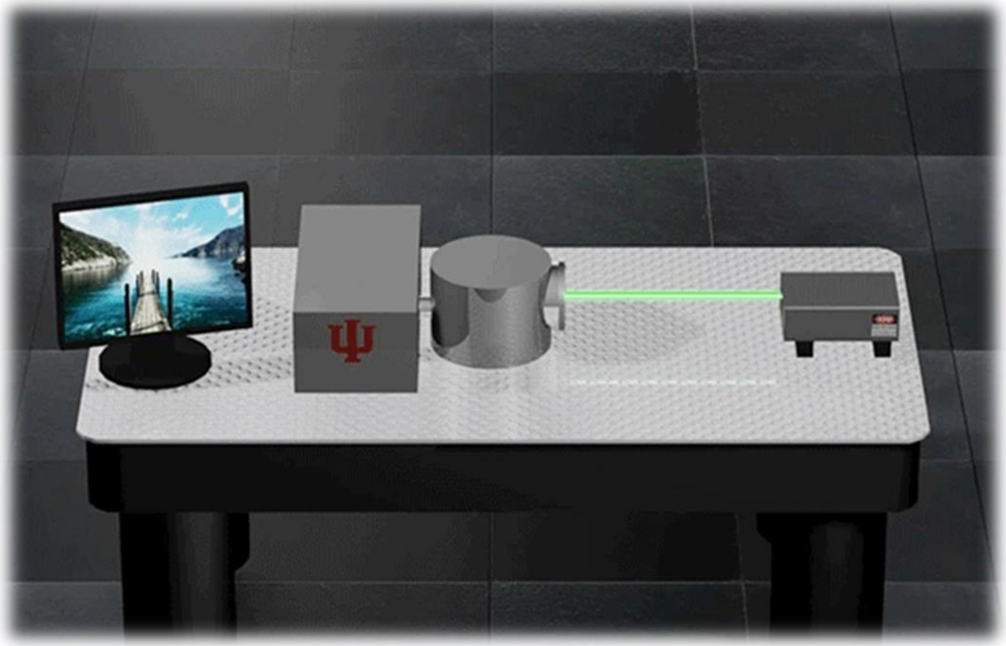




Lorentz symmetry

Experimental results are independent of the overall orientation and velocity of the experiment



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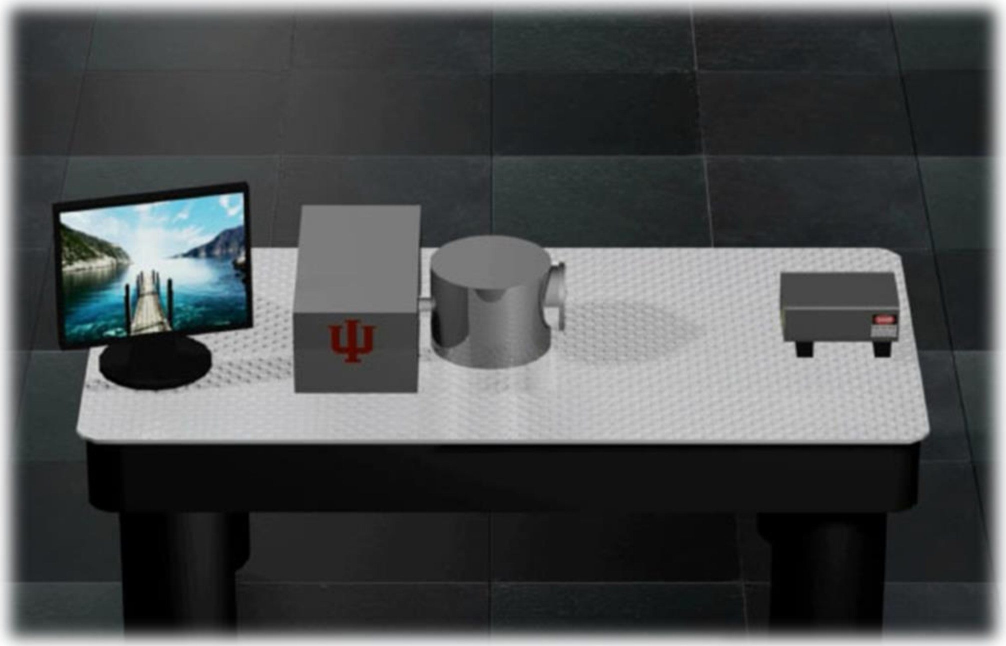

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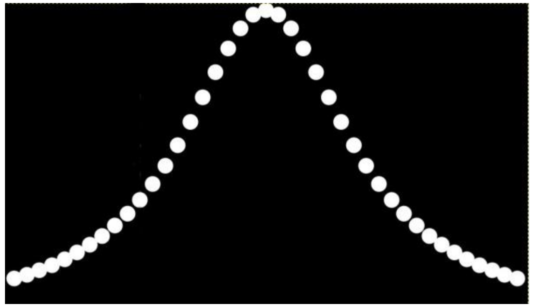
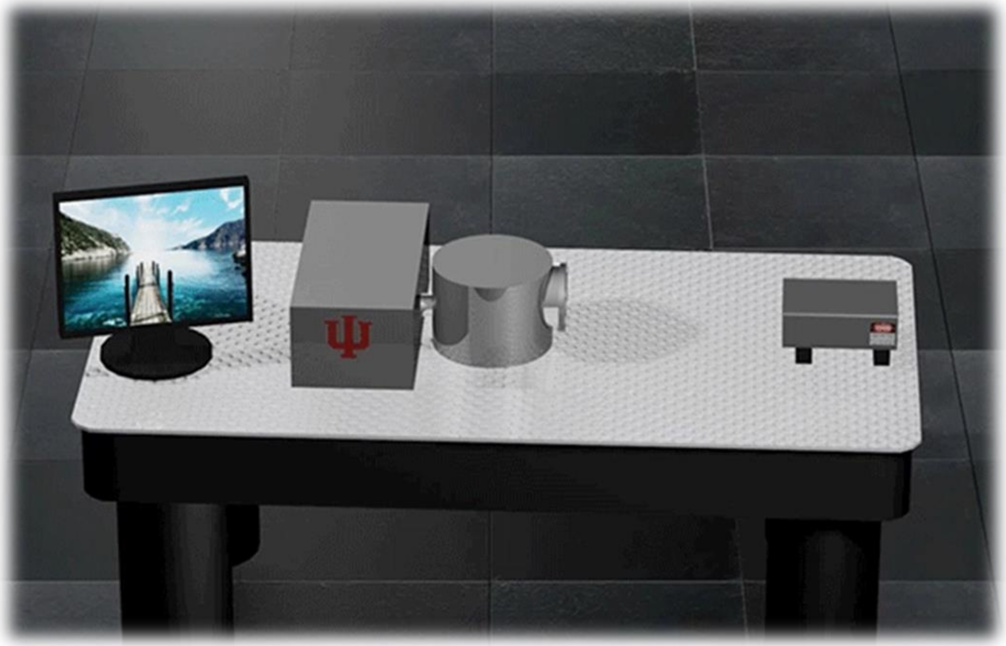
Original inertial reference frame



Lorentz symmetry



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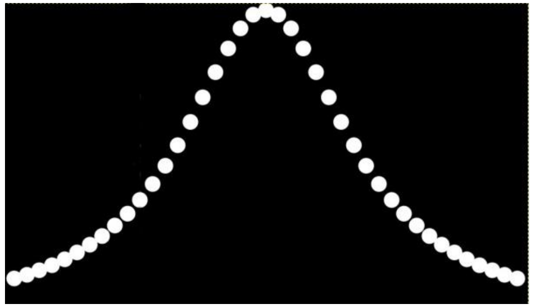

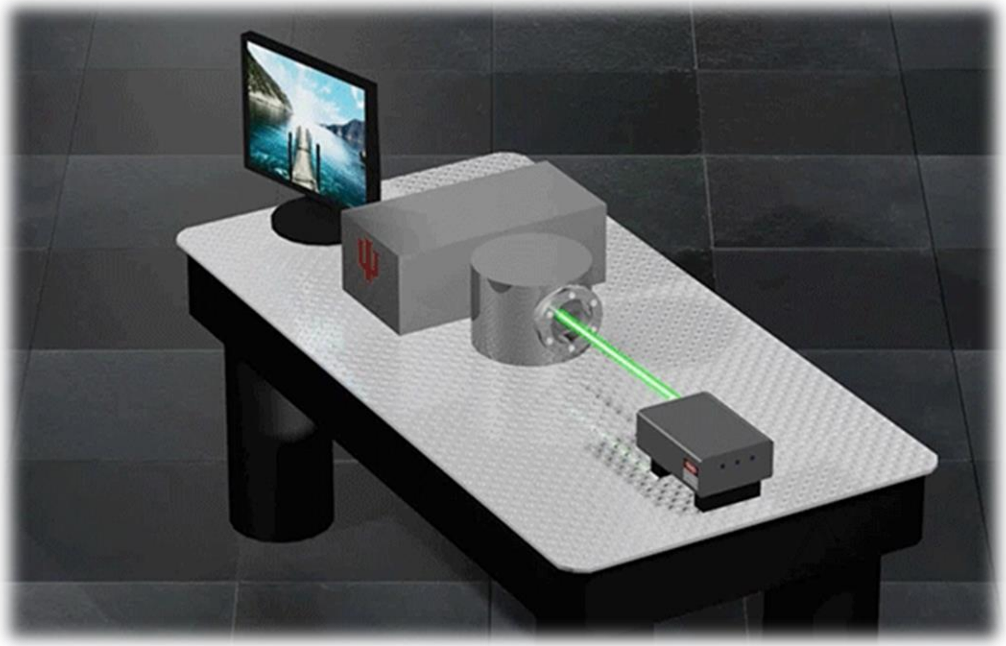

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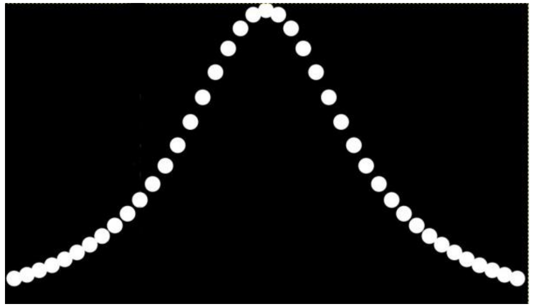

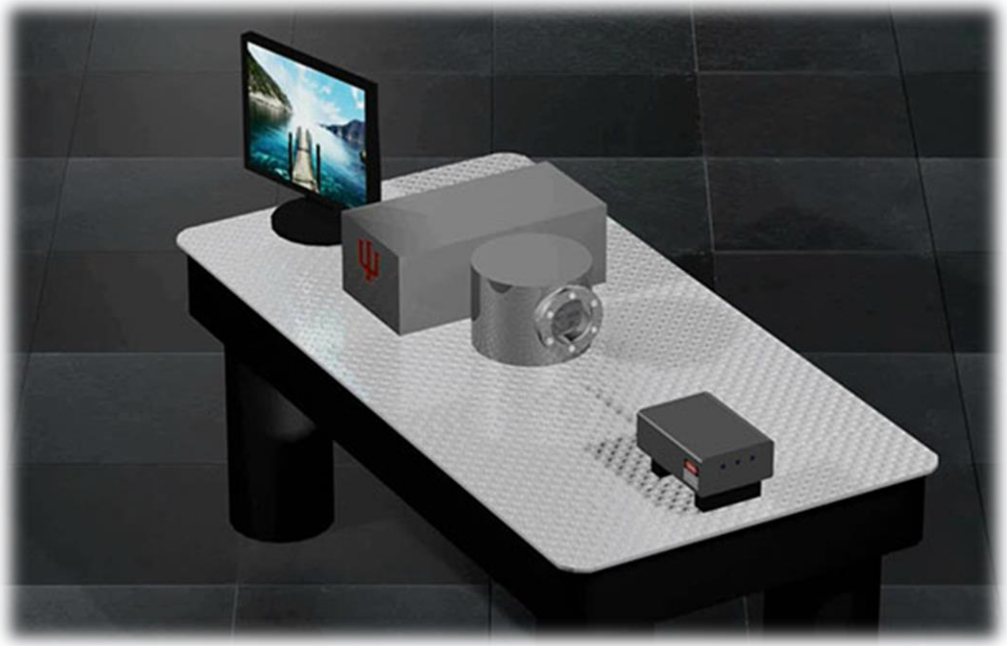

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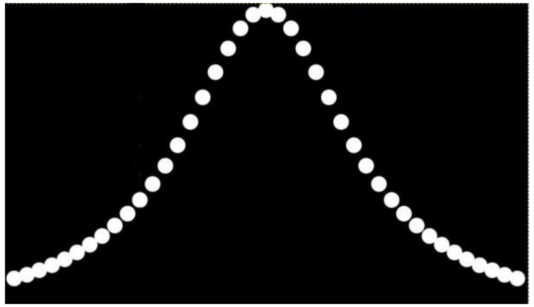

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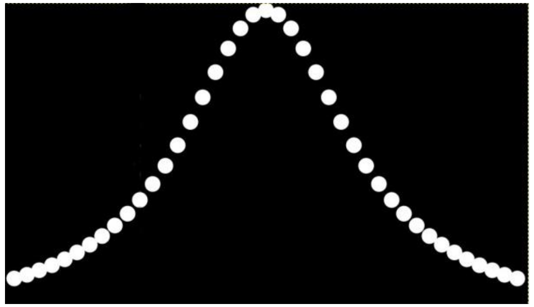
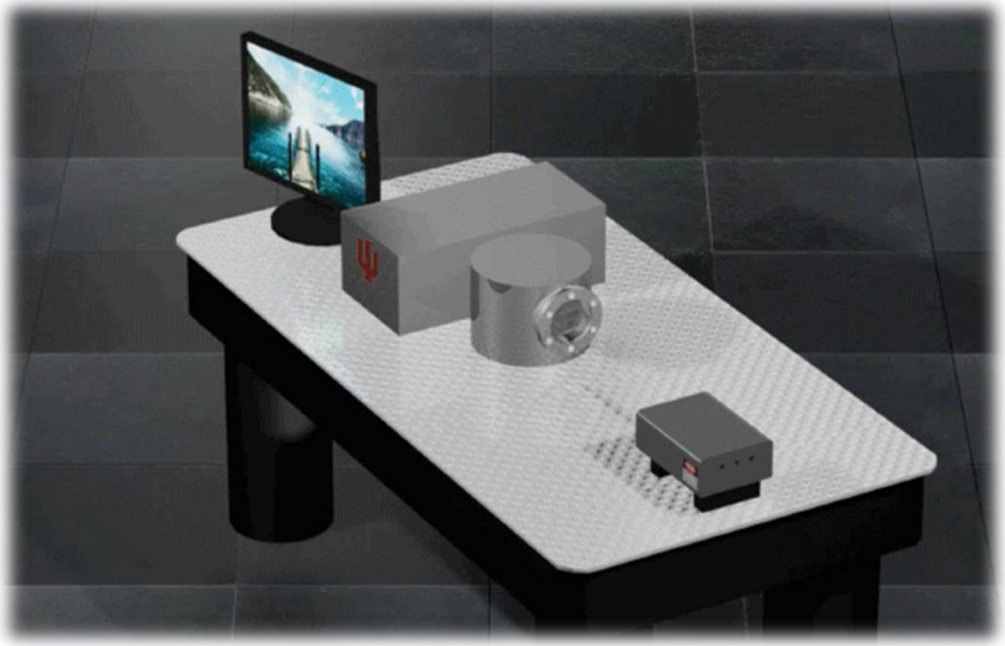
Rotated reference frame





Lorentz symmetry

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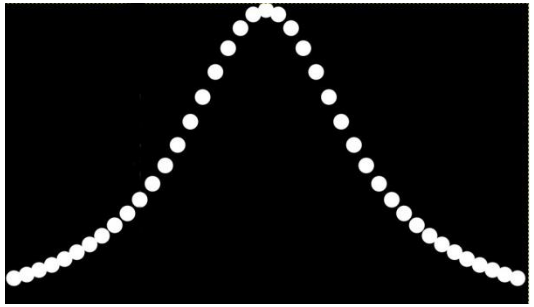

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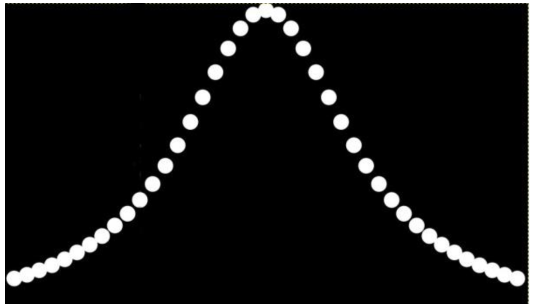
Rotated reference frame



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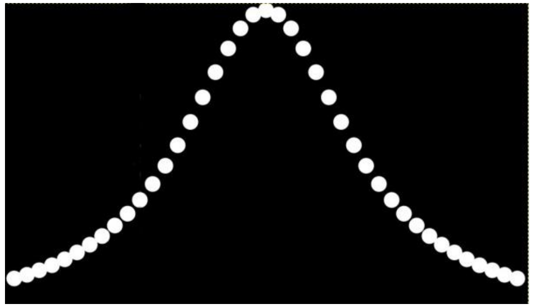
Boosted reference frame



The SME Lagrangian

Colladay and Kostelecký, PRD **55**, 6760 (1997)
Colladay and Kostelecký, PRD **58**, 116002 (1998)
Kostelecký, PRD **69**, 105009 (2004)

$$\mathcal{L}_{SME} = \mathcal{L}_{SM} + \mathcal{L}_{GR} + \mathcal{L}_{LV}$$

Lorentz violation

Conventional physics

Facilitates the systematic test of Lorentz and CPT symmetry

- ❖ Models for Lorentz violation applicable to diverse physical scenarios
- ❖ Compare and classify tests of Lorentz symmetry
- ❖ Predicts signals for Lorentz and CPT violation

Lorentz violation can be represented as constant uniform background fields that permeate Minkowski spacetime

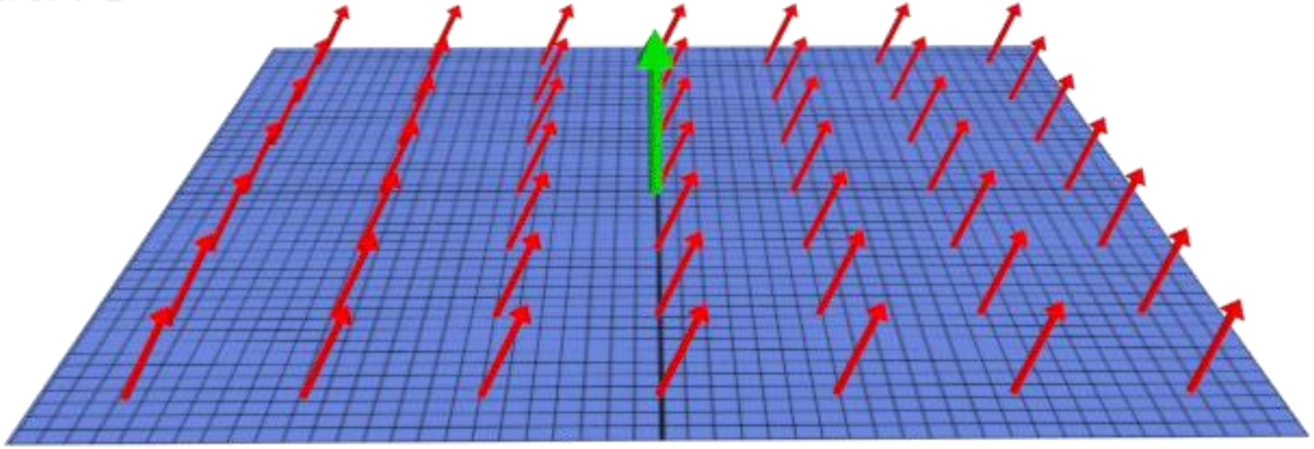
$$\mathcal{L} \supset \boldsymbol{k}^{\mu} \mathcal{O}_{\mu}(x)$$

$\boldsymbol{k}^{\mu}$ Lorentz-violating background field

$\mathcal{O}^{\mu}$ field operator

Lorentz violation happens when the experimental results depend on the spacetime orientation of the laboratory frame

Velocity of the laboratory frame relative to fixed inertial reference frame



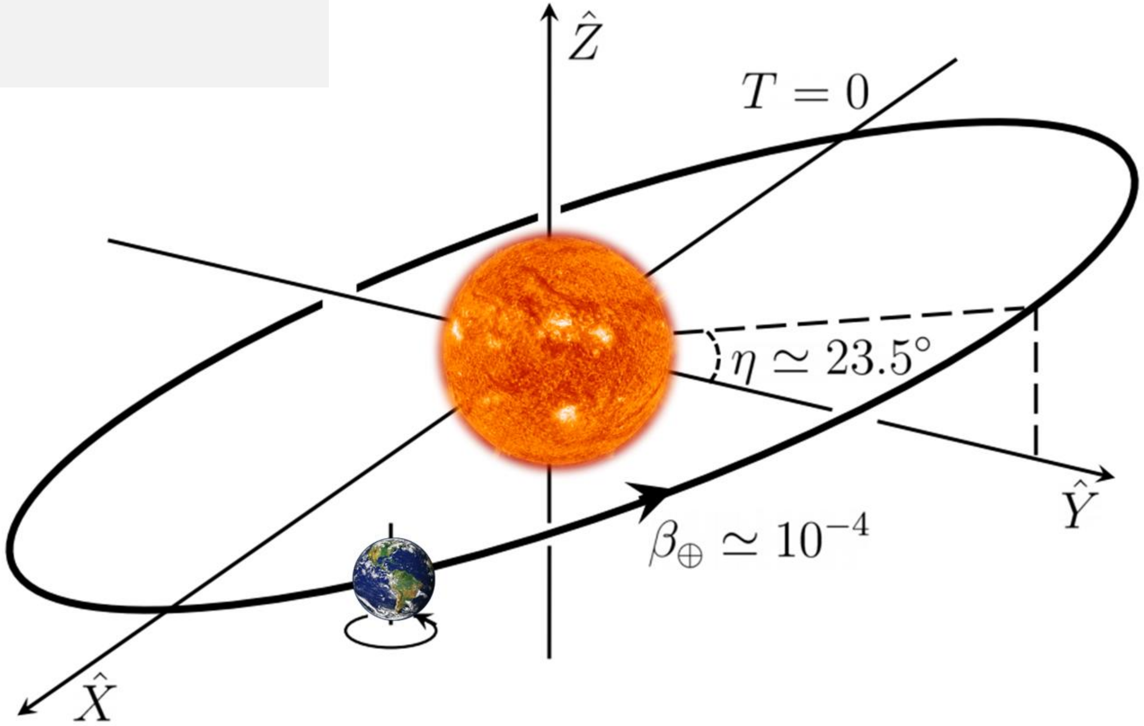
fixed inertial reference frame

The components $\boldsymbol{k}^{\mu}$ of the background field are called the coefficients for Lorentz violation or SME coefficients

The coefficients for Lorentz-violation transform under coordinate transformations, therefore it is important to report all the results in the same reference frame

$$\mathcal{L} \supset \boldsymbol{k}^{\mu} \mathcal{O}_{\mu}(x)$$

The reference frame used is the Sun-centered frame (SCF)



Kostelecký and Russell, arXiv:0801.0287v7

The Standard-Model Extension (SME) Lagrangian

$$\mathcal{L}_{SME} = \mathcal{L}_{SM} + \mathcal{L}_{GR} + \mathcal{L}_{LV}$$

$$\mathcal{L}_{LV} \supset \mathcal{O}^{\mu_1 \ldots \mu_n} \boldsymbol{k}_{\mu_1 \ldots \mu_n}$$

The components $\boldsymbol{k}_{\mu_1 \ldots \mu_n}$ are called coefficients for Lorentz violation

The field operator $\mathcal{O}^{\mu_1 \ldots \mu_n}$ represents standard field operators

Example of a Lorentz-violating term

$$\bar{\psi}_f \gamma_\alpha \psi_f \mathcal{V}_f^\alpha$$

$\psi_f(x)$ is a fermionic field and f labels the flavor of the field

Electron Sector

Combination	Result
$\mathring{a}^{\mathrm{UR}(5)}$	$< 6.5 \times 10^{-27}$ GeV^{-1}
"	$> -3.5 \times 10^{-27}$ GeV^{-1}
$\mathring{a}^{\mathrm{UR}(5)} - m\mathring{g}^{\mathrm{UR}(6)}$	$(-1 \text{ to } 1) \times 10^{-34}$ GeV^{-1}
$\mathring{a}^{\mathrm{UR}(5)} \pm m\mathring{g}^{\mathrm{UR}(6)}$	$(-4 \text{ to } 4) \times 10^{-25}$ GeV^{-1}
$\mathring{a}^{\mathrm{UR}(5)}$	$(-0.001 \text{ to } 2.8) \times 10^{-17}$ GeV^{-1}
$\mathring{c}^{\mathrm{UR}(6)}$	$(-8.5 \text{ to } 0.0025) \times 10^{-20}$ GeV^{-2}
$\mathring{g}^{\mathrm{UR}(6)}$	$(-5.4 \text{ to } 5.4) \times 10^{-14}$ GeV^{-2}

Combination	Result
$\tilde{b}_X$	$(-0.9 \pm 1.4) \times 10^{-31}$ GeV
$\tilde{b}_Y$	$(-0.9 \pm 1.4) \times 10^{-31}$ GeV
$\tilde{b}_Z$	$(-0.3 \pm 4.4) \times 10^{-30}$ GeV
$\frac{1}{2}(\tilde{b}_T + \tilde{d}_- - 2\tilde{g}_c - 3\tilde{g}_T + 4\tilde{d}_+ - \tilde{d}_Q)$	$(0.9 \pm 2.2) \times 10^{-27}$ GeV
$\frac{1}{2}(2\tilde{g}_c - \tilde{g}_T - \tilde{b}_T + 4\tilde{d}_+ - \tilde{d}_- - \tilde{d}_Q)$ $+\tan\eta(\tilde{d}_{YZ} - \tilde{H}_{XT})$	$(-0.8 \pm 2.0) \times 10^{-27}$ GeV
$\tilde{b}_X$	$(2.8 \pm 6.1) \times 10^{-29}$ GeV
$\tilde{b}_Y$	$(6.8 \pm 6.1) \times 10^{-29}$ GeV
$\tilde{b}_X$	$(0.1 \pm 2.4) \times 10^{-31}$ GeV
$\tilde{b}_Y$	$(-1.7 \pm 2.5) \times 10^{-31}$ GeV
$\tilde{b}_Z$	$(-29 \pm 39) \times 10^{-31}$ GeV
$\tilde{b}_\perp$	$< 3.1 \times 10^{-29}$ GeV
$\lvert\tilde{b}_Z\rvert$	$< 7.1 \times 10^{-28}$ GeV
r_e	$< 3.2 \times 10^{-24}$
$\lvert\vec{b}\rvert$	< 50 radians/s
$r_{\omega_a^-,\mathrm{diurnal}}$	$< 1.6 \times 10^{-21}$
$\lvert\tilde{b}_J\rvert,\ (J = X, Y)$	$< 10^{-27}$ GeV
$\lvert\tilde{b}^*_J\rvert,\ (J = X, Y, Z)$	$< 10^{-22}$ GeV

Combination	Result
$\mathring{c}^{\mathrm{UR}(4)}$	$< 1.5 \times 10^{-15}$
"	$> -5 \times 10^{-13}$
"	$(-1.3 \text{ to } 0.2) \times 10^{-15}$
"	$> -1.2 \times 10^{-16}$
"	$> -6 \times 10^{-20}$
$c_{(TX)}$	$(3.1 \pm 1.9) \times 10^{-11}$
$0.92c_{(TY)} + 0.40c_{(TZ)}$	$(2.6 \pm 5.3) \times 10^{-11}$
c_{TT}	$> -5 \times 10^{-21}$
$0.10c_{X-Y} - 0.99c_{XZ}$	$(-9.0 \pm 11) \times 10^{-17}$
$0.99c_{X-Y} + 0.10c_{XZ}$	$(3.8 \pm 5.6) \times 10^{-17}$
$0.94c_{XY} - 0.35c_{YZ}$	$(-0.4 \pm 2.8) \times 10^{-17}$
$0.35c_{XY} + 0.94c_{YZ}$	$(3.2 \pm 7.0) \times 10^{-17}$
$0.18c_{TX} - 0.98c_{T(Y+Z)}$	$(0.95 \pm 18) \times 10^{-15}$
$0.98c_{TX} + 0.18c_{T(Y+Z)}$	$(5.6 \pm 7.7) \times 10^{-15}$
$c_{T(Y-Z)}$	$(-21 \pm 19) \times 10^{-13}$
c_{TT}	$(-8.8 \pm 5.1) \times 10^{-9}$
"	$(-14 \pm 28) \times 10^{-9}$
$\bar{c}_{TT}$	$(-0.014 \pm 0.028) \times 10^{-6}$
"	$(4.6 \pm 4.6) \times 10^{-6}$
c_{TT}	$(-4 \text{ to } 2) \times 10^{-15}$
$c_{(TX)}$	$(-30 \text{ to } 1) \times 10^{-14}$
$c_{(TY)}$	$(-80 \text{ to } 6) \times 10^{-15}$
$c_{(TZ)}$	$(-11 \text{ to } 1.3) \times 10^{-13}$
$0.83c_{(TX)} + 0.51c_{(TY)} + 0.22c_{(TZ)}$	$(4 \pm 8) \times 10^{-11}$
$c_{XX} - c_{YY}$	$(-2.9 \pm 6.3) \times 10^{-16}$
$\frac{1}{2}c_{(XY)}$	$(2.1 \pm 0.9) \times 10^{-16}$
$\frac{1}{2}c_{(XZ)}$	$(-1.5 \pm 0.9) \times 10^{-16}$
$\frac{1}{2}c_{(YZ)}$	$(-0.5 \pm 1.2) \times 10^{-16}$
$c_{XX} + c_{YY} - 2c_{ZZ}$	$(-106 \pm 147) \times 10^{-16}$
λ^{ZZ}	$(13.3 \pm 9.8) \times 10^{-16}$

Combination	Result
$\frac{1}{2}c_{(YZ)}$	$(2.1 \pm 4.6) \times 10^{-16}$
$\frac{1}{2}c_{(XZ)}$	$(-1.6 \pm 6.3) \times 10^{-16}$
$\frac{1}{2}c_{(XY)}$	$(7.6 \pm 3.5) \times 10^{-16}$
$c_{XX} - c_{YY}$	$(1.15 \pm 0.64) \times 10^{-15}$
$\lvert c_{XX} + c_{YY} - 2c_{ZZ} - 0.25(\tilde{\kappa}_{e-})^{ZZ}\rvert$	$< 10^{-12}$
$\lvert\frac{1}{2}c_{(XY)}\rvert$	$< 8 \times 10^{-15}$
$\lvert c_{XX} - c_{YY}\rvert$	$< 1.6 \times 10^{-14}$
$\lvert c_{XX} + c_{YY} - 2c_{ZZ}\rvert$	$< 10^{-5}$
$\lvert c_{TJ} + c_{JT}\rvert,\ (J = X, Y, Z)$	$< 10^{-2}$
c_{XX}	$(-3 \text{ to } 5) \times 10^{-15}$
c_{YY}	$(-0.7 \text{ to } 2.5) \times 10^{-15}$
c_{ZZ}	$(-1.6 \text{ to } 2.5) \times 10^{-15}$
$c_{(YZ)}$	$(-2.5 \text{ to } 1.8) \times 10^{-15}$
c_{0X}	$(-7 \text{ to } 4) \times 10^{-15}$
c_{0Y}	$(-0.5 \text{ to } 1.5) \times 10^{-15}$
c_{0Z}	$(-4 \text{ to } 2) \times 10^{-17}$
$\lvert 0.05c_{XX} + 0.55c_{YY} + 0.41c_{ZZ}$ $+0.16c_{(XY)} - 0.14c_{(XZ)} - 0.47c_{(YZ)}$ $+0.22c_{(0X)} + 0.74c_{(0Y)} - 0.64c_{(0Z)} + c_{00}\rvert$	$< 1.3 \times 10^{-15}$
$\lvert 0.58c_{XX} + 0.04c_{YY} + 0.38c_{ZZ}$ $-0.14c_{(XY)} - 0.47c_{(XZ)} + 0.12c_{(YZ)}$ $+0.76c_{(0X)} - 0.19c_{(0Y)} - 0.62c_{(0Z)} + c_{00}\rvert$	$< 2.5 \times 10^{-15}$
$\tilde{d}_{XY} - \tilde{H}_{ZT} + \tan\eta\tilde{H}_{YT}$	$(0.1 \pm 1.8) \times 10^{-27}$ GeV
$\tilde{H}_{ZT}$	$(-4.1 \pm 2.4) \times 10^{-27}$ GeV
$\tilde{H}_{YT} - \tilde{d}_{ZX}$	$(-4.9 \pm 8.9) \times 10^{-27}$ GeV
$+\tilde{H}_{XT} + \tan\eta(\tilde{g}_T - 2\tilde{d}_+ + \tilde{d}_Q)$	$(1.1 \pm 9.2) \times 10^{-27}$ GeV
$\lvert d_{XX}\rvert$	$< 2 \times 10^{-14}$
$\lvert d_{YY}\rvert, \lvert d_{ZZ}\rvert$	$< 3 \times 10^{-15}$
$\lvert d_{(XY)}\rvert$	$< 2 \times 10^{-15}$
$\lvert d_{(XZ)}\rvert$	$< 2 \times 10^{-14}$
$\lvert d_{(YZ)}\rvert$	$< 7 \times 10^{-15}$
$\lvert d_{TX}\rvert$	$< 5 \times 10^{-14}$
$\lvert d_{TY}\rvert$	$< 5 \times 10^{-15}$
$\lvert d_{TZ}\rvert$	$< 8 \times 10^{-17}$
$\lvert\tilde{d}_J\rvert,\ (J = X, Y)$	$< 10^{-22}$ GeV
$\lvert\tilde{d}_Z\rvert$	$< 10^{-19}$ GeV
$\lvert\tilde{g}_{XY}\rvert, \lvert\tilde{g}_{XZ}\rvert$	$< 10^{-17}$ GeV
$\lvert\tilde{g}_{YZ}\rvert, \lvert\tilde{g}_{YX}\rvert$	$< 10^{-17}$ GeV
$\lvert\tilde{g}_{ZX}\rvert, \lvert\tilde{g}_{ZY}\rvert$	$< 10^{-18}$ GeV
$\lvert\tilde{g}_{D,J}\rvert,\ (J = X, Y, Z)$	$< 10^{-22}$ GeV
$\lvert\tilde{g}_{D,J}\rvert,\ (J = X, Y)$	$< 10^{-22}$ GeV

Muon Sector

Combination	Result
b_Z^μ	$-(1.0 \pm 1.1) \times 10^{-23}$ GeV
$\sqrt{(b_X^{\mu^+})^2 + (b_Y^{\mu^+})^2}$	$< 1.4 \times 10^{-24}$ GeV
$\sqrt{(b_X^{\mu^-})^2 + (b_Y^{\mu^-})^2}$	$< 2.6 \times 10^{-24}$ GeV
$\sqrt{(\check{b}_X^\mu)^2 + (\check{b}_Y^\mu)^2}$	$< 2 \times 10^{-23}$ GeV
$b_Z^\mu - 1.19(m_\mu d_{Z0}^\mu + H_{XY}^\mu)$	$(-1.4 \pm 1.0) \times 10^{-22}$ GeV
b_Z^μ	$(-2.3 \pm 1.4) \times 10^{-22}$ GeV
$m_\mu d_{Z0}^\mu + H_{XY}^\mu$	$(1.8 \pm 6.0) \times 10^{-23}$ GeV
$\lvert c^\mu \rvert$	$< 10^{-11}$
$\mathring{a}_\mu^{\mathrm{UR}(5)} - m_\mu \mathring{g}_\mu^{\mathrm{UR}(6)}$	$(-1 \text{ to } 1) \times 10^{-34}$ GeV^{-1}
$\mathring{c}_\mu^{\mathrm{UR}(6)}$	$(-8.5 \text{ to } 0.0025) \times 10^{-20}$ GeV^{-2}
$\lvert c^\tau \rvert$	$< 10^{-8}$
$\mathring{a}_\tau^{\mathrm{UR}(5)} - m_\tau \mathring{g}_\tau^{\mathrm{UR}(6)}$	$(-2 \text{ to } 2) \times 10^{-33}$ GeV^{-1}

Minimal Lorentz-violating terms contain field operator of mass dimensions 3 or 4

Mass dimension 3

Minimal Lorentz-violating term

$$\bar{\psi}_f \gamma_\alpha \psi_f \mathcal{V}_f^{\alpha}$$

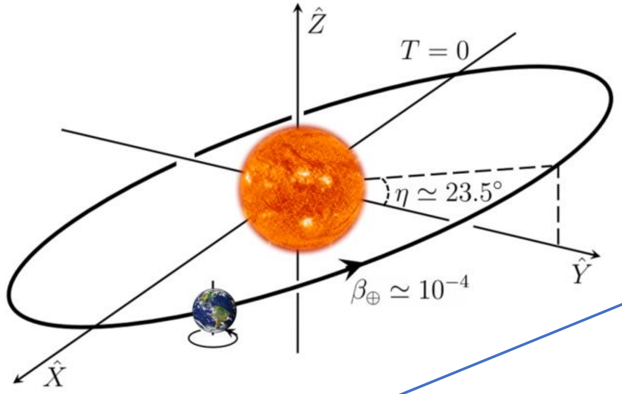
Mass dimension 5

Nonminimal Lorentz-violating term

$$\bar{\psi}_f \gamma_\alpha \partial_\beta \partial_\nu \psi_f \mathcal{V}_f^{\alpha\beta\nu}$$

Low-energy experiments are expected to be more sensitive to minimal terms than to nonminimal terms in a Lorentz-violation effective field theory.

The minimal SME only considers Lorentz-violating operators of mass dimension 3 and 4.



Components of magnetic field in SCF

$$\delta\omega_a^{\pm} \simeq 2\check{\boldsymbol{b}}^{\pm} \cdot \widehat{\boldsymbol{B}} + \frac{\boldsymbol{B_I}}{\boldsymbol{B}} \left(\check{\boldsymbol{T}}^{\pm}\right)^{\boldsymbol{IJ}} (\boldsymbol{\beta_{LF}})_{\boldsymbol{J}}$$

Laboratory's velocity in SCF

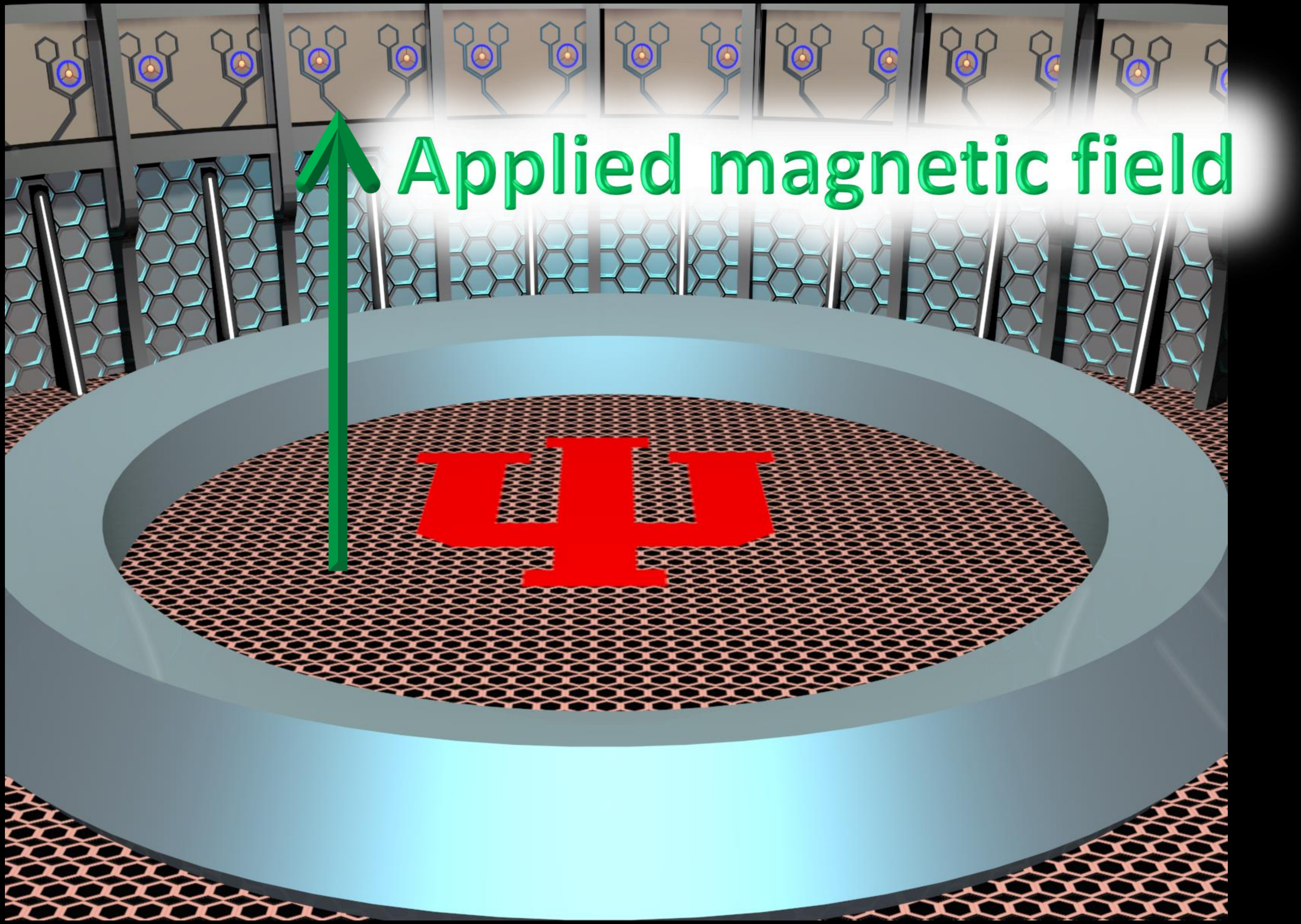
Lorentz-violating anomalous precession frequency shift

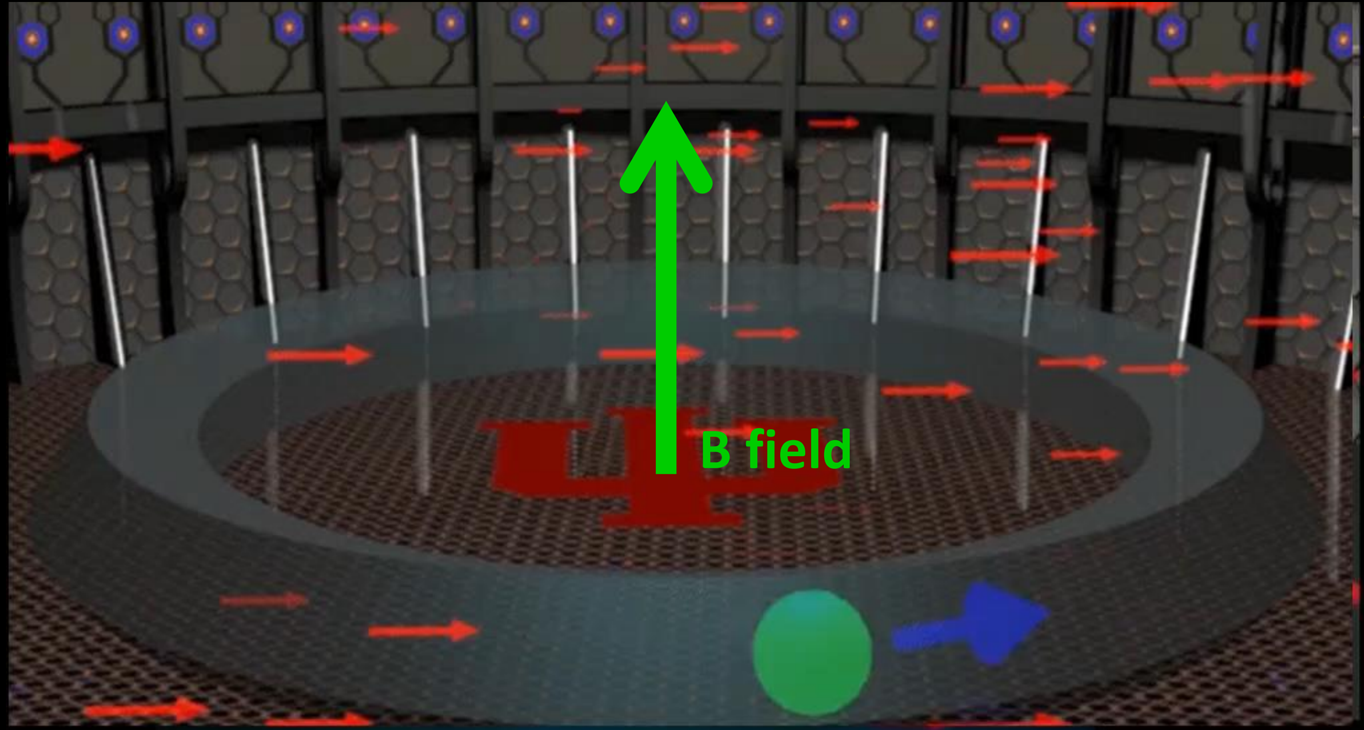
- $+$ for positive muon
- $-$ for negative muon

Direction of the magnetic field in SCF

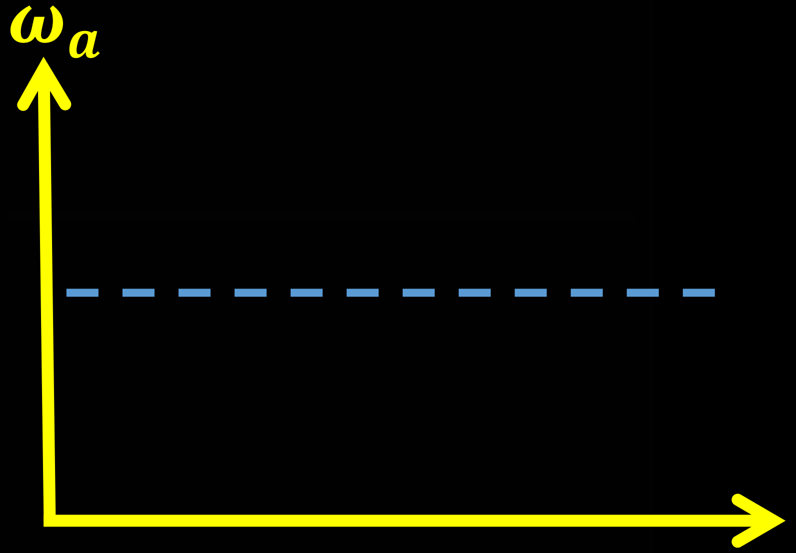
A linear combination of SME coefficients that transform as a spatial vector under rotations of the coordinate system


T.A.R.D.I.S.


Applied magnetic field



Lab Frame



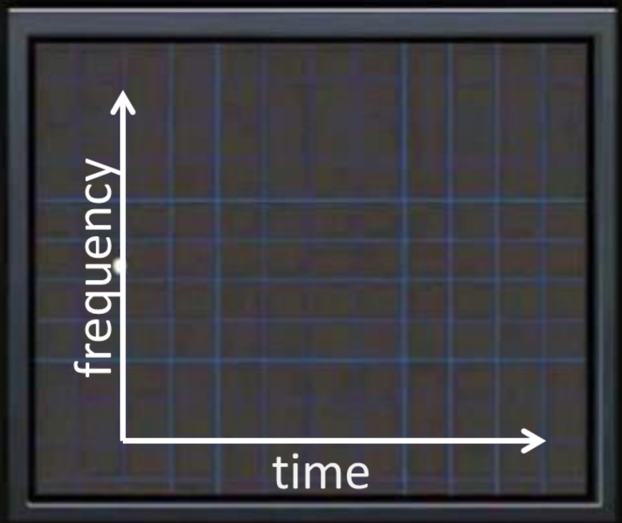
Fixed frame

Lorentz-violating frequency shift

$$\delta\omega_a = 2\check{b}^{\pm}\cdot\hat{B}$$

Lorentz-violating field

B field



Sidereal variation of the anomalous frequency

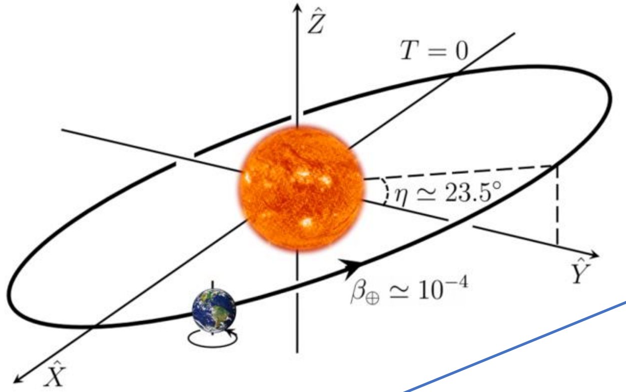
Lorentz-violating frequency shift

$$\boldsymbol{\delta\omega_a = 2\breve{b}^{\pm} \cdot \hat{B}}$$

Lorentz-violating field

B field

Minimal Lorentz-violating terms contain field operator of mass dimensions 3 or 4



Component of the magnetic field in SCF

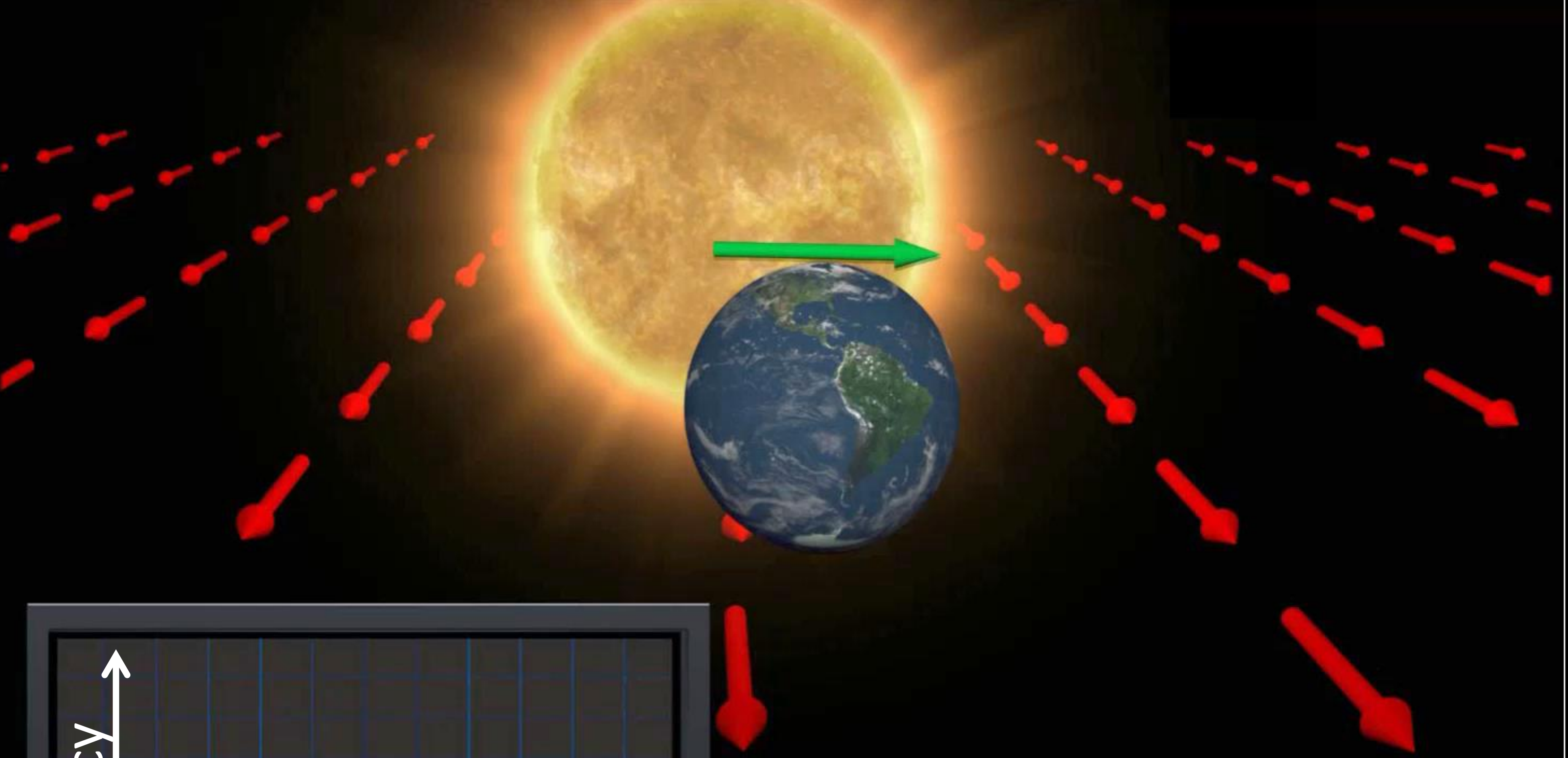
$$\delta\omega_a^{\pm} \simeq 2\check{\boldsymbol{b}}^{\pm} \cdot \widehat{\boldsymbol{B}} + \frac{\boldsymbol{B}_{\boldsymbol{I}}}{\boldsymbol{B}}(\check{\boldsymbol{T}}^{\pm})^{\boldsymbol{IJ}}(\boldsymbol{\beta}_{\boldsymbol{LF}})_{\boldsymbol{J}}$$

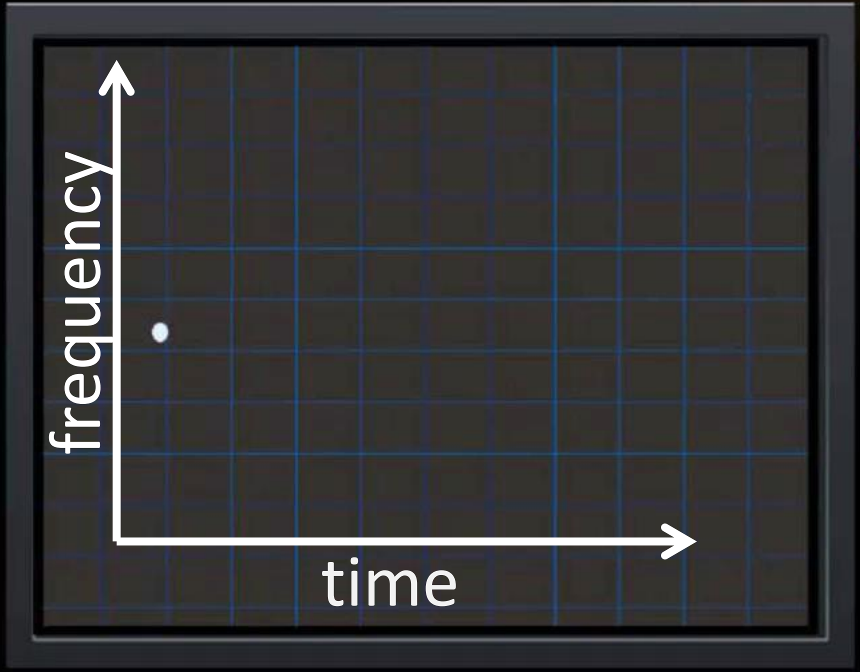
Laboratory’s velocity in SCF

Lorentz-violating anomalous precession frequency shift
- $+$ for positive muon
- $-$ for negative muon

Direction of the magnetic field in SCF

A linear combination of SME coefficients that transform as a spatial vector under rotations of the coordinate system





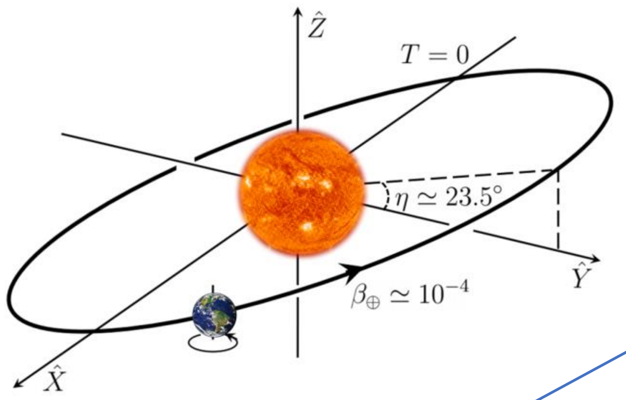
Orbital velocity of the Earth

Lorentz-violating field

Annual variation
of the frequency

$$\delta\omega_a = \check{V}^J(\beta_{LF})_J$$

$$\frac{B_I}{B}\left(\check{T}^{\pm}\right)^{IJ}$$



$$\delta\omega_a^{\pm} \simeq 2\check{\boldsymbol{b}}^{\pm} \cdot \widehat{\boldsymbol{B}} + \frac{\boldsymbol{B}_{\boldsymbol{I}}}{\boldsymbol{B}} (\check{\boldsymbol{T}}^{\pm})^{\boldsymbol{IJ}} (\boldsymbol{\beta}_{\boldsymbol{LF}})_{\boldsymbol{J}}$$

Linear combination of SME coefficients

- $+$ for positive muon
- $-$ for negative muon

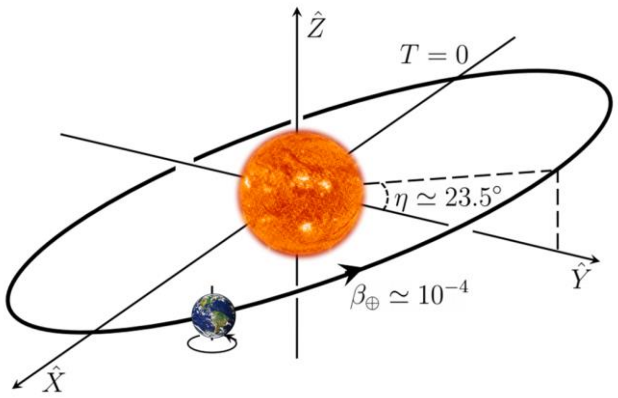
Muon mass

$$\check{b}_J^{\pm} = \pm\frac{1}{\gamma}\left(b_J - m_\mu g_J^{(A)}\right) + \epsilon_{JKL} H_{KL} + m_\mu d_{JT} \pm \frac{1}{\gamma}\left(1 + \frac{3}{2}\beta^2\gamma^2\right) m_\mu \epsilon_{JKL} g_{KLT}^{(M)}$$

SME coefficients that appear on the Lagrangian

β velocity of muon relative to the laboratory frame

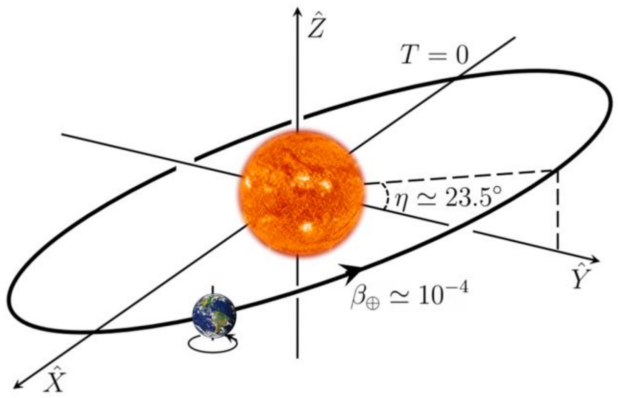
$\gamma = (1-\beta^2)^{-1/2}$



$$\delta\omega_a^{\pm} \simeq 2\check{\boldsymbol{b}}^{\pm} \cdot \widehat{\boldsymbol{B}} + \frac{\boldsymbol{B_I}}{\boldsymbol{B}} \left(\check{\boldsymbol{T}}^{\pm}\right)^{\boldsymbol{IJ}} (\boldsymbol{\beta_{LF}})_{\boldsymbol{J}}$$

$$\check{b}_J^{\pm} = \pm\frac{1}{\gamma}\left(b_J - m_\mu g_J^{(A)}\right) + \epsilon_{JKL}H_{KL} + m_\mu d_{JT} \pm \frac{1}{\gamma}\left(1 + \frac{3}{2}\beta^2\gamma^2\right) m_\mu \epsilon_{JKL} g_{KLT}^{(M)}$$

g-2 experiments with negative muons are sensitive to a different linear combination of SME coefficients than g-2 experiments with positive muons

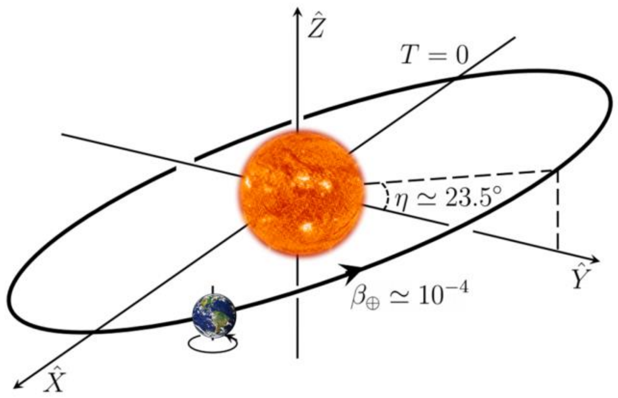


$$\delta\omega_a^{\pm} \simeq 2\check{\boldsymbol{b}}^{\pm} \cdot \hat{\boldsymbol{B}} + \frac{\boldsymbol{B}_I}{\boldsymbol{B}}\left(\check{\boldsymbol{T}}^{\pm}\right)^{IJ}(\boldsymbol{\beta}_{LF})_J$$

$$\check{b}_J^{\pm} = \pm\frac{1}{\gamma}\left(b_J - m_\mu g_J^{(A)}\right) + \epsilon_{JKL}H_{KL} + m_\mu d_{JT} \pm \frac{1}{\gamma}\left(1 + \frac{3}{2}\beta^2\gamma^2\right)m_\mu \epsilon_{JKL} g_{KLT}^{(M)}$$

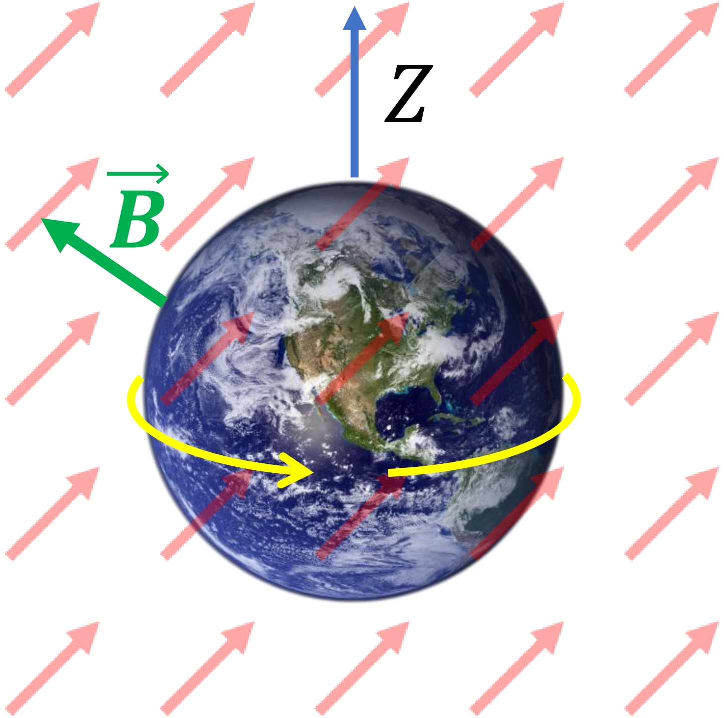
J-PARC's experiment and Fermilab's experiment are sensitive to slightly different combinations of SME coefficients

J-PARC	Fermilab and BNL
$\beta \simeq 0.94$	$\beta \simeq 1$
$\gamma \simeq 3$	$\gamma \simeq 30$



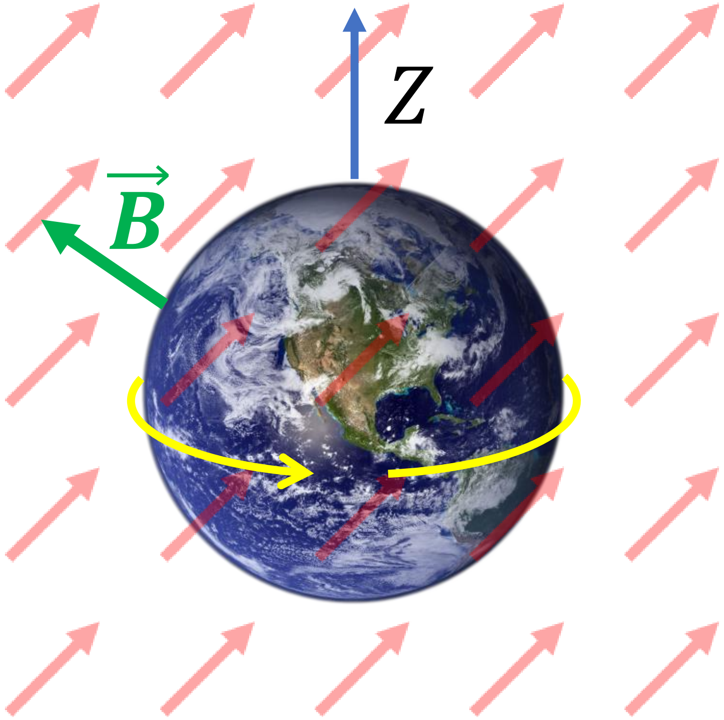
$$\delta\omega_a^{\pm} \simeq 2\boldsymbol{\check{b}}^{\pm} \cdot \boldsymbol{\hat{B}} + \frac{\boldsymbol{B_I}}{\boldsymbol{B}} \left(\boldsymbol{\check{T}}^{\pm}\right)^{\boldsymbol{IJ}} (\boldsymbol{\beta_{LF}})_{\boldsymbol{J}}$$

$$\frac{2}{B}\left(\check{b}_X^{\pm} B_X + \check{b}_Y^{\pm} B_Y + \check{b}_Z^{\pm} B_Z\right)$$



The term $2\check{b}_Z^{\pm} B_Z / B$ does not contribute to the sidereal or annual variation of ω_a

$\check{b}_Z^{\pm}$ can be studied by comparing the anomalous frequencies for the negative and positive muon

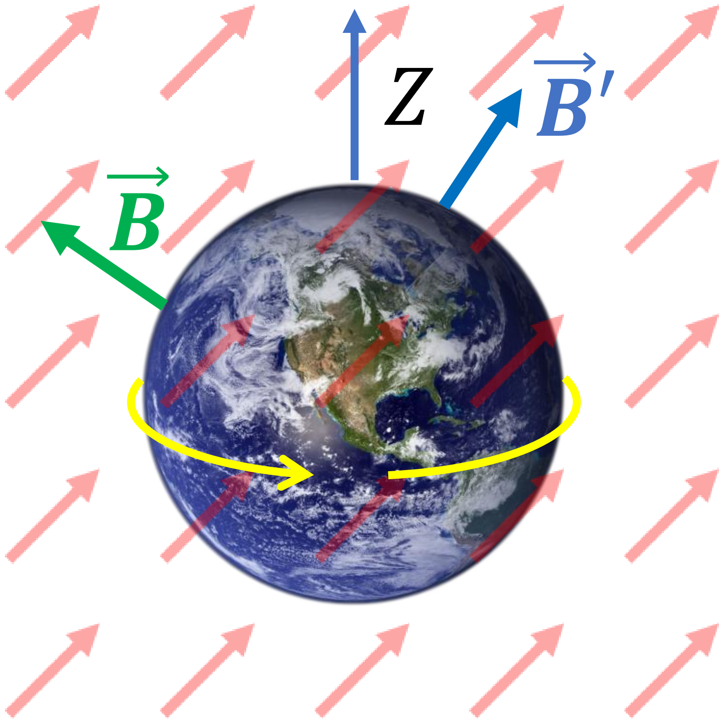


In the same magnetic field

$$\frac{\omega_a^+}{\omega_p} - \frac{\omega_a^-}{\omega_p'} = \cdots + 2\,\frac{B_z}{B}\left(\frac{\check{b}_Z^+}{\omega_p} - \frac{\check{b}_Z^-}{\omega_p'}\right) + \cdots$$

Proton precession frequency

$\breve{b}_Z^{\pm}$ can be studied by comparing the anomalous frequencies for two orientations of the magnetic field



$$\frac{\omega_a^{\pm}(\hat{B})}{\omega_p} - \frac{\omega_a^{\pm}(\hat{B}')}{\omega_p'}$$

Proton precession frequency

$$= \cdots + 2\left(\frac{B_Z}{B\omega_p} - \frac{B_Z'}{B'\omega_p'}\right)\breve{b}_Z^{\pm} + \cdots$$

Minimal cases

Nonminimal cases

$$2\check{b}_Z^{\pm}\hat{B}_Z \Rightarrow 2\sum_{dnj} E_0^{d-4}\,\boldsymbol{G}_{j0}(\chi)\left(\check{\boldsymbol{H}}_{nj0}^{(d)\mathrm{Sun}} \pm \check{\boldsymbol{g}}_{nj0}^{(d)\mathrm{Sun}}\right)$$

Combination of nonminimal SME coefficients

Energy of the muon in the laboratory frame

$$\frac{E_{\mathrm{Fermilab}}}{E_{J\text{-}PARC}} \simeq 10$$

Fermilab's experiment is more sensitive to nonminimal SME coefficients than J-PARC by a factor of $(10)^{d-4}$ where d is the mass-dimension of the coefficient

Comparing the anomalous frequency for the negative muon with the positive muon in the Fermilab experiment will result on the best bounds on the effective coefficients $\check{\boldsymbol{g}}_{nj0}^{(d)\mathrm{Sun}}$ with $d \geq 5$

More information

Laboratory tests of Lorentz and CPT symmetry with muons
André H. Gomes, V. Alan Kostelecký, and AJV
Phys. Rev. D **90**, 076009 (2014)

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