Electric Dipole Moment in COM Framework

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Energy Pattern Asymmetry

In the COM framework, the electric dipole moment is redefined as an asymmetry in the energy pattern:

$$E_{\text{EDM}} = \int_V \Psi(x,t)\cdot x \, dV$$

where E_{EDM} is the COM-equivalent of the electric dipole moment.

Asymmetric Energy Pattern

$$\Psi(x,t) = A \sin(\omega t - kx + \phi)\cdot e^{-\alpha|x|}\cdot(1 + \beta \tanh(x))$$

The asymmetry factor β controls the degree of energy pattern asymmetry, directly relating to the magnitude of the EDM.

Phase Asymmetry Parameter

The phase asymmetry that corresponds to time-reversal violation is:

$$\Delta\phi = \phi_{\text{forward}} - \phi_{\text{backward}} = 2arcsin\left(\frac{E_{\text{EDM}}}{2\text{LZ}\cdot E_0}\right)$$

where E_0 is the base energy of the particle.

COM-EDM Scaling Law

The scaling of EDM across different particles follows:

$$E_{\text{EDM}}(m) = E_0\cdot\left(\frac{m}{m_0}\right)^{\text{LZ}}$$

where:

- $E_{\text{EDM}}(m)$ is the EDM for a particle of mass m
- E_0 is a reference EDM value
- m_0 is a reference mass

HQS Threshold Constraint

The upper limit on EDM is constrained by:

$$|E_{\text{EDM}}| < E_0\cdot\text{HQS}\cdot \sin\left(\frac{\pi}{2}\cdot\text{Oct}(m)\right)$$

Experimental Measurement in COM Terms

The precession frequency shift in EDM experiments is reinterpreted as:

$$\Delta\omega \quad = \frac{2E_{\mathrm{EDM}} \cdot F}{\hbar \cdot \mathrm{LZ}}$$

where:

- $\Delta\omega$ is the frequency shift
- F is the effective field amplitude
- $\hbar$ is the reduced Planck constant