The **spin precession** in electric and magnetic fields affected by an electric dipole moment (EDM)

Thomas-BMT equation: \[ \frac{d\mathbf{S}}{dt} = \mathbf{\Omega}_s \times \mathbf{S} \] with \[ \mathbf{\Omega}_s = -q \frac{m}{\gamma^2 - 1} \mathbf{E} \frac{1}{c} + d mc^2 \mathbf{E} \times \mathbf{B} \]

**Spin tune measurement sensitive to EDM:** \[ \nu_s = \frac{\mathbf{\Omega}_s}{\omega \text{rev}} \]

Pure magnetic ring (COSY) and \( d = 0 \): Search for Charged Particle EDMs

Measure up-down asymmetry in polarized deuteron-carbon elastic scattering

Asymmetry: \[ A(t) = \frac{N_{up}(t) - N_{down}(t)}{N_{up}(t) + N_{down}(t)} \cdot \sin(|\mathbf{\Omega}| t + \phi_0) \]

Spin precession \( \sim 120 \text{ kHz} >> 5 \text{ kHz event rate} \rightarrow \) no direct fit possible

Solution:

I. Take modulo of event time with a assumed spin precession period \( T_s \)

\[ t_s = t \mod T_s \]

II. Calculate asymmetry for every one second interval and fit a sine

\[ A_{fit}(\phi_s) = A \sin(\phi_s + \phi_0) + \text{offset} \]

III. Vary the spin tune \( \nu_s \) and find maximal amplitude

\[ \nu_s(t) = \nu_{max} + \frac{1}{\omega \text{rev}} \left. \frac{d\phi_0}{dt} \right|_{t} \]

\[ \phi_0, \text{ fit} = p_0 + c_0 t + c_2 t^2 \]

Time depending spin tune:

\[ \nu_s(t) = \nu_{max} + 3.71 \cdot 10^{-7} \frac{1}{\text{s}} (c_0 + 2c_2 t) \]

**Spin tune precision** of \( 10^{-10} \) for a 100 s interval

Results

Interpolation of the spin tune from the asymmetry phase

Spin tune for different runs with varying sextupole settings

**Conclusion and Questions**

The spin tune can determined with a precision of \( 10^{-10} \) in 100 s

Why does the spin tune change

I. during one cycle?

II. from cycle to cycle?