Anomalous magn. moment of e^- in strong fields

- **Physics requirements on polarization**
- **Spin Precession: T-BMT equation**
  - anomalous magnetic moment of the electron: how to calculate?
  - what has been used? shortcomings?
- **Further promising method**
  - proposed strategy
  - required steps and checks
- **Conclusions and outlook**

Physics requirement

- **Goals: Polarized beams needed to**
  - **analyze the structure of all kinds of interactions**
  - **improve statistics: enhance rates, suppress backgrounds**
  - **detect new physics via deviations from SM predictions in high precision measurements**
- **Needed accuracy**
  - **expected: for most physics studies $\Delta P/P=0.5\%$ (0.25%) sufficient; for precision measurements $\Delta P/P<0.1\%$ required**
  - **polarization@IP = lumi-weighted polarization $\neq$ polarization@polarimeter**
- **All depolarization effects have to precisely known !**

Spin precession

- Validation of T-BMT equation in CAIN are applicable
  - several approximations and assumptions have been made
- What has been used?

$$\frac{dS}{dt} = -\frac{e}{m\gamma}\left[(\gamma a + 1)B_T + (a+1)B_L - \gamma(a + \frac{1}{\gamma+1})\beta e_v \times \frac{E}{c}\right] \times S,$$

  - 'a' is anomalous magnetic moment of electron $a=(g-2)/2=\alpha/2\pi + \ldots$
  - higher-order effect, radiative corrections to $ee\gamma$–vertex
  - exp. measured up to accuracy of 10^{-11}
- Due to strong fields (beamstrahlung), a is function of field
  - excellent work of V. Baier
  - but also other strategy proposed

Spin precession -- intro

- **Baier derived**

  a) expression for anomalous moment of e in a medium

  ➾ use ansatz in perturbation theory

  ➾ relates spin-dependent part of mass corrections with magn. moment

  b) get expression valid in beam-beam interactions

  ➾ use this expression for the case that 'no' scattering happens

  c) one used approximation: quasi-classical approximation

  ➾ (one) condition: change of momentum due to external field has to be slowly

  ➾ applicable if: Larmor radius in magn. field much larger than particle wavelength

Expression for anom. magn. moment

Quasi-classical approximation in our case

- particle wavelength in our cases:
  - ~h / p
- Larmor radius:
  - typical magnetic field in the bunches O(kT)
  - radius ~ pc / eB
  - → much larger than characteristic wavelength

    used approximation seems to be ok in our case
- from this point of view, derived expression in CAIN seems to be ok
  - but further concerns about the used methods and assumptions
  - therefore other strategy proposed

From now on....

- **blackboard talk.......**
  - **sorry, too many formulae and explanations**