Search for Time Reversal Violating Effects: A Simultaneous Measurement of R- and N-Correlations in the Decay of Free Neutrons

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Precision measurements in the decay of the free neutron allow for very sensitive test of the Standard Model (SM). SM predictions for the time reversal violating effects for systems built up of u and d quarks are by 7 to 10 orders of magnitude smaller than the experimental accuracies achievable at present. Thus, any detected deviation from the time reversal invariance will be due to "physics beyond the SM". Direct, i.e. first-order access to the T-violating part of the weak interaction coupling constants is possible in measurements of directional correlations between spins and momenta of particles involved in the decay process.

Physics with very slow, polarized neutrons has a great potential in this respect. An experiment aiming at the simultaneous determination of both components of the transversal polarization of electrons emitted in the decay of free, polarized neutrons, which are the measures of the R- and N-correlations, respectively, is underway at the cold neutron facility FUNSPIN at the spallation source SINQ, PSI, Villigen. In neutron decay, the R-correlation – the time reversal violating observable – is sensitive to a linear combination of exotic scalar and tensor couplings and will be determined with the precision of 0.005. The N-correlation conserves T-symmetry and its SM-value scales with the decay asymmetry parameter A. In our experiment, the N-correlation will serve as an excellent internal check for systematic effects.

The main challenge of the experiment is the measurement of the polarization of the low energy electrons ($<$ 782 keV). As feasibility tests show, large angle Mott scattering for polarization analyzis combined with tracking of electrons in special gas detectors [1] allow for the required accuracy within a few months of data taking. Now the experimental apparatus is being set up. Present status and results of the performance tests will be discussed in the presentation.

References

[1] K. Bodek, et al., Nucl. Instr. Meth. **A473** (2001) 326.