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Final results of μp capture rate Λ_S and pseudoscalar coupling g_P

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We present the final results of muon capture on the proton $\mu^- + p \rightarrow \nu_\mu + n$, an experiment which was conducted by the MuCap collaboration at the Paul Scherrer Institute. Our method was a high precision lifetime measurement of the μp singlet state, rate $\lambda(\mu^-)$, which in comparison with the free μ^+ lifetime, rate $\lambda(\mu^+)$, yields the μp singlet capture rate $\Lambda_S = \lambda(\mu^- p) - \lambda(\mu^+)$. From Λ_S the pseudoscalar coupling constant g_P can be deduced using low energy chiral perturbation theory (ChPT). A description of this experiment and its results is published in [1].

The apparatus consisted of an active central detector, a 10-bar hydrogen time projection chamber (TPC) which registered every single muon stop, and a surrounding electron detector, 2 sets of cylindrical wire chambers and a plastic counter hodoscope, which registered the electrons from muon decay. During three major experimental runs in 2004-2007, a total statistics of 1.2×10^{10} good events was collected from which Λ_S was determined to 1% accuracy. The most difficult systematical challenges of this experiment were to keep the hydrogen gas in the TPC ultra-clean with purity levels of ~10ppb, and to avoid or correct in the data analysis any effects which would distort the exponential decay curve.

A major problem of previous experiments was the formation of pμp molecules and the poorly known transition rate λ_{op} between molecular ortho or para states. As shown in Fig. 1, this made the interpretation of observed capture rates difficult. By the choice of low gas density, MuCap was nearly insensitive to this problem and thus produced a clear cut result of g_P, in excellent agreement with the ChPT prediction.

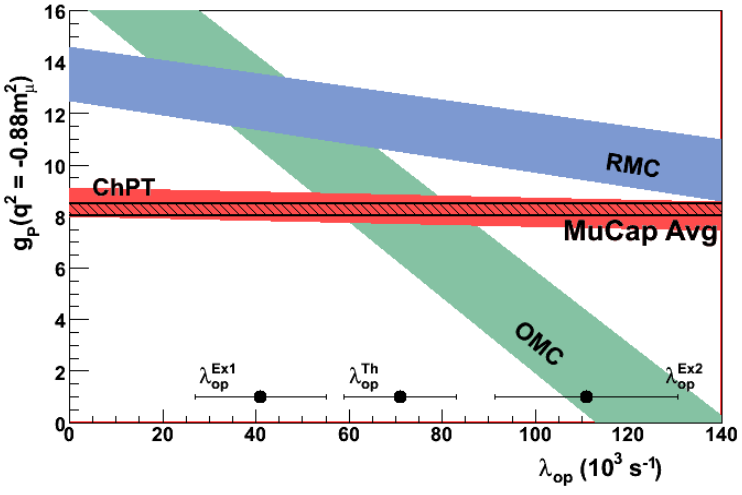

Figure 1: *Extracted values of pseudoscalar coupling g_P plotted versus the poorly known molecular transition rate λ_{op}. In contrast to earlier experiments (OMC at Saclay, RMC at TRIUMF), MuCap is rather insensitive to this parameter..*

[1] V.A. Andreev et al. (MuCap Collaboration), Phys. Rev. Lett. **106**, 041803 (2013).