Status of $K_S \to \pi e \nu$ branching ratio and lepton charge asymmetry measurements with the KLOE detector

D. Kamińska
for KLOE-2 Collaboration

Institute of Physics, Jagiellonian University, Cracow, Poland

The physical K_S and K_L mesons are mixtures of states K^0 and $\bar{K^0}$ with parameters ϵ_K and δ_K accounting for $\mathcal{CP}$ and $\mathcal{CPT}$ violation, respectively. This sensitivity of neutral kaon system to discrete symmetries made it one of the best candidates for the search of $\mathcal{CPT}$ violation. One of the possible tests is based on studies of charge asymmetry in semileptonic decay ($K \to \pi e \nu$). The difference between semileptonic charge asymmetry in K_S decays (A_S) and the analogous asymmetry in K_L decays (A_L) is related only to parameters describing $\mathcal{CPT}$ violation [1].

The charge asymmetries for K_S and K_L kaons were determined by KTeV and KLOE experiments, respectively. A value of $A_L = (3.322 \pm 0.058_{stat} \pm 0.047_{syst}) \times 10^{-3}$ was obtained by examination of around 1.9 millions $K_L \to \pi e \nu$ decays produced in collisions of proton beam with a BeO target [2]. Analogous charge asymmetry for K_S meson was determined with 0.41 fb^{-1} total luminosity data sample: $A_S = (1.5 \pm 9.6_{stat} \pm 2.9_{syst}) \times 10^{-3}$ [3]. Until now both values are the most accurate measurements and they are consistent within error limits which suggests conservation of $\mathcal{CPT}$ symmetry. However, accuracy on A_L determination is more than two orders of magnitude bigger than this of the A_S and the uncertainty on A_S is dominated by the data sample statistics which is three times larger than the systematic contribution. Therefore, further studies of $K_S \to \pi e \nu$ decay using larger statistical samples can improve the precision of $\mathcal{CPT}$ test.

Especially suited for studies of rare semileptonic decays of K_S is the KLOE experiment located at the DAΦNE ϕ factory. The KLOE detector consists of two main parts: a drift chamber [4] and a barrel shaped electromagnetic calorimeter [5], both inserted into electromagnetic field (0.5 T). Around 60% of produced K_L mesons reach electromagnetic calorimeter and can be identified by the deposited energy and characteristic value of velocity. Moreover, due to the pair production of neutral kaons, identification of K_L meson on one side allows to tag a K_S meson on the other side of ϕ meson decay point. Further selection of $K_S \to \pi e \nu$ decays required a vertex with two oppositely charged particles near the Interaction Point. These particles must reach the calorimeter and deposit their energy inside it in order to apply the Time of Flight technique. This technique aims at rejecting background, which consists mainly of $K_S \to \pi^+ \pi^-$ decay, and at identifying the final charged states ($\pi^+ e^- \bar{\nu}$ and $\pi^- e^+ \nu$). Based on an integrated luminosity of 1.7 fb^{-1} around 10^5 of $K_S \to \pi e \nu$ events were reconstructed and will be used to determine branching ratio and charge asymmetry of K_S semileptonic decays. The analysis is still in progress and preliminary result will be available soon. Further improvements of both statistical and systematical uncertainties are expected due to the installation of new sub-detectors in the KLOE-2 setup [6] and the luminosity upgrade of the DAΦNE collider [7].

Acknowledgements

This work was supported in part by the EU Integrated Infrastructure Initiative Hadron Physics Project under contract number RII3-CT- 2004-506078; by the European Commission under the 7th Framework Programme through the 'Research Infrastructures' action of the 'Capacities' Programme, Call: FP7-INFRASTRUCTURES-2008-1, Grant Agreement No. 227431; by the Polish National Science Centre through the Grants No. DEC-2011/03/N/ST2/02641, 2011/01/D/ST2/00748, 2011/03/N/ST2/02652, 2013/08/M/ST2/00323, DEC-2014/12/S/ST2/00459, 2013/11/B/ST2/04245 and by the Foundation for Polish Science through the MPD programme and the project HOMING PLUS BIS/2011-4/3.

References

[1] L. Maiani, G. Pancheri, N. Paver, INFN-LNF (1995)

[2] KTeV Collaboration, Phys. Rev. Lett. **88** (2002), p. 181601-181606

[3] KLOE Collaboration, Phys. Lett. B **636** (2006), p. 173-182

[4] KLOE Collaboration, Nucl. Instrum. Meth. A **461** (2001), p. 25-28

[5] KLOE Collaboration, Nucl. Instrum. Meth. A **482** (2002), p. 364-386

[6] KLOE-2 Collaboration, Eur. Phys. J. C **68** (2010), p. 619-681

[7] M. Zobov, Phys. Part. Nucl. **42** (2011), p. 782-799