Contribution ID : **103** Type : **plenary talk**

First πK atom lifetime measurement and recent results from the DIRAC experiment

Monday, 2 June 2014 10:00 (0:30)

Collaboration

DIRAC

Abstract content

Low-energy QCD and specifically Chiral Perturbation Theory (ChPT) calculated $\pi\pi$ and πK scattering lengths with per cent precision. For processes involving u- and d-quarks theoretical predictions have been experimentally checked by $\pi^+\pi^-$˜atom lifetime measurement [1] and by analysis of K-decays [2,3]. Detection and lifetime measurement of πK˜atom cast a look into processes which involve s-quark as well. We report evidence for πK atoms production, using 24 GeV/c proton beam from CERN PS interacting with a thin Ni target. We have identified (178 ± 49) πK˜pairs, which were produced and were subsequently broken-up (ionized) in the Ni target. Analysis yields a first measurement of the πK˜atom lifetime $\left(2.5^{+3.0}_{-1.8}\right)$ fs [4]. This lifetime is connected in a model-independent way to the S-wave isospin-odd πK scattering lengths difference $|a_0^-| = \frac{1}{3}|a_{1/2} - a_{3/2}| = \left(0.11^{+0.09}_{-0.04}\right) M_\pi^{-1}$ (a_I for isospin˜I). Through the measurement of the $\pi^+\pi^-$˜atom (pionium) lifetime, the experiment obtained the S-wave $\pi^+\pi^-$ scattering lengths difference $|a_0 - a_2|$ with 4% precision [1]. In 2011-2012 DIRAC collaboration collected data towards observation of long-lived (metastable) states of pionium. The observation of long-lived states opens the possibility to measure the energy difference between ns and np states and to determine the value of the combination $(2a_0 + a_2)$ of S-wave $\pi\pi$ scattering lengths. The experiment used two targets method: after production in the beryllium foil, atoms flied through a permanent magnetic field to reach the platinum ionization foil. The distance between foils is large enough for ns-states to vanish due to annihilation. Only $\pi^+\pi^-$ atoms in states with non-zero angular momentum can get into the second Pt target. We report unambiguous observation of long-lived (metastable) states of $\pi^+\pi^-$˜atoms.

[1] B. Adeva, et al. (DIRAC Collaboration), Phys. Lett. B704 (2011) 24. [2] J.R. Batley, et al. (NA48/2 Collaboration), Eur. Phys. J. C64 (2009) 589. [3] J.R. Batley, et al. (NA48/2 Collaboration), Eur. Phys. J. C70 (2010) 635. [4] B. Adeva, et al. (DIRAC Collaboration), arXiv:1403.0845.

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Session Classification : Plenary Session