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First observation of π-K+ and π+K- atoms, their lifetime measurement and πK scattering lengths evaluation. (12' + 3')

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The Low Energy QCD allows to calculate the π-π and π-K scattering lengths with high precision. There are accurate relations between these scattering lengths and π+-π-, π-K+, π+K- atoms lifetimes. The experiment on the first observation of π-K+ and π+K- atoms is described and results are presented. The atoms were generated on Ni and Pt targets hit by the PS CERN proton beam with momentum P=24 GeV/c. Moving in the target, part of atoms break up producing characteristic π-K pairs (atomic pairs) with small relative momentum Q in their c.m.s. In the experiment, we detected na=345+-61 (5.7 standard deviations) π-K+ and π+K- atomic pairs. The main part of π-K pairs are produced in free state. The majority of particles in these pairs are generated directly or from short-lived sources as rho, omega and similar resonances. The electromagnetic interactions in the final state create Coulomb pairs with a known dependence on Q of the number of pairs. This effect allows to evaluate the number of these Coulomb pairs. There is a precise ratio (~1%) between the number of π-K+ (π+K-) Coulomb pairs with small Q and the number of produced π-K+ (π+K-) atoms. Using this ratio, we obtained the numbers of generated π-K+ and π+K- atoms Na=1200+-80 in total. The breakup probability Pbr=na/Na depends on the atom lifetime. Using for Ni and Pt targets this dependence, known with a precision about 1%, the πK atom lifetime was measured and from its value the πK scattering lengths were evaluated. The presented analysis shows that the π-K+ and π+K- atoms production in the p-nucleus interactions increases by 16 and 38 times respectively if the proton momentum P is increased from 24 GeV/c up to 450 GeV/c.

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