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Search for Long-Lived States of pi+pi- atom

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The observation of long-lived (metastable) states of pi+pi- atoms (A2pi) opens the possibility to measure the energy difference between ns and np states and to determine the value of the combination 2a0 +a2 of S-wave pipi
scattering lengths with isotope spins 0,2 in a model-independent way. This result, together with the A2pi lifetime
measurement that provides the value |a0 -a2|, allows to get a0 and a2 separately using only pi+pi- atoms data.

In this experiment the proton beam with momentum 24 GeV/c interacts with a Be target with thickness 100mm and
generates A2pi in short-lived ns states. Passing through the target a fraction of A2pi interacts with Be-atoms and
get exited into long-lived 2p, 3p, 4p… states. From the Be target more than 6% of A2pi come out to the vacuum in
the long-lived states. For the short lived A2pi, with Lorenz factor 20, the decay lengths of 2S, 3S and 4S are in the interval between 0.017 and 1.1mm, while the metastable atoms in the states 2P, 3P and 4P have the decay lengths
between 5.7cm and 44cm.

After the Be target at a distance of 100mm, it was installed a Pt foil in which only long-lived atoms break up, generating pi+pi- pairs with small relative momentum Q in their c.m.s. In order to suppress the background from the
pi+pi- generated in the Be target, a magnet with BL=0.023 Tm was installed between Pt foil and the target. At the
exit of this magnet the pairs produced on the Be target have their Qy component increased of 12.7 MeV/c, while the
pairs generated on Pt foil, have their Qy component increased only of 2.3MeV/c by the fringing magnetic field. In
this report we present the results of the analysis which select pi+pi- pairs with small transverse component QT<1.5
MeV/c. The distribution in the longitudinal component QL of these pairs shows a peak around QL=0 MeV/c. The
statistical significance of this peak is 5s and it could be explained by the long-lived pi+pi- atoms breaking in the Pt foil.

Author: Prof. NEMENOV, Leonid (JINR Dubna)

Presenter: Prof. NEMENOV, Leonid (JINR Dubna)