ANTIPROTON-PROTON ANNIHILATION INTO COLLINEAR CHARGED PIONS AND KAONS

ASTERIX Collaboration

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ABSTRACT

An analysis is presented of two body final states of collinear charged pions or kaons from antiproton-proton annihilation at rest in the ASTERIX spectrometer at LEAR. The relative branching ratio of kaons to pions, which is sensitive to the dynamics of quark-antiquark annihilation and rearrangement, is shown to differ for P and S wave initial states.

The sensitivity of antiproton-proton annihilation observables to details of quark dynamics has been recently emphasized by many authors.¹ Annihilation into two mesons has been treated in terms of planar (annihilation and creation) and rearrangement (following annihilation) quark line graphs. Different assumptions have been invoked such as the 3P_0 model (the vertex has vacuum quantum numbers) and the gluon exchange model (the vertex has gluonic properties). One observable often calculated is the relative branching ratio R for production of K^+K^- with respect to $\pi^+\pi^-$, since the former channel is not accessible in the rearrangement picture due to the presence of strange quarks.

The ASTERIX spectrometer at LEAR² provides the possibility to enhance at the trigger level and to select in the analysis the annihilation from P wave ($\ell=1$) orbital angular momentum states of antiprotonic hydrogen. Whereas in liquid H_2 annihilation from S states ($\ell=0$) dominates, due to density-dependent mixing at higher atomic levels, in gaseous H_2 at NTP a large fraction of antiprotons cascade to the 2P level³ from which annihilation is strongly favoured over a radiative transition to the 1S state. The nd-2P L x rays are detected with high efficiency in an x ray drift chamber (XDC) and indicate P wave annihilation. The distinctive ionization from x ray absorption is normally collected on only one of ninety XDC wires with no signal on neighbouring wires, providing an x ray trigger ('one gap').

For the present analysis two data samples were used, one with no x ray enhancement and the other identical except for the 'one gap' demand. Charged collinear tracks were selected by fitting the coordinates for both tracks (negative and positive) for candidate events to a single arc. The momentum spectrum for events well repre-

mented by the single arc was then fit to a function describing two gaussian peaks on a constant background (Fig. 1). This procedure

Fig. 1 Fits to collinear momentum spectra for annihilation in gas (a) and for P wave annihilation (b).

improves resolution by more than a factor of three, so that kaon and pion peaks are well separated. The ratio of events in the kaon to pion peaks R, after correction for kaon decay in flight by Monte Carlo simulation, is obtained for each data set. In addition a value was obtained for 'one gap' events which were subjected to a further demand of x rays with pulse shape, pulse length, position and energy appropriate to L x rays (I_0 energy 1.74 KeV). With no x ray enhancement, $R=0.155(12)$, while the 'one gap' data sample yields $R=0.097(9)$. For events in which an L x ray was selected, $R=0.064(12)$; however, known backgrounds (from argon fluorescence and inner bremsstrahlung) exist in the L region so that the latter value is an upper limit. The quoted errors are statistical only.

The extraction of an absolute branching ratio for annihilation to $\pi^+\pi^-$ is foreseen shortly which, coupled with improved S wave measurements from current experiments in liquid H_2 , should provide further important tests of the annihilation mechanism.

REFERENCES

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