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Spin-Spin Correlations of Λ Hyperon Pairs Produced in Hadronic Z^0 Decays

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Correlation studies can provide valuable information on properties of the emitter of hadrons. The studies for boson pairs revealed the existence of an enhancement of the number of identical bosons with small difference of their momenta over that of non-identical bosons (the Bose-Einstein Correlation - BEC). Analogous phenomenon is expected for a pair of identical fermions in the triple spin state [1]. The number of fermion-fermion pairs with parallel spins and close to each other in phase space, could be depleted due to the Pauli exclusion principle. The observation of this effect would allow us to estimate the dimension of the identical fermions emitter, without the need of constructing uncorrelated reference samples which plagues the BEC studies for bosons. The above considerations led us to study spin-spin correlations of pairs of Λ hyperons produced inclusively in Z^0 decays [2]. The analysis was based on the sample of 3.5 millions of hadronic Z^0 decays collected in 1992÷95. The Λ hyperons were selected by reconstructing their decay vertices into $p\pi$. The purity of the selected Λ sample was further improved to 90% level employing particle identification in RICH and ionisation energy losses in the TPC. Events with at least one Λ hyperon pair in the same quark jet have been selected for the spin analysis. The data sample consists of 3650 ΛΛ pairs, 620 of which are pairs of identical fermions. The information on the spin composition of pairs has been extracted from distributions of the angle between two decay protons, each measured in its parent hyperon rest frame. The spin composition of spin triplet (S = 1) and spin singlet (S = 0) states have been determined for both identical and non-identical fermion pairs as a function of the difference Q of their momenta. The fraction of S = 1 component for the $\Lambda\bar{\Lambda}$ pairs was found to be consistent with 0.75 in whole analysed Q range. This value is expected for a statistical spin mixture. The spin composition of the ΛΛ ($\bar{\Lambda}\bar{\Lambda}$) system is different from a statistical spin mixture for $Q < 1.8$ GeV, being consistent with a dominance of S = 0 component. The effect observed allows us to estimate (Fig. 1) the spatial dimension (in units of fermi) of Gaussian ΛΛ emitter to be: $R = 0.11^{+0.05}_{-0.03}(stat) \pm 0.01(syst)$. The dimension of the emitter of identical Λ hyperons appears to be significantly smaller than that measured for identical boson pairs i.e. $(0.5 \div 0.75)$ fm.

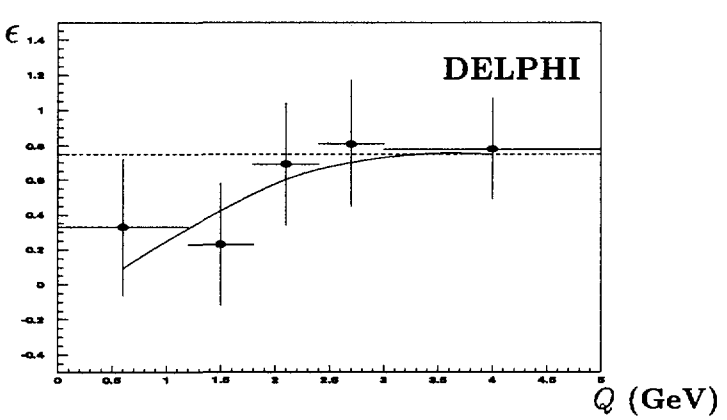

Fig. 1: Fraction of the S = 1 spin state for the ΛΛ system vs four-momentum difference Q. The dashed line corresponds to the statistical spin mixture.

References:

[1] G. Alexander and H.G. Lipkin, Phys. Lett. **B352** (1995) 162;

[2] T. Lesiak and H.Pałka, DELPHI 98-114 CONF 176 (submitted to Conf. HEP98, Vancouver, July 22-29).