

STUDY OF $\phi(1020)$, $D^{*\pm}$ AND B^* SPIN ALIGNMENT IN HADRONIC Z^0 DECAYS

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Abstract

Measurements of helicity density matrix elements have been made for the $\phi(1020)$, $D^{*\pm}$ and B^* vector mesons in multihadronic Z^0 decays in the OPAL experiment at LEP. Results for inclusive ϕ produced with high energy show evidence for production preferentially in the helicity zero state, with $\rho_{00} = 0.54 \pm 0.08$, compared to the value of $1/3$ expected for no spin alignment. The corresponding element for the $D^{*\pm}$ has a value of 0.40 ± 0.02 , also suggesting a deviation from $1/3$. The B^* result, with $\rho_{00} = 0.36 \pm 0.09$, is consistent with no spin alignment. Off-diagonal elements have been measured for the ϕ and D^* mesons; for the D^* the element $\text{Re}\rho_{1-1}$ is non-zero, indicating non-independent fragmentation of the primary quarks.

The spin alignment of vector mesons produced in Z^0 decays in the OPAL experiment at LEP has been studied and these measurements compared with the expectations of those models of hadronisation that make predictions for spin alignment of inclusively produced vector mesons in e^+e^- annihilation.

The production and decay properties of vector mesons can be described by the helicity density matrix: a 3×3 hermitian matrix, $\rho_{\lambda\lambda'}$, whose diagonal elements are the relative intensities of the spin components -1, 0 or 1. An even mix of helicity states, $\rho_{00}=1/3$, is conventionally considered unaligned. Measurements of the value of ρ_{00} of vector mesons are obtained from the polar angular decay distribution and off-diagonal elements from the azimuthal angular distribution. A number of models place limits on the value of ρ_{00} . Simple spin counting models constrain ρ_{00} to $0 < \rho_{00} < 1/2$ whilst other models suggest various values in the range 0 to 1.

OPAL's full LEP1 sample, consisting of 4.3 M $e^+e^- \rightarrow Z^0$ events has been analysed and the decays $\phi(1020) \rightarrow KK$; $D^* \rightarrow D^0 \pi_{\pm}^{\pm}$ where $D^0 \rightarrow K^- \pi^+$; and $B^* \rightarrow B + \gamma$ selected. The measurements of spin alignment made from these reconstructed vector mesons are shown in Table 1. These results indicate that ϕ mesons containing primary $q(\bar{q})$ from Z^0 decay are spin aligned.

	ρ_{00}	$Re\rho_{1-1}$	$Im\rho_{1-1}$
$\phi \rightarrow KK$	0.53 ± 0.08	-0.11 ± 0.07	0.06 ± 0.07
$D^* \rightarrow D^0 \pi$	0.40 ± 0.02	-0.04 ± 0.01	-
$B^* \rightarrow B\gamma$	0.36 ± 0.09	-	-

Table 1: The results of measurements of the spin alignment of vector mesons

This is barely consistent with spin counting models. The D^* also has $\rho_{00} > 1/3$ and is consistent with spin counting only if the vector to pseudoscalar rate in the D sector is > 3 , which is not observed to be the case. The B^* has ρ_{00} quite consistent with $1/3$. The non-zero diagonal spin density matrix elements for the ϕ and D^* favour non-independent fragmentation.

References

- [1] The OPAL Collaboration, K. Ackerstaff et al., CERN-PPE/97-05