Comments on the Simultaneous Measurement of Charged and Neutral Components of multi-hadron events

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Abstract

Comprehensive measurement of neutral and charged secondary particles from the same event may not be necessary and is certainly difficult and expensive. $\eta(549)$, $\rho(770)$, $\omega(784)$, $\phi(1019)$, etc. have substantial all neutral or all charged decay modes and so can be studied separately.

Correlations between the energy given to neutral and charged particles need not be obtained on an event by event basis. Suggestions for charged particles measurement with magnetic momentun analysis and neutral detection with no magnetic field will be presented.

The purpose of this note is to point out the large amount of physics which can be learned by separately measuring charged (C) and neutral (N) events. If the two functions are combined within a single apparatus (CN), each is compromised and the range of accessible physics is not substantially broadened.

Inclusive Reactions

The following table summarized the principal decay modes and branching ratios of several particle states

$\eta(549)$	$\rightarrow \pi^+\pi^-\pi^o$	24%
	$\rightarrow \gamma\ \gamma$	38%
	$\rightarrow \pi^o\pi^o\pi^o$	30%
$\rho^{+,-,o}(770)$	$\rightarrow \pi\pi$	100%
$\omega(784)$	$\rightarrow \pi^o\pi^o\pi^o$	90%
	$\rightarrow \pi^o\gamma$	9%
$\phi(1019)$	$\rightarrow k^+k^-$	47%
	$\rightarrow k_L K_S$	35%
$f(1270)$	$\rightarrow \pi^+\pi^-$	80%
	$\rightarrow k\ \bar{k}$	5%
$\omega(1675)$	$\rightarrow \rho\pi$	90%

As can be seen, with the exception of the $\omega(1675)$, each particle has a substantial all neutral or all charged decay modes so its inclusive production spectrum can be studied without CN detection. For example, $\omega(784)$ and $\eta(549)$ production is amendable to N detection and ρ and f to C. Similar considerations apply to K^*'s, N^*'s and Δ's. However, it would be prudent to optimize any detector for particle identification.

Exclusive Processes

$e^+e^- \rightarrow \rho^+\rho^-$ is of interest since $e^+e^- \rightarrow \rho^o\rho^o$ is forbidden. This requires CN detection but certainly need not be attempted in the first round of experiments.

Energy Crisis

Much has been made of the excessive energy going into (undetected) neutral particles at SPEAR. However the extent of the "crisis" depends on the accuracy of charged $K/\pi/p$ identification. Nevertheless it is important to measure the fraction of energy going into neutral and charged particles, but there seems to be no compelling reason why this need be done on event by event basis.

Apparatus

The requirements of charged particle identification indicate long track lengths for time-of-flight measurements. Using the curves of Mast and Nelson,[2] we see that a 2m flight path and 0.5 ns resolution would permit $\pi/k/p$ separation to about 1 GeV. Long path lengths provide sufficient decay length for the study of K^o, Λ, and Ξ^o.

Neutral (i.e. γ) identification requires a large converter with good spatial and energy resolution. If this requirement is combined with the long track lengths for charged identification, an enormous amount of NaI or lead glass is required.

Conclusions and Recommendations

A low momentum charged hadron detector is feasible with a large magnetic volume if it need not be surrounded by γ detection. In this case, coil thickness is not important so power requirements need not be large. Such a large volume would permit accurate time-of-flight identification and ample decay length of K, Λ, Ξ^o, Ξ^o.

A small all-γ detector can be built economically if no magnetic is employed.

The physics accessible to these devices should keep us busy for quite a while. In any event, CN detection is not immediately necessary.

References

1. Particle Data Group, April 1973
2. Terry Mast and Jerry Nelson, "Some Design Considerations for a large Solid Angle Charged plus Neutrals Detector for e^+e^- Storage Rings" 8/21/74, PEP-153.