OZI rule violation in vector meson production at COMPASS

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Motivation

Okubo-Zweig-Iizuka rule\(^1\): processes with disconnected quark lines suppressed \(\phi(1020)\) to \(\omega(782)\) production ratios (\(A\) and \(B\) non-strange hadrons), not corrected for phase-space\(^2\):

\[
\frac{\sigma(AB \rightarrow \phi X)}{\sigma(AB \rightarrow \omega X)} \simeq \tan^2(\theta - \theta_0) \simeq 4.2 \cdot 10^{-3}
\]

Numerous violations observed, possible explanations:

- reactions on nucleons: \(s\bar{s}\) production due to strangeness content of proton
- intermediate (gluon-rich) states

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No data available for higher energies

**Study at COMPASS:**

Compare $\phi(1020) \rightarrow K^+ K^-$ to $\omega(782) \rightarrow \pi^+ \pi^- \pi^0$ production
The COMPASS spectrometer at CERN

190 GeV/c $\pi^\pm/K^\pm/p$ beam
2 stage high resolution spectrometer
with large acceptance

beam PID with CEDAR detectors
particle ID with RICH and Calorimetry

hep-ex/0703049, NIM A 577, 455 (2007)
update in preparation
Event selection

Interest in $p p \rightarrow p (\pi^+ \pi^- \pi^0) / (K^+ K^-) p$ final states

- select event topology (charged tracks, reaction inside target volume, recoil proton etc.)
- ID $K^+$ with RICH, $\pi^0$ with ECALs
- conservation of charge, exclusivity

![Graph showing event selection criteria](image-url)
Reaction Kinematics

COMPASS 2008

\[ p \ p \rightarrow p \ \pi^+ \pi^- \pi^0 \ p \]

not acceptance corrected

preliminary
Invariant mass distributions ($K^+ K^-$)

COMPASS 2008

$p p \rightarrow p_f K^+ K^- p_s$

not acceptance corrected

preliminary
Invariant mass distributions \((\pi^+\pi^-\pi^0)\)

**COMPASS 2008**

\[ p p \rightarrow p \pi^+\pi^-\pi^0 p \]

not acceptance corrected

- \(\omega(782)\)
- \(\eta(550)\)
- \(a_2(1320)\)
Test OZI violation: Analysis

1. fit invariant mass distributions with Breit-Wigner folded with Gaussian plus polynomial background in $x_F$ bins ⇒ yields
2. correct for acceptance and branching ⇒ corrected yields
3. calculate $R = \frac{\text{Number of } \phi}{\text{Number of } \omega}$
Test OZI violation: Result

N.B.: Included only systematics from fit and ECAL reconstruction, additional effects are still under investigation
Outlook and Conclusions

Preliminary results from 2008 proton campaign (one week):

**OZI violation of a factor 3 at 190 GeV beam energy**

Ongoing:
- 2009 data sample (> 5x statistics of 2008)
- OZI tests w.r.t. $t'$
- Improved Monte-Carlo (multi-dim. acceptance)
- $\omega/\phi$ spin alignment $\Rightarrow$ production mechanisms
Spares
Exclusivity

COMPASS 2008

\[ p \ p \rightarrow p \ \pi^+\pi^-\pi^0 \ p \]

not acceptance corrected

Selection of exclusive events: energy balance 191 GeV ± 6 GeV
Production mechanism

COMPASS 2008

$p p \rightarrow p \pi^+\pi^-\pi^0 p$

not acceptance corrected

Ongoing: binning the ratio

\[ R = \frac{\text{Number of } \phi}{\text{Number of } \omega} \text{ in } t \]
Background

Composition 2008 data sample: exclusive vs. non-exclusive

COMPASS 2008

p p → p π^+π^-π^0 p

not acceptance corrected

Important for background studies