OZI test in vector meson production with the COMPASS experiment

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Motivation

Okubo-Zweig-Iizuka rule\(^1\): processes with disconnected quark lines suppressed

\[ \Phi \{ s \rightarrow s \} \quad \Phi \{ u \rightarrow d, d \rightarrow \pi^+ \} \quad \Phi \{ s \rightarrow s, d \rightarrow \pi^0 \} \quad \Phi \{ s \rightarrow s, d \rightarrow \pi^- \} \]

OZI forbidden

\[ \Phi \{ s \rightarrow s \} \quad \Phi \{ u \rightarrow u \rightarrow K^- \} \]

OZI allowed

Calculation\(^2\) for \(\phi(1020)\) to \(\omega(782)\) production ratios (\(A\) and \(B\) non-strange hadrons), not corrected for phase-space:

\[ \sigma(AB \rightarrow \phi X)/\sigma(AB \rightarrow \omega X) = 4.2 \cdot 10^{-3} \]

Numerous violations observed, possible explanations:

- reactions on nucleons: strangeness content of the nucleon enhances \(s\bar{s}\) production
- intermediate (gluon-rich) states
- differences in production mechanisms


Violations of the OZI rule / COMPASS

No data available for higher energies\(^3\)

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

Hadron spectroscopy
*cf.* talk K.Schönning

Spin physics
*cf.* talk C.Schill

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

COMPASS 2008

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

not acceptance corrected

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

COMPASS 2008

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

not acceptance corrected

$\phi(1020)$

$a_2(1320)$

$f_0(1500)/f_2'(1525)$
Invariant mass distributions \((\pi^+ \pi^- \pi^0)\)

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

not acceptance corrected

COMPASS 2008

\(\omega(782)\)

\(\eta(550)\)

\(a_2(1320)\)
Reaction Kinematics

COMPASS 2008

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

not acceptance corrected

preliminary
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**

- proton beam data allows for differential studies
- data sample 2 orders of magnitude larger compared to former experiments

Ongoing studies:

- further systematic studies
- improved background estimation (include possible coherent background)
- measurement of $\omega/\phi$ spin alignment via Gottfried-Jackson angles
  $\Rightarrow$ production mechanisms
Spares
Selection of exclusive events: energy balance $191 \text{ GeV} \pm 6 \text{ GeV}$
Production mechanism

COMPASS 2008

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

not acceptance corrected

Ongoing: binning the ratio

\[ R = \frac{\text{Number of } \phi \text{ in } t'}{\text{Number of } \omega \text{ in } t} \]
Background

Composition 2008 data sample: exclusive vs. non-exclusive

COMPASS 2008

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

not acceptance corrected

Important for background studies