Multiplicity dependence of strange and multi-strange particle in jets in pp collisions at $\sqrt{s} = 7$ TeV

authors

Abstract

Comprehensive results on the production of unidentified charged particles, $\pi^{\pm}$, $K^{\pm}$, p, K^0_S, K^{*0}, ϕ, Λ, $\Xi^{\pm}$, $\Omega^{\pm}$ hadrons in jets in proton-proton (pp) collisions at $\sqrt{s} = 7$ TeV are presented with two developed color reconnection models, the new color reconnection model and the rope hadronization model, in PYTHIA 8 generator. The observables are ratios of identified hadron yields as a function of the transverse momentum (p_{T}) and the final-state activity (the charged multiplicity).

1 Introduction

In heavy-ion collisions at ultra-relativistic energies, it is well established that a strongly coupled Quark-Gluon-Plasma (QGP) is formed [**? ? ? ? ?**]. Recent measurements in high multiplicity pp, p–A and d–A collisions at different energies have revealed strong flow-like effects even in these small collision systems [**? ? ? ? ? ? ? ? ? ? ?**]. In a recent letter [**?**], the ALICE Collaboration reported the multiplicity dependent enhancement of strange ($\mathrm{K^0_S}$, Λ and $\overline{\Lambda}$) and multi-strange (Ξ^-, $\overline{\Xi}^+$, Ω^- and $\overline{\Omega}^+$) particle in pp collisions at $\sqrt{s}\ =\ 7$ TeV. As well as, those results were complemented by the measurement of $\pi^{\pm}$, $\mathrm{K}^{\pm}$, p, $\overline{\mathrm{p}}$, K^{*0} and ϕ with ALICE [**?**].

In a recent study, the ALICE Collaboration has studied baryon-to-meson ratios with a new method: by studying the ratios in two parts of the events separately – inside jets and in the event portion perpendicular to a jet cone [**?**].

In contrast to the inclusive distribution, the $\Lambda/\mathrm{K^0_S}$ ratio within jets in pp and p–Pb collisions does not exhibit baryon enhancement. It is plausible that the baryon enhancement may therefore be attributable to the soft (low Q^2) component of the collision as discussed in [**?**]. This results disfavors the hard-soft recombination models, while it is consistent with a picture in which the value of baryon/meson ratio has two independent mechanisms: i) the expansion of the soft particles of the underlying event within a common velocity field (radial flow), and ii) the production of particles via hard parton-parton scatterings and the subsequent jet fragmentation. This comprehensive set of data does allow for a detailed test of production models.

Such behaviour cannot be reproduced by any of the MC models commonly used, suggesting that further developments are needed to obtain a complete microscopic understanding of strangeness production and indicating the presence of a phenomenon novel in high-multiplicity pp collisions.

The theoretical picture of collective effects in heavy ion collisions is vastly different from the picture known from pp collisions. Due to the very different geometry of the two system types, interactions in the final state of the collision become dominant in heavy ion collisions, while nearly absent in pp collisions.

To provide a description of the hadrochemistry in the underlying event of pp collisions, it has been suggested a "rope hadronization" model [**?**], based on work by Biro, Knoll and Nielsen [**?**]. This model provides corrections to the string hadronization model, by allowing strings overlapping in transverse space to act coherently as a "rope". The model is implemented in the DIPSY event generator [**?**], which provides a dynamical picture of the event structure in impact parameter space, allowing for a calculation of the colour field strength in each small rope segment[1]. This formalism also includes all fluctuations. The colour field is characterized by two quantum numbers p, q, which together signifies its SU(3) multiplet structure. Lattice calculations have shown [**?**], that the string tension – energy per unit length – scales with the quadratic Casimir operator of the multiplet, such that the ratio of the enhanced rope tension ($\widetilde{\kappa}$) to the triplet string tension in vacuum κ is:

In this study we consider two of the models: the new colour reconnection (CR) model [**?**] and the colour rope model [**?**] in the PYTHIA 8 generator.

[1] A Lund string is in its simplest form, a straight piece stretched between a quark and an anti-quark, or a colour triplet and anti-triplet. As gluons are added to the string, they act as point-lik "kinks" on the string, carrying energy and momentume [**?**]. We will denote all straight pieces between gluons or (anti)quarks string segments. A $q-g-\overline{q}$ string thus has two segments.

2 Models

3 Compare to data

4 Predictions

5 Summary

References

53 # A Model parameters

Parameters	Values
MultiPartonInteractions:pT0Ref	2.15
BeamRemnants:remnantMode	1
BeamRemnants:saturation	5
ColourReconnection:reconnect	on
ColourReconnection:mode	1
ColourReconnection:allowDoubleJunRem	off
ColourReconnection:m0	0.3
ColourReconnection:allowJunctions	on
ColourReconnection:junctionCorrection	1.2
; ColourReconnection:timeDilationMode	2
ColourReconnection:timeDilationPar	0.18

Table A.1: Colour reconnection model parameters

Parameters	Values
Ropewalk:RopeHadronization	on
Ropewalk:doShoving	on
Ropewalk:tInit	1.5
Ropewalk:deltat	0.05
Ropewalk:tShove	0.1
Ropewalk:gAmplitude	0.
Ropewalk:doFlavour	on
Ropewalk:r0	0.5
Ropewalk:m0	0.2
Ropewalk:beta	0.1

Table A.2: Rope hadronization model parameters