

$\Lambda(1520)$ resonance production with respect to transverse sphericity using EPOS3+UrQMD

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51st International Symposium on Multiparticle Dynamics (ISMD2022)
Pitlochry, Scottish Highlands, 1-5 August 2022
doi:[10.21468/SciPostPhysProc.15](https://doi.org/10.21468/SciPostPhysProc.15)

Abstract

Resonances are sensitive to the properties of the medium created in heavy ion collision. They also provide insight into the properties of the hadronic phase. Studying the dependence of the yield of resonances on transverse sphericity and multiplicity allows us to understand the resonance production mechanism with event topology and system size, respectively. The results reported pertain to $\Lambda(1520)$, using predictions from EPOS3+UrQMD event generator.



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Published by the SciPost Foundation.

Received 29-09-2022

Accepted 28-08-2023

Published 03-04-2024

doi:[10.21468/SciPostPhysProc.15.027](https://doi.org/10.21468/SciPostPhysProc.15.027)



1 Introduction

At collider experiments, a major challenge is to understand production/interaction of resonances in a hot dense medium because their lifetime is comparable to that of hadronic phases [1]. Resonance particle $\Lambda(1520)$ having a life-time between $K^{*0\pm}(980)$ and $\phi(1020)$ make it a good candidate to understand the hadronic phase [2, 3]. Here we are analysing production of $\Lambda(1520)$ with respect to transverse sphericity S_0 using the EPOS3 event generator [4–6] with UrQMD as an afterburner to simulate the hadronic rescatterings after hadronisation.

Transverse sphericity is an event shape variable which help to distinguish between isotropic and jetty events. Its value ranges from 0 to 1 and it is given by

$$S_0 = \frac{\pi^2}{4} \min_{\vec{n}=(n_x, n_y, 0)} \left(\frac{\sum_i |p_{\vec{n}_i} \times \hat{n}|}{N_{\text{particles}>5}} \right)^2,$$

where

$$S_0 = \begin{cases} 0, & \text{“pencil-like” limit (hard events),} \\ 1, & \text{“isotropic” limit (soft events),} \end{cases}$$

Table 1

(a) Percentile of multiplicity distribution.

| No. of charged particle | Percentile (lower) | Percentile (upper) |
|-------------------------|--------------------|--------------------|
| 28 - 110 | 90-100% | 0-10% |
| 18-28 | 70-90% | 10-30% |
| 11 - 18 | 40-70% | 30-60% |
| 0-110 | 0-100% | 0-100% |

(b) Quantile of sphericity distribution.

| Multiplicity(%) | Jetty 0-10% (lower) | Isotropic 0-10% (upper) |
|-----------------|---------------------|-------------------------|
| 0-100 | 0.00-0.381 | 0.834-1.00 |
| 0-10 | 0.00-0.644 | 0.896-1.00 |
| 30-60 | 0.00-0.442 | 0.824-1.00 |

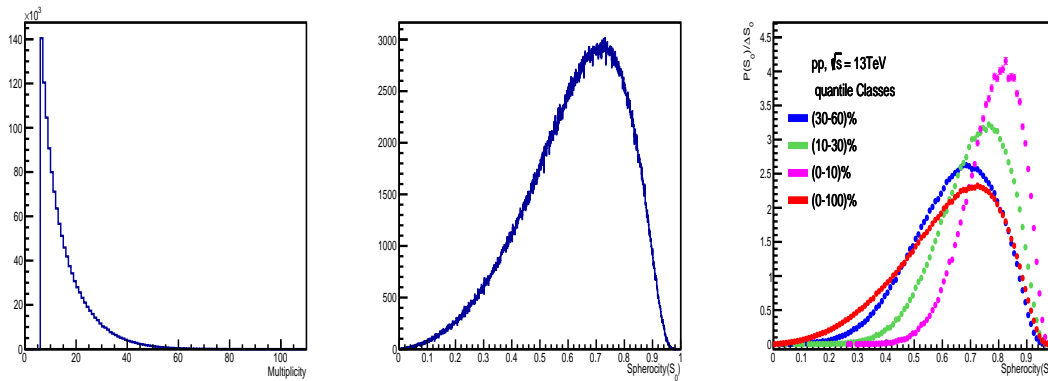


Figure 1: Shows distribution of: (a) Charge particle multiplicities. (b) Transverse sphericity. (c) Transverse sphericity vs multiplicity.

and \hat{n} is a two dimensional unit vector in the transverse plane, chosen such that S_0 is minimised. By restricting it to the transverse plane, transverse sphericity becomes infrared and collinear safe. Also the jetty events are usually hard events while the isotropic ones are the result of soft processes [7–10].

2 Distribution plots

For the present study, events having more than 5 charge particles are considered. Moreover, to study in various multiplicity intervals and transverse sphericity classes, we separated events into the 0-10% quantile (high multiplicity) and 30-60% quantile (low multiplicity). To disentangle the sphericity classes i.e jetty and isotropic events, we have applied event-selection cuts on the sphericity distribution. The values, cuts and definition of various multiplicity percentile and sphericity classes can be found in Table 1a and 1b. We observed that the sphericity distributions are shifted toward 1 from the low multiplicity quantile to the high multiplicity one. Figure 1 displays charged particle multiplicity, transverse sphericity and sphericity as a function of multiplicity.

3 pT spectra of $\Lambda(1520)$

Figure 2(2a,2b) shows the pT-spectra of $\Lambda(1520)$ for 0-10% and 30-60% multiplicity classes with top and bottom 10% sphericity values responsible for selecting jetty and isotropic events respectively. The bottom panels show the ratio with respect to the sphericity integrated class.

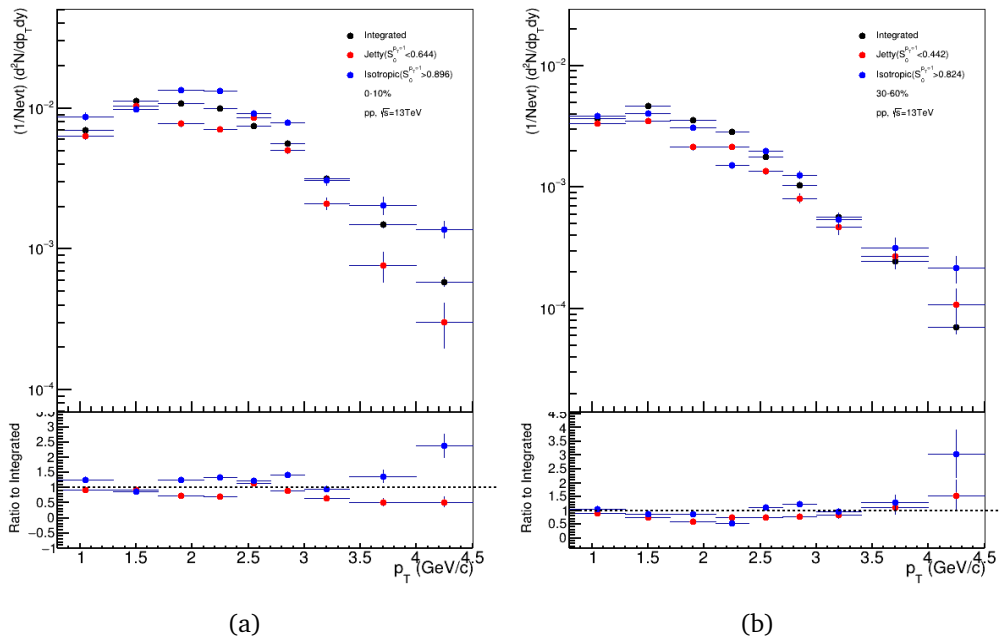


Figure 2: (a) p_T spectra of $\Lambda(1520)$ evaluated at 0-10% multiplicity for Isotropic(blue), Jetty (red) and Integrated(black). (b) p_T spectra of $\Lambda(1520)$ evaluated at 30-60% multiplicity for Isotropic(blue), Jetty (red) and Integrated(black).

4 Conclusion

A study of the transverse sphericity of $\Lambda(1520)$ in p-p collisions at $\sqrt{s} = 13$ TeV using EPOS3 generator with UrQMD as afterburner was reported. The observables are measured using primary charge particles and reported as a function of charged particle multiplicity for events with different scales defined by the transverse sphericity. As can be seen in Figure(1c),jetty events dominate the low-multiplicity region. However, we see that production of $\Lambda(1520)$ is dominated in both multiplicity regions by isotropic event shapes, since EPOS is a parton model, with many parton-parton binary interaction,so highest multiple interaction(MPI) mean dominance in isotropic event(soft QCD). An experimental investigation in this direction would be very beneficial to comprehend the event shape dependence of system dynamics.

Acknowledgements

We thank Vikash Sumberia, Randhir Singh and Dr. Ranbir Singh for inspiring us to do this work and providing also valuable advice. Thanks are also due to Johannes Jahan Ph.D. student in Subatech, Nantes -France for helping us to understand technical term in EPOS3.

Funding information This work was supported by Council of Scientific and Industrial Research (CSIR), India. The authors acknowledge the HEP Lab. Department of Physics, University of Jammu for providing infrastructure for computing etc.

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