Mass modification of rho meson at SIS 300 energy

Soumya Sarkar, Amitabha Mukhopadhyay
Department of Physics, University of North Bengal, Siliguri 734013, India

Subhasis Chattopadhyay
Variable Energy Cyclotron Centre, 1/AF Bidhannagar, Kolkata 700064, India

The Compressed Baryonic Matter (CBM) experiment at the Facility for anti-proton and ion research (FAIR) [1] is being designed to investigate the baryonic matter under extreme thermodynamic conditions. The CBM experiment offers a possibility to discover the most prominent landmarks of the QCD phase diagram expected to exist at high net baryon densities – the first order deconfinement phase transition and the critical end point. At high baryon densities hadrons are expected to change their properties and chiral symmetry to be restored. Special focus is set on the rare observables such as the charm and dilepton production, as these observables can give an insight into the hot and dense medium created in high-energy heavy-ion collisions.

The present work is done within the CBM simulation framework which allows full event reconstruction. We have used (i) the PLUTO generator [2] for phase space decay of the vector mesons taking multiplicities from HSD [3], (b)the URQMD generator [4] for the background particles and (c) the GEANT3 [5] for transport of the generated particles through the setup. The CBM-dimuon setup consists of a set of silicon tracking stations (STS) followed by a muon detection system (MUCH).

For low mass vector mesons we have used the MUCH compact geometry comprising of 5 absorbers having a total length of 125 cm with 5 stations each consisting of 3 GEM type detectors. Different theoretical models and data from SPS indicate the broadening of the width and/or a shift of the peak of the spectral function for low mass vector mesons (ρ, ω etc) [6]. The in-medium spectral function of these short-lived vector mesons can be measured directly via their decay into dileptons. Since leptons are very little affected by the passage through the high density baryonic matter, they provide almost undistorted information on the conditions in the interior of the collision zone. It is expected that with the increase in the baryon density at FAIR energies, vector mesons will melt inside the central fireball. In our

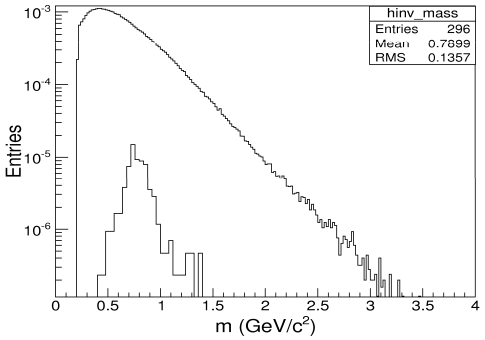

FIG. 1: Invariant mass spectra of the reconstructed rho mesons in presence of hadronic background generated by UrQMD

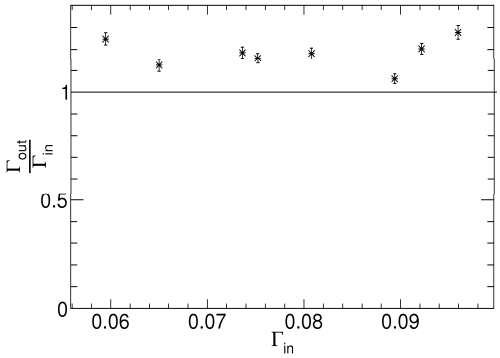

FIG. 2: Ratio of output and input width of rho mesons plotted against input width

TABLE I: Mass variation of ρ meson within a dense baryonic environment

Input		Output		OP-IP Ratio	
Centre	Width	Centre	Width	Centre	Width
0.765(0.0008)	0.059(0.0010)	0.764(0.0045)	0.074(0.0053)	0.998(0.0010)	1.247(0.0278)
0.763(0.0010)	0.065(0.0012)	0.770(0.0045)	0.073(0.0054)	1.009(0.0013)	1.123(0.0280)
0.765(0.0010)	0.073(0.0012)	0.776(0.0057)	0.087(0.0068)	1.014(0.0013)	1.184(0.0265)
0.765(0.0011)	0.076(0.0012)	0.770(0.0057)	0.087(0.0056)	1.006(0.0015)	1.156(0.0231)
0.762(0.0011)	0.080(0.0014)	0.779(0.0058)	0.095(0.0059)	1.022(0.0015)	1.180(0.0252)
0.761(0.0012)	0.089(0.0014)	0.778(0.0066)	0.095(0.0063)	1.022(0.0016)	1.059(0.0218)
0.758(0.0014)	0.093(0.0015)	0.771(0.0068)	0.110(0.0070)	1.017(0.0019)	1.202(0.0251)
0.759(0.0013)	0.096(0.0015)	0.772(0.0085)	0.122(0.0143)	1.017(0.0018)	1.273(0.0312)

present analysis the sensitivity of MUCH in measuring the modification in the width of the invariant mass spectra of the rho mesons in presence of hadronic background, has been studied.

The inputs used for this analysis are as following: (i) 5K PLUTO generated rho mesons with thermal distribution in transverse momentum and Gaussian distribution in rapidity are used as signal, and (ii) 5K UrQMD Au+Au events at 35A GeV comprise the hadronic background. Optimized cuts are applied for muon detection. The invariant mass spectra of the reconstructed rho mesons in presence of hadronic background for one set of our simulated data is shown in Fig 1. Appropriate normalisation (scale) factor arising out of the multiplicity distribution and branching ratios, is incorporated into the distributions. Table 1 gives the correspondence between gaussian fitted width of reconstructed invariant mass spectra of rho mesons with the input width which are varied slowly from 0.059 GeV/c^2 to 0.096 GeV/c^2 keeping the centroid same. We have also caculated the ratio (α) of the width of the output distribution (Γ_{out}) to that of the input distribution (Γ_{in}) (col. 6 of Table I). The corresponding statistical errors are shown within parenthesis. The plot of α with Γ_{in} is shown in Fig 2. Our analysis shows a variation (broadening) of the mass distribution of ρ mesons after they pass through the detector set up (Fig 2). This indicates that our detector is quite sensitive to determine the mass modification of the ρ mesons within a dense baryonic matter.

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References

[1] CBM Collabn., Compressed Baryonic Matter Experiment: Technical Status Report, GSI, Darmstadt (2005).
[2] http://www-hades.gsi.de/computing /pluto
[3] W. Cassing, E. L. Bratkovskaya and S. Juchem, Nucl. Phys. A674, 249 (2000).
[4] S. A. Bass et al., Prog. Nucl. Part. Phys. 41, 255 (1998).
[5] R. Brun et al., GEANT User Guide, CERN/DD/EE84-1 (1986).
[6] R. Arnaldi et al., Phys. Rev. Lett. 96, 162302 (2006).