Title:	A Unified Description of the Particle Production in Heavy-ion Collosion
Authors:	Gupta, Rohit
Keywords:	Particle Heavy-ion
Issue Date:	Jun-2022
Publisher:	IISER Mohali
Abstract:	Search for Quark-Gluon Plasma (QGP), a deconfined state of quarks and gluons, is the pri- mary motivation behind several experimental as well theoretical studies in particle physics. Formation of the QGP state requires extreme condition of temperature and energy density. Such conditions are believed to exist during the birth of our universe. However, those astro- nomical observable effectively washed out due to the subsequent evolution of the universe, and the only means to study this fundamental state of matter is via the collision of heavy nuclei in the laboratory. Thus, the study of QGP, which enables a detailed and quantitative characterization of the high density, high temperature phase of strongly interacting mat- ter, together with the exploration of new phenomena, are some of the important milestones where we can fully exploit the scientific potential of the front-line experiments at RHIC and LHC. Some of the questions that are crucial in understanding the nature of QGP includes the study of the nature of phase transition between confined hadronic state and the deconfined QGP state and to determine the location of the critical point in the QCD phase diagram, the point where the first-order phase transition line terminates. In order to quantify the confinement-deconfinement phase transition and to search for the critical point, the QCD phase diagram has been scanned by varying collision energy and studying the thermody- namical properties such as temperature and the baryon chemical potential of the system created during such collision. Extracting the temperature, which is a crucial ingredient of the phase diagram, requires a proper parameterization of transverse momentum (p T) spec- tra. Although the standard theoretical description of the strong interaction comes from the QCD, however, due to the asymptotic freedom of the QCD coupling constant, it is difficult to apply QCD theory to study the p T -spectra. In this direction, several phenomenological models with varied physics motivation have been developed to study the spectra of final state particles produced in high energy collision.Although there are several phenomenological models, ranging from statistical thermal models such as Boltzmann-Gibbs statistics & Tsallis statistics to the hydrodynamical mod- els such as Blast-Wave & Tsallis blast-wave model, majority of them apply only to the low-p T region. It is important to mention here that particle production in high energy col- lision can be classified into two separate categories. The low-p T particles are produced by the soft processes, whereas the hard scattering process contributes to the majority of particles in the high-p T region. These models have been used extensively to study the transverse momentum spectra in the low-p T region. For fitting the high-p T region, a well defined, QCD inspired power-law form of the distribution function is used. Since there is no fine line separating these two regions, a unified formalism which can explain both the low- and high-p T region is still an open problem and important to tap into the full poten- tial of the high energy collision experiment measuring the spectra over a broad p T range. In the thesis, we have discussed a unified thermodynamical framework based on the Pear- son probability distribution function to study both low- and high-p T region in a consistent manner. Pearson distribution is a generalized probability function, which under limits on its parameters, reduces to other distributions such as Gaussian, Gamma, Beta, Student's t distribution, etc. We have provided the first application of the Pearson formalism in study- ing the particle production spectra in high energy collision. We have discussed the detailed mathematical formulation of the unified statistical framework. This thesis also discusses the detailed derivation of the thermodynamical consistency and the backward compatibility of this model. The fit results obtained using this formalism on the transverse momentum spectra at different collision energies, centralities and the collision system are provided, along with its application to study other quantities such as the response function etc.
URI:	http://hdl.handle.net/123456789/5529
Appears in Collections:	PhD-2015

Files in This Item:

File	Description	Size	Format	
PHD_THESIS_Final.pdf		3.41 MB	Adobe PDF	View/Open