Government of West Bengal

Government General Degree College, Kalna-I

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Date: 06-03-2024

To Whom It May Concern

This is to certify that the college has no objection in permitting **Dr. Mahatsab Mandal, Assistant Professor in Physics** to continue his research/academic linkages/activities with the **Department of Physics, Mugberia Gangadhar Mahavidyalaya** started in **2020** without hampering the normal duties of the college.

I wish him all success in life.

Principal

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This is to certify that the college has no objection in permitting **Dr. Wadut Shaikh, Assistant Professor in Physics** to continue his research/academic linkages/activities with the **Department of Physics, Government General Degree College, Kalna-I** started in **2020** without hampering the normal duties of the college.

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Eur. Phys. J. Plus (2023) 138:598
https://doi.org/10.1140/epjp/s13360-023-04208-6

THE EUROPEAN PHYSICAL JOURNAL PLUS

Regular Article

Nuclear modification factor of average D mesons in an anisotropic quark–gluon plasma at the LHC energies

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Received: 10 March 2023 / Accepted: 19 June 2023

Abstract We evaluate the nuclear modification factor (R_{AA}) of average D mesons at center of mass energies $\sqrt{s_{\mathrm{NN}}} = 2.76$ TeV and 5.02 TeV in two centrality classes incorporating radiative energy loss in an anisotropic quark–gluon plasma (aQGP). A simple (1+1)d hydrodynamic model is used to describe the space-time evolution of the aQGP. We compare our results with the ALICE and CMS measurements and it is found that the data are consistent if the isotropization time, τ_{iso}, is between 2 and 4 fm/c. We also plot the ratio of R_{AA} at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV to 2.76 TeV and find it to be consistent with the model prediction existing in the literature.

1 Introduction

In ultra-relativistic heavy-ion collisions, the hadronic matter undergoes a phase transition to a new state of matter which is characterised by high temperature and energy density. According to Quantum Chromodynamics (QCD), such extreme conditions lead to the formation of a deconfined medium of quarks and gluons, known as Quark–Gluon Plasma (QGP) [1, 2]. Many experimental evidences support the production of the deconfined medium at Brookhaven National Laboratory in Relativistic Heavy Ion Collider (RHIC) experiments [3] and at CERN in Large Hadron Collider (LHC) experiments [4]. One of the most striking signatures of the deconfined medium produced in nucleus-nucleus (A–A) collisions is the suppression of high transverse-momentum hadrons compared to the binary scaled proton-proton (pp) collisions, commonly known as jet quenching [5–13]. The jets are produced at the very early stages of the collision. In A–A collisions, the initial hard partons lose energy via collisional and radiative processes inside the deconfined QCD medium and lead to the suppression of jets compared to the proton-proton collisions. The energy loss experienced by the initial hard partons of both light and heavy flavours in the deconfined medium is of considerable interest because it unravels the dynamical properties of the plasma medium. In addition to the jet quenching, several possible probes have been studied in order to characterize the properties of QGP.

The heavy quarks, i.e. charm and bottom, are produced in hard scattering processes at the initial stages of the heavy-ion collisions and while passing through the transient matter, they can interact with the medium and lose energy via both inelastic processes (radiative energy loss) and elastic scatterings (collisional energy loss). The partonic energy loss mechanism in the deconfined QCD medium has been developed remarkably [10, 14–17]. Experimentally, it can be probed by measuring the high-p_T hadrons emanating from the ultra-relativistic heavy-ion collisions.

The heavy quarks, after losing energy, fragment into open-charm (bottom) heavy mesons (D,B). The formation of the QGP can be established by measuring the energy loss vis-a-vis the nuclear modification factors (R_{AA}) of various heavy mesons such as D, B, J/Ψ, ϒ, etc. The experimental data at various LHC energies exhibit considerable modifications of the transverse-momentum spectra of these mesons in A–A collisions compared to pp collisions [18–26]. Different theoretical models have also been exploited to explain the data. In this work, we concentrate on the charm mesons p_{T} spectrum and nuclear modification factors within the ambit of anisotropic quark–gluon plasma (aQGP) [27] and extract the isotropization time, τ_{iso} by comparing with the experimental data. In the following paragraph, we argue how an aQGP can be realised in relativistic heavy-ion collisions.

It is to be noted that many properties of the QGP probes are still poorly understood. The most relevant question is whether the medium produced in the relativistic heavy-ion collisions is in thermal equilibrium or not. The experimental studies of the

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Published online: 09 July 2023

Source details

European Physical Journal Plus

Scopus coverage years: from 2011 to Present

Publisher: Springer Nature

ISSN: 2190-5444

Subject area: Chemical Engineering: Fluid Flow and Transfer Processes | Physics and Astronomy: General Physics and Astronomy

Source type: Journal

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