ID de Contribution: **156** Type: **Poster**

In-medium properties of open strange and open heavy flavour mesons in asymmetric nuclear matter: A QMC model study

mardi 4 juin 2024 19:42 (1 minute)

One of the important topics in strong interaction physics is the study of in-medium properties of hadrons, which has direct relevance to Heavy Ion Collision experiments. Several experiments, e.g. CERN-SPS, KEK-PS E325, RHIC-PHENIX, etc., have indicated the influence of the generated medium on the properties of the hadrons. In this work, we investigate the in-medium properties of open strange (K, $\bar{K}$), open charm (D, $\bar{D}$), and open bottom (B, $\bar{B}$) mesons in the asymmetric nuclear matter (ANM) using Quark Meson Coupling (QMC) model. Within this framework, a direct coupling of scalar (σ, δ) and vector (ω, ρ) mesons to the light quarks and anti-quark constituents of the mesons give rise to the medium modification of the properties of these pseudoscalar mesons. We examine the role of the δ (scalar iso-vector) meson which breaks the isospin degeneracy of the masses of the light quark and antiquark doublets and causes mass splitting between (u, d) as well as ($\bar{d}$, $\bar{u}$) and thus we observe the mass splittings within the isodoublets of K, $\bar{K}$, D, $\bar{D}$, B, and $\bar{B}$ mesons when embedded in ANM. Further, we analyze the excitation energies of the pseudoscalar mesons in the asymmetric nuclear matter. In ANM, due to the interaction of the pseudoscalar mesons with the vector iso-vector ρ meson as well as scalar iso-vector δ meson, there is a splitting in the excitation energies of the mesons within the isospin doublets. The isospin effects become more pronounced at higher baryon densities.

This study indicates a less favourable K^--condensation in the matter with a higher neutron fraction compared to the symmetric case. Additionally, it elucidates the in-medium behaviour of the meson potentials, unveiling the likelihood of substantial absorption for certain mesons that experience strong effective attractive potential within the medium. Such absorption may further lead to the formation of bound states with the nuclei. Therefore, the study of open strange as well as open heavy flavour (charm, bottom) mesons could yield significant observable consequences in terms of particle spectroscopy in the upcoming heavy ion collision experiments at the FAIR project at GSI, where the experiments are planned to be performed using neutron-rich beams to study the compressed baryonic matter.

References

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Auteurs principaux: MONDAL, Arpita (Indian Institute of Technology Delhi); Prof. MISHRA, Amruta (Indian Institute of Technology Delhi)

Orateur: MONDAL, Arpita (Indian Institute of Technology Delhi)

Classification de Session: Posters

Classification de thématique: Light-flavours and Strangeness