

In-medium properties of strange and heavy flavor mesons

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Abstract

In this thesis, we explore the influence of the nuclear environment on the properties of strange and heavy-flavor (charm and bottom) mesons. These studies are directly relevant to experimental investigations of the strong interaction in the non-perturbative, low-energy regime in understanding the low-energy meson-nucleon interaction. The implications of this work extend across diverse areas, from the search for exotic meson–nucleus bound states (mesic nuclei) to insights into the structure of compact astrophysical objects such as neutron stars. The study encompasses a comprehensive analysis of meson properties in both nuclear matter and finite nuclei. A significant focus of the thesis is dedicated to explore the possibility of formation of meson (K , D , B as well as ϕ , charmonia, and bottomonia) bound in atomic nuclei, mesic-nuclei bound states, arising due to the potentials experienced by the mesons while inside the nuclei.

The thesis starts with the investigations of in-medium masses of open strange and open heavy flavor mesons in symmetric and asymmetric nuclear matter, using quark–meson coupling (QMC) model, which are then extended to study formation of their bound states in atomic nuclei. The hidden-flavor (ϕ) meson-nucleus bound states are explored with the medium modification of ϕ meson properties, such as masses and decay widths, using the tree level $\phi K \bar{K}$ lagrangian, employing the in-medium masses of K and $\bar{K}$ mesons as calculated within the QMC model. On the other hand, masses of the hidden heavy flavor mesons are evaluated using a generalized linear sigma model, where the medium modifications are driven by a scalar dilaton field, which simulates the gluon condensates of QCD. This work also attempts to understand the effects of density, isospin asymmetry, and temperature of the nuclear medium on the quarkonia masses and using the effective quarkonia-nuclei potentials, estimates the binding energies of the heavy Quarkonium-nuclear bound states. In addition, we discuss the feasibility of observing such states and examine the influence of the nuclear environment by tracing their possible signatures.