Contribution ID: **14** Type: **not specified**

Heavy flavor transport and exotic hadron production in heavy ion collisions

Friday, 15 July 2022 09:30 (20 minutes)

For heavy ion collisions in the TeV beam energy region, the large number of initial hard scatterings create a richly “doped”hot quark-gluon plasma embedding an unparalleled abundance of charm quarks/anti-quarks. This provides a uniquely “charming”environment for the massive production of exotic hadrons in nuclear collisions and possibly helps solve puzzles about their intrinsic structures, as demonstrated by the latest theoretical studies and experimental measurements. A notable example concerns the nature of the well-known X(3872) particle. Despite significant efforts, consensus on their internal structures is still lacking and it remains a pressing open question to decipher the X(3872) state between two popular exotic configurations: a loose hadronic molecule or a compact tetraquark. It turns out the two different structures have rather different sensitivity to size of the production source and thus the the fireball volume in heavy ion collisions could play a crucial role. By scanning centrality and thus systematically tuning the fireball volume, recent dynamical simulations based on a multiphase transport model (AMPT) have indeed found about 2-order-of-magnitude difference in the X(3872) yield and a markedly different centrality dependence between hadronic molecules and compact tetraquarks, offering a novel approach for distinguishing the two scenarios. More recently such study has been further extended to the newly observed doubly-charmed exotic states, finding about three-order-of-magnitude enhancement in the production of the Tcc states in Pb-Pb collisions as compared with the yield in proton-proton collisions. Compared with X(3872), the Tcc yield shows an even stronger decrease from central toward peripheral collisions, due to a “threshold”effect of the required double charm quarks for its formation. This talk will report such exciting theoretical progress and discuss relevant experimental results. The talk will end with an outlook on interesting issues to be addressed and opportunities in the future. [Refs: PRL126,012301(2021);PRD104,L111502(2021); Eur.Phys.J.C80(2020)7,671; Chin.Phys.C43(2019)4,044101]

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Session Classification: Exotica