Exotic hadrons in heavy ion collisions

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We have continued to investigate the possibilities of using measurements in present and future experiments on heavy ion collisions to answer some longstanding problems in hadronic physics, namely identifying hadronic molecular states and exotic hadrons with multiquark components [1]. Specifically, we considered the yields of following proposed exotic hadrons: $f_0(980)$, $a_0(980)$, K(1460), $D_s(2317)$, T_{cc}^{1}, X(3872), $Z^+(4430)$, and T_{cb}^{0} for exotic mesons, $\Lambda(1405)$, $\Theta^+(1530)$, KKN, DN, D^*N, Θ_{cs}, BN and B^*N for exotic baryons; H, KNN, $\Omega\Omega$, H_c^{++}, DNN and BNN for exotic dibaryons. To obtain the yields of these exotic multiquark hadrons or hadronic molecular states, we used the coalescence model based on either the quark degrees of freedom or the hadronic degrees of freedom. Our results indicate that the yields of many exotic hadrons are large enough to be measurable in experiments. In particular, heavy exotic hadrons containing charm and bottom quarks as well as strange quarks can be possibly observed at RHIC and especially at LHC. Therefore, relativistic heavy ion collisions will provide a good opportunity to search for exotic hadrons. In particular, it may lead to the first observation of new exotic hadrons. Also, we have found that the structure of light exotic hadrons has a significant effect on their yields in heavy ion collisions. As shown in Fig.1, for a hadron of normal quark structure, its production yield relative to the statistical model prediction is found in the range of 0.2-2. The yield ratio is smaller if a hadron has a compact multiquark configuration. For a hadron of molecular configuration with an extended size, its yield is, on the other hand, larger than the normal values. Therefore, the ratios of measured yields from experiments on heavy ion collisions to those predicted by the statistical model provides a new method to discriminate the different pictures for the structures of exotic hadrons.

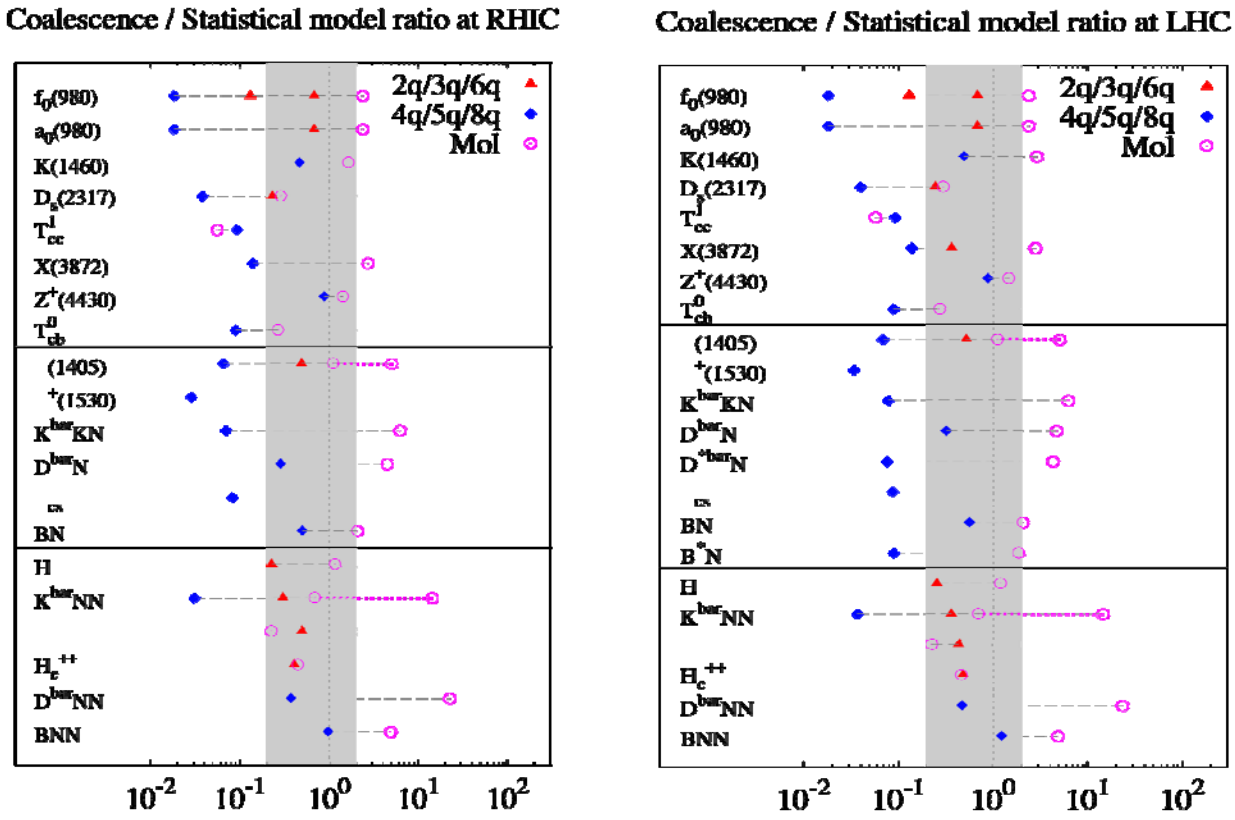

FIG. 1. Ratios of hadron yields at RHIC (left window) and LHC (right window) in the coalescence model to those in the statistical model for normal hadrons (gray band), hadronic molecules (above gray band), and multiquark states (below gray band).

[1] S. Cho, T. Furumoto, T. Hyodo, D. Jido, C.M. Ko, S.H. Lee, M. Nielsen, A. Ohnishi, T. Sekihara, S. Yasui, and K. Yazaki, Phys. Rev. C **84**, 064910 (2011).