Baryon-Baryon Interactions from Heavy-Ion Collisions

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The study of baryon-baryon interactions are of fundamental importance in understanding relativistic heavy-ion collisions [1], modeling of astronomical objects such as neutron stars [2] and existence of various exotic hadrons [3, 4]. A detailed knowledge of nucleon-nucleon (NN) potentials exists in literature, at the same time very little is known about interactions between antinucleons. Similarly lack of scattering data for hyperon-nucleon (YN) and multi-strange hyperon-hyperon (YY) systems makes it difficult to construct YN and YY potentials. Very often the experimental information on bound states of hypernuclei is used to provide information on YN interactions [5], however, the contamination from many-body effects in these data makes the task of extracting YN and YY interactions extremely difficult.

A large number of baryons are produced in each nucleus-nucleus collisions [6], which allows us to study the NN, YN and YY interactions from heavy-ion collisions. Measurements of the two-particle correlation function are used to study the space-time dynamics of the source created in heavy-ion collisions. At low relative momentum, the two-particle correlation functions are effected by the Final State Interactions (FSI), making it possible to measure FSI between NN, YN and YY. However the presence of the Coulomb interactions between the charged particles make it difficult to access strong interactions directly from the measured two-particle correlation function. Therefore, the ratio of the correlation function between the small and large collision systems is proposed as a new measure by K. Morita *et al.* [7] to access the strong interactions directly. To extract the FSI between baryons, the two-particle correlation function is fitted by using the Lednický and Lyuboshitz analytical model [8]. In the talk, this novel method to use measurement of the two-particle correlation function from heavy-ion collisions to understand antiproton-antiproton [9], proton-Ω [10] and $\Lambda\Lambda$ [11] interactions will be discussed.

The measured FSI between some of the baryons have direct implications to the existence of exotic hadrons, with quark content different from conventional hadrons [3, 4]. The H-dibaryon, containing six quarks, is the most searched exotic hadron in the experiments [12]. The Nucleon-Ω state with the strangeness = -3, spin = 2 and isospin = 1/2 is the most interesting candidate [4] after H-dibaryon. We will also discuss, in brief, implication of recent measurements of the FSI for proton-Ω [10] and $\Lambda\Lambda$ [11] on the existence of these exotic dibaryons.

Furthermore, the hypernuclei serves as an excellent laboratory to study YN interactions and provides an additional experimental probe to study the YN interactions. The strength of the YN interactions effects lifetime and binding energy of hypernuclei [13, 14]. Therefore, a precise determination of the lifetime of hypernuclei would provide direct information on the YN interactions strength [14, 15].

The lightest hypernucleus is hypertriton ($^{3}_{\Lambda}$H) containing a proton, a neutron and a Λ hyperon. The world average of the measured $^{3}_{\Lambda}$H lifetime is 215^{+19}_{-16} ps [16], which is shorter than the free Λ lifetime, which is 263$\pm$2 ps. According to current theoretical understanding, the $^{3}_{\Lambda}$H is considered as a weakly-bound deuteron core and a Λ system. Hence the $^{3}_{\Lambda}$H lifetime is considered close to free Λ lifetime. The shorter lifetime of the $^{3}_{\Lambda}$H than the free Λ lifetime challenges our current understanding of structure of this simplest hypernuclei and YN interactions. Recent developments on

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hypertriton lifetime measurements from various heavy-ion collisions experiment will be discussed in this talk.

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