Production of lght anti-/nuclei at thermal freezeout in ultrarelativistic heavy-ion collisions

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The production of light atomic nuclei (deuteron, triton, He-3, He-4 and their anti-particles) in ultrarelativistic heavy-ion collisions has posed a puzzle. While their production systematics is well produced by hadro-chemical freezeout at temperatures near the QCD pseudo-critical temperature, T_c ~ 160 MeV, their small binding energies of a few MeV per nucleon suggest that they cannot survive as bound states under these conditions (see Ref. [1] for a recent review). Here [2], we adopt the concept of effective chemical potentials in the hadronic evolution from chemical to thermal freezeout (at typically T_{fo} ~ 100 MeV), which, despite frequent elastic rescatterings in hadronic matter, conserves the effective numbers of particles which are stable under strong interactions, most notably pions, kaons and nucleons. It turns out that the large chemical potentials that build up for anti-baryons [3] result in thermal abundances of light nuclei and anti-nuclei, formed at thermal freezeout, which essentially agree with the ones evaluated at chemical freezeout. We also confirm that their transverse-momentum spectra are consistent with a kinetic decoupling near T_{fo}, which, due to the large transverse flow of the expanding fireball in the late hadronic stage of URHICs, are much harder than those evaluated at chemical freezeout, where the transverse-flow velocity is significantly smaller. Our calculations thus provide a natural explanation for the production systematics of light anti-/nuclei without having to postulate their survival at high temperatures.

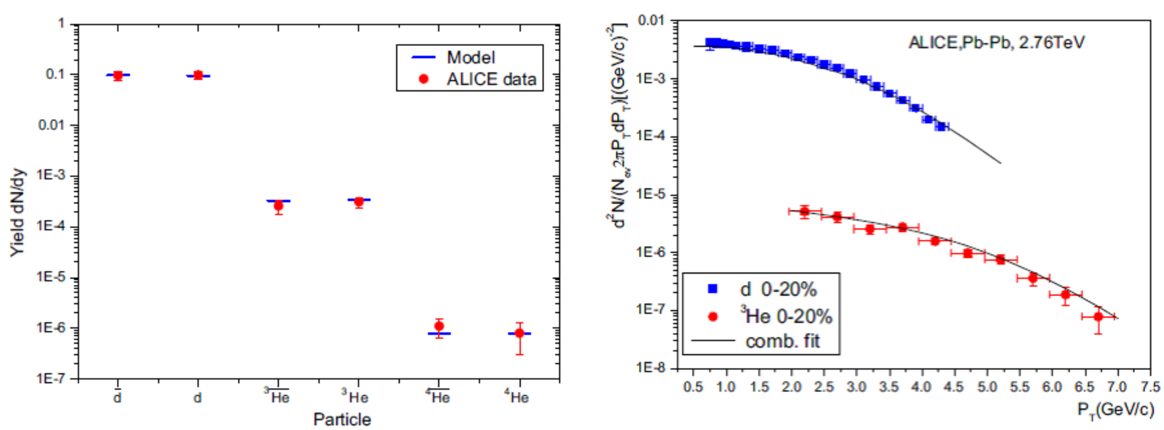

FIG. 1. Production yields of light anti-/nuclei (left panel, with an overall 3-volume adjusted to reproduce the deuteron yield) and pertinent p_T spectra (right panel) calculated at thermal freezeout (T_{fo} = 100 MeV) in 2.76TeV Pb-Pb collisions at the LHC, compared to ALICE data [3].

[1] P. Braun-Munzinger and B. Dönigus, Nucl. Phys. **A987**, 144 (2019).
[2] X. Xu and R. Rapp, Eur. Phys. J. A **55**, 68 (2019).
[3] R. Rapp, Phys. Rev. C **66**, 017901 (2002).
[4] ALICE collaboration, Phys. Rev. C **93**, 024917 (2016); Nucl. Phys. **A971**, 1 (2018).