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Highlights of the production of (Anti-)(Hyper-)Nuclei and Exotica with ALICE at the LHC

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The high collision energies reached at the Large Hadron Collider (LHC) at CERN in proton-proton, proton-lead and, in particular, lead-lead collisions, lead to significant production rates of fragile objects, i.e. objects whose binding energies are small compared to the average kinetic energy of the particles produced in the system. Such objects are, for instance, light (anti-)nuclei and (anti-)hypernuclei.
The most extreme example here is the hypertriton, a bound state of a proton, a neutron and a lambda, where the separation energy of the lambda is only around 130 keV. These states, from the anti-deuteron up to the anti-alpha nuclei, are nevertheless created and observed in heavy-ion collisions at the LHC.

Their production yields can even be well described in a statistical-thermal model approach with only three parameters, namely chemical freeze-out temperature Tch, volume V and baryo-chemical potential μB. The latter is close to zero at LHC, which means the ratio of anti-baryons to baryons is close to unity and in continuation also anti-nuclei and nuclei of the same type are produced in equal amounts. Tch at the LHC is extracted to be 156 MeV, which is a factor 1000 above the binding energy of the lambda to the deuteron inside the hypertriton.

In addition, the thermal model can be used to make predictions for the production of other fragile objects, such as bound states of hyperons and nucleons, or hyperonhyperon bound states. The data collected at LHC can be used to test the existence of these bound states.

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