A realistic coalescence model for (anti)nuclei production

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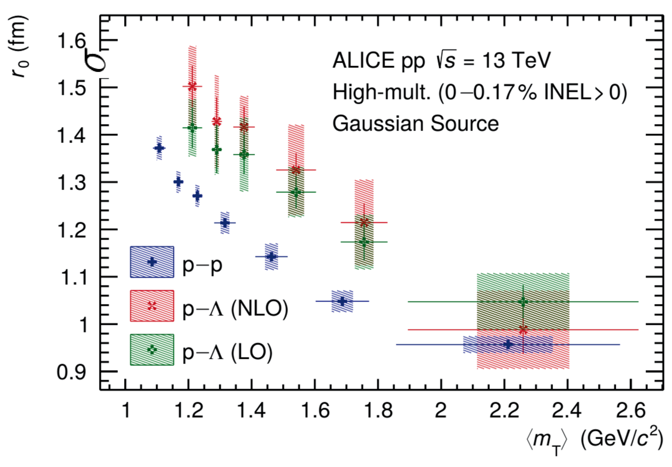
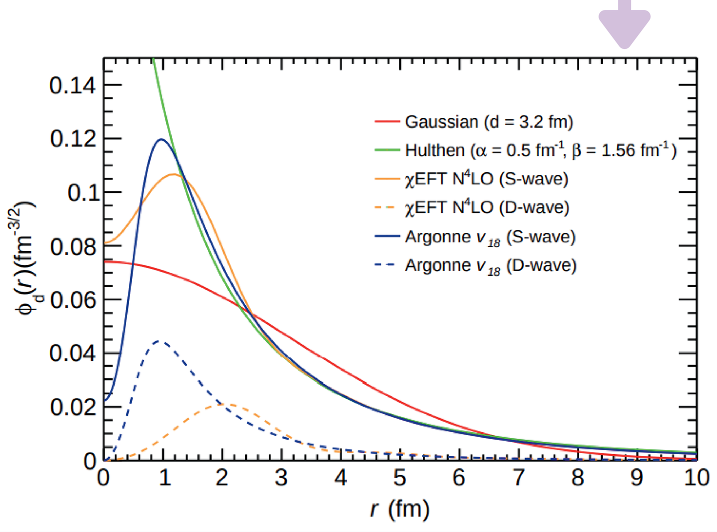
(Anti)nuclei formation using coalescence

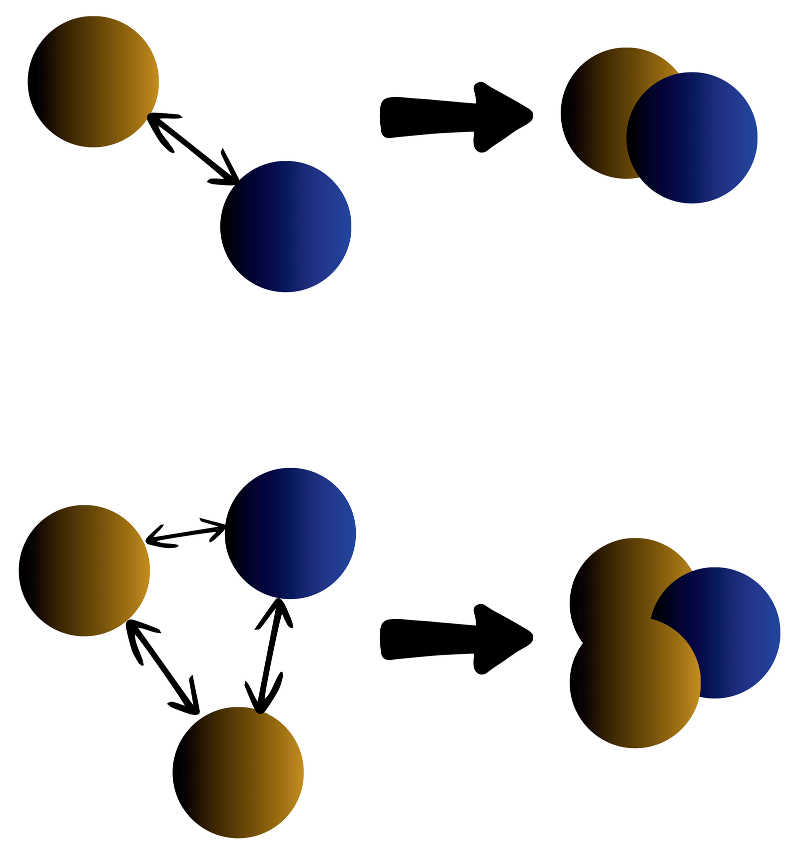
- (Anti)protons and (anti)neutrons close in phase-space can coalesce and form a nucleus
- Wigner function formalism $\mathcal{P}(q,\sigma) = \int d^3r_p d^3r_n h(r_n, r_p) \mathcal{D}(q,r)$

$$\frac{1}{(2\pi\sigma^2)^3}\exp\left(-\frac{r_n^2+r_p^2}{2\sigma^2}\right)$$

$$\int d^3\zeta\ \Psi(\vec{r}+\vec{\zeta}/2)\Psi^*(\vec{r}-\vec{\zeta}/2)\exp(i\vec{q}\cdot\vec{\zeta})$$

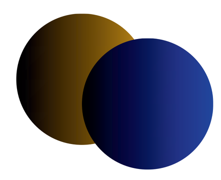






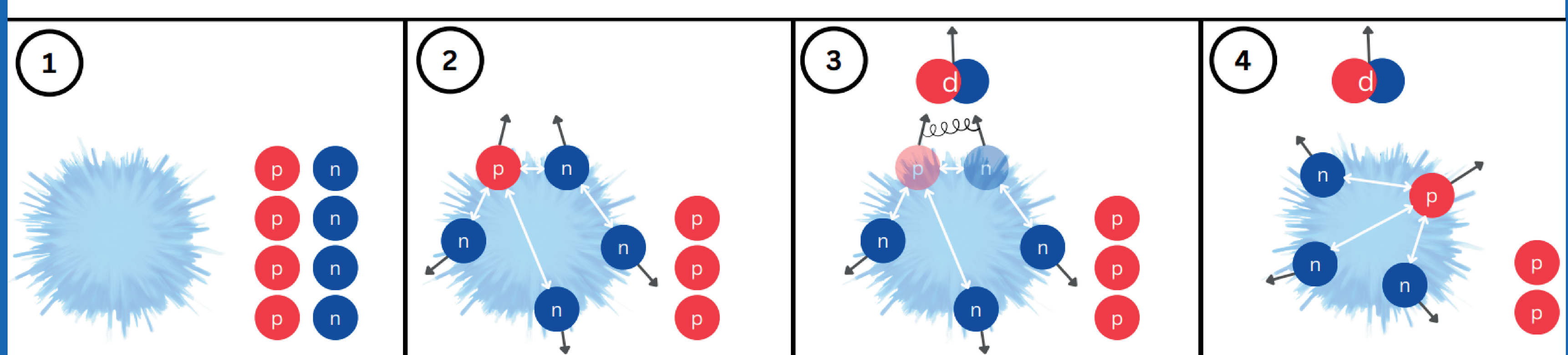
The ToMCCA toy Monte-Carlo Generator

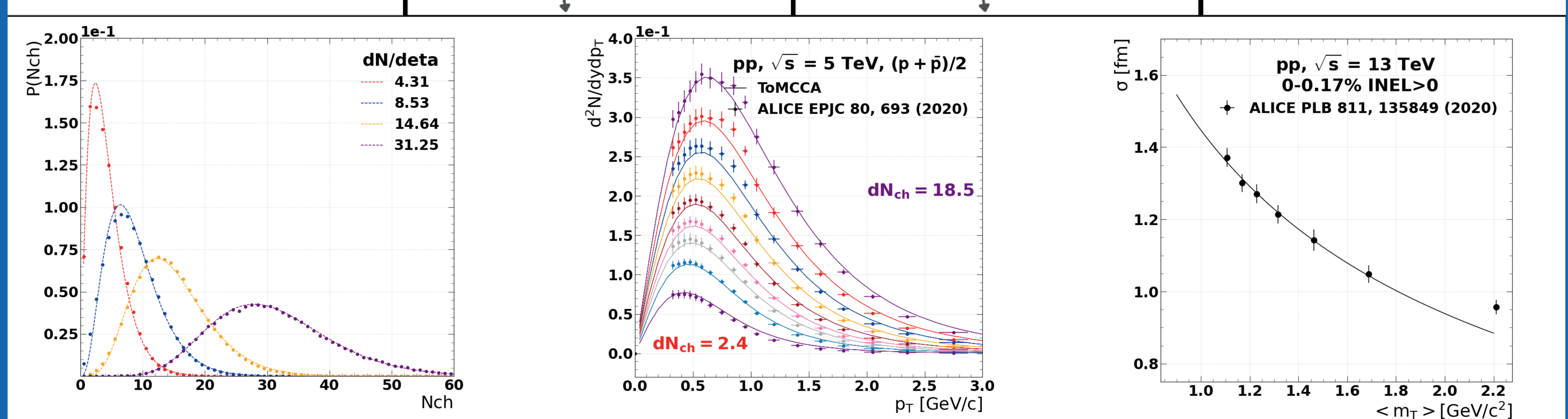
ToMCCA: arXiv:2404.03352
github.com/HorstMa/ToMCCA-Public



Working principle

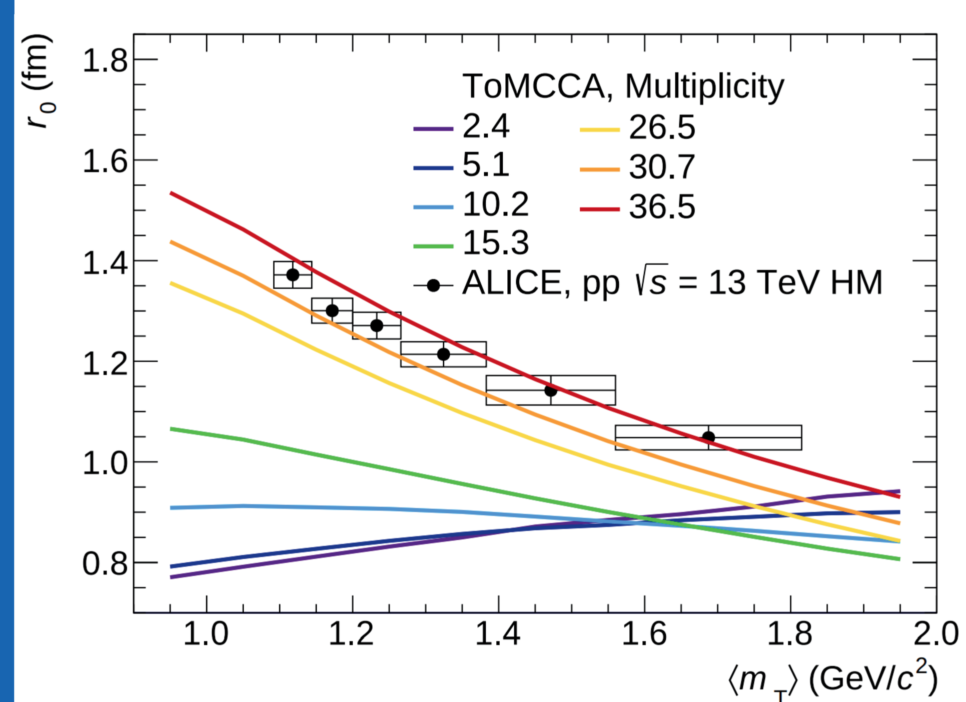
1. Generate number of nucleons(proton and neutrons)
2. For each Proton, determine distances and momenta of neutrons
3. Check coalescence condition for each p-n pair
4. Repeat for all protons

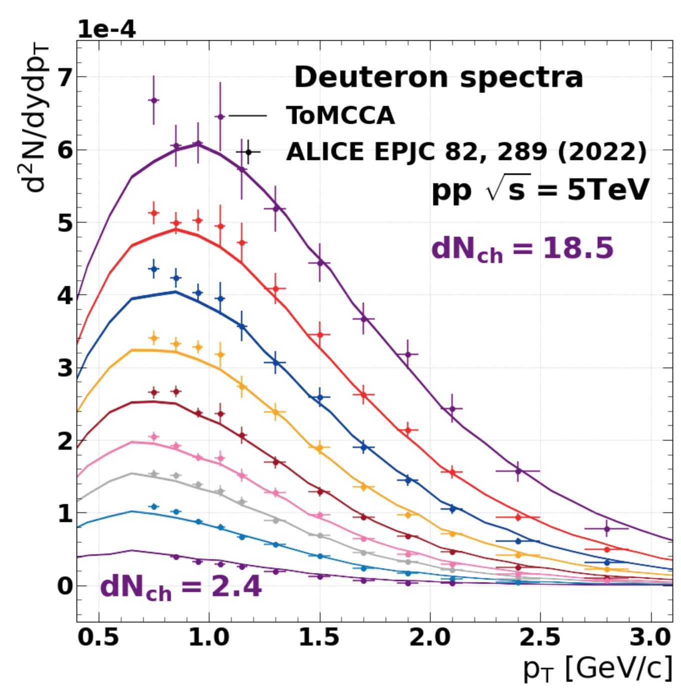




2-Body coalescence

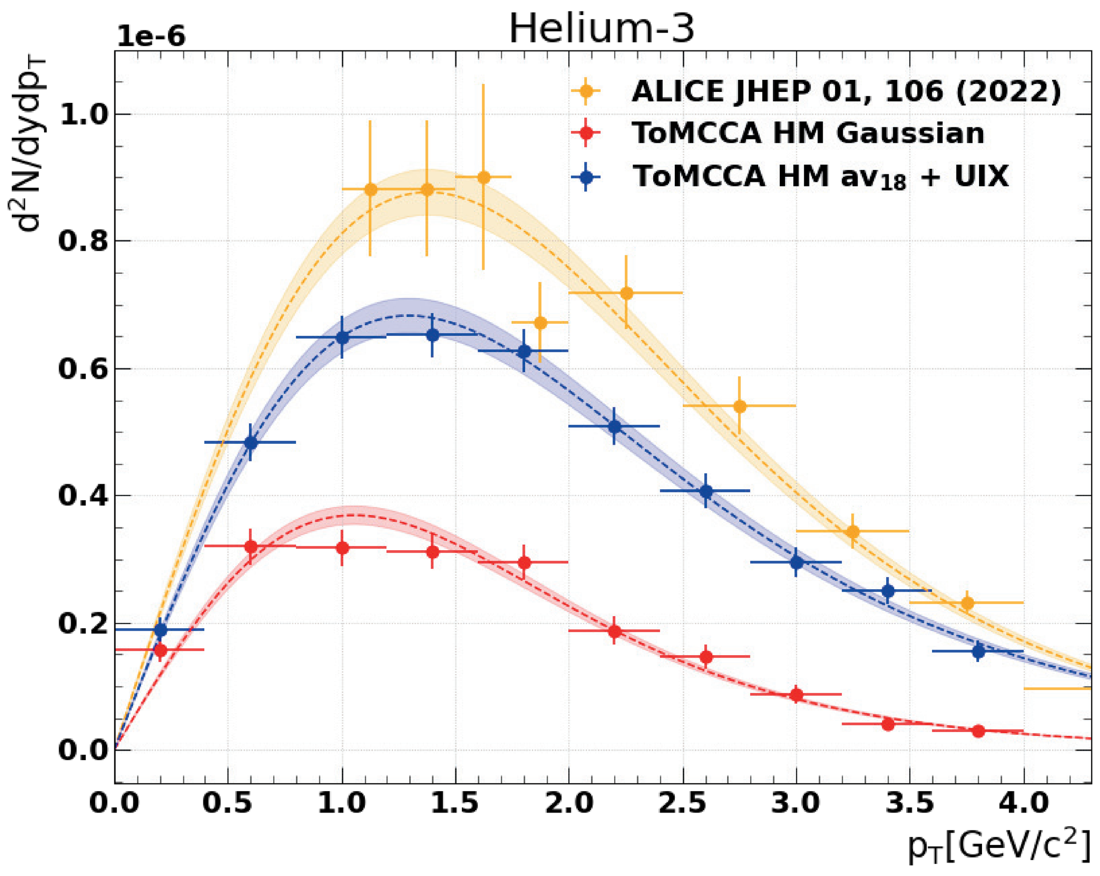
- There is a plethora of data on Deuteron production by ALICE
  ➡Ideal testing ground for a coalescence model
- Using existing deuteron spectra to fix the Source size

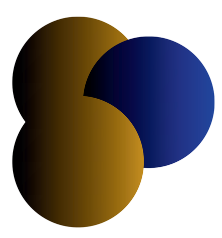




3-Body coalescence

- The case of A=3 coalescence is far more intricate
- Multiple states: ^{3}He, ^{3}H and $^3_\Lambda$H

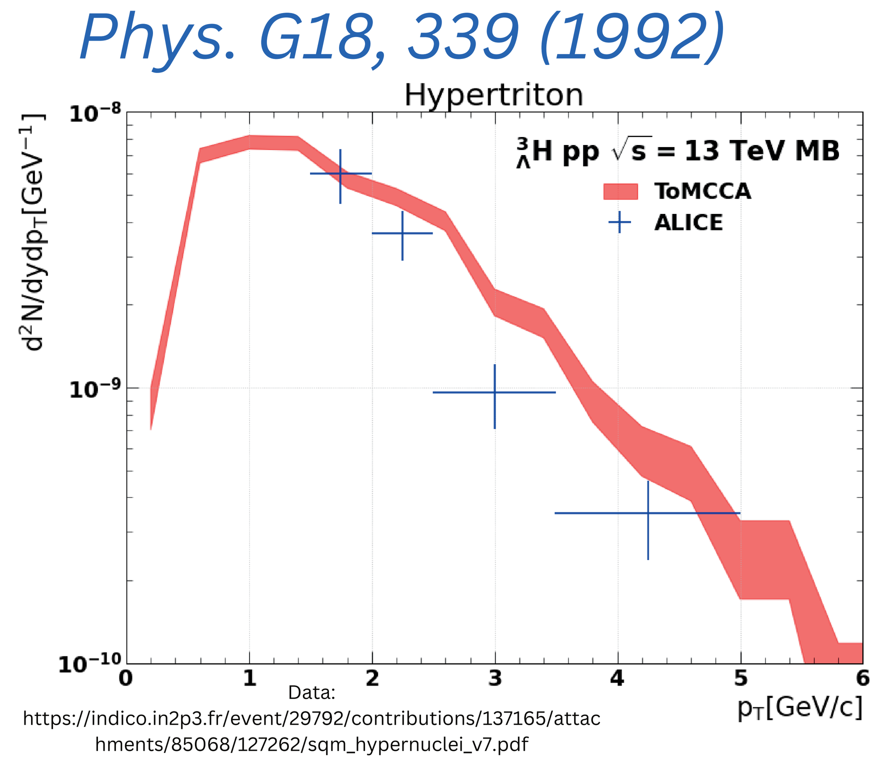




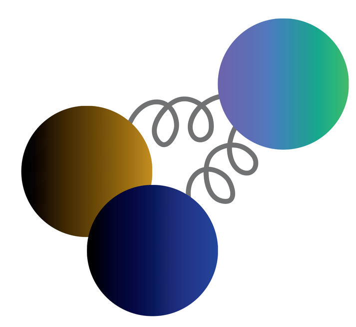
- ^{3}He wavefunction based on Argonne v18 + UIX
- Collaboration with Michele Viviani from Pisa theory group

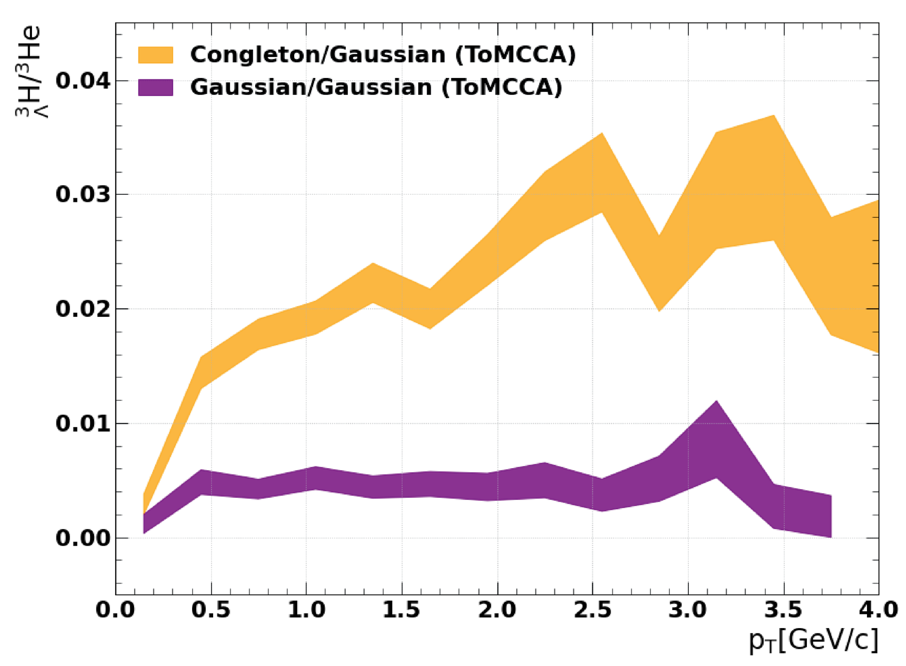
Hypertriton

- Hypertriton ($^3_\Lambda$H) Wavefunction from Congleton *J. Phys. G18, 339 (1992)*



- Assumes factorization of deuteron and Λ wave functions $\Psi_{^3_\Lambda H} = \Psi_\Lambda + \Psi_d$





- $^3_\Lambda$H/^{3}He Ratio is sensitive to the Production mechanism