Summary of "Formation models for cosmic ray antinuclei"

Cosmic ray antinuclei have for a long time been considered a ideal probe for new and exotic phyics due to the suppressed background at small kinetic energies. In fact, a reliable detection of even a few low energy antinuclei can be considered as a proof of new physics, such as dark matter annihilations. Despite of intense searches, no detection has yet been confirmed. However, with the ever-growing statistics of AMS-02 and the upcoming GAPS experiment, a detection is conceivably around the corner. At the same time, the small binding energies and composite structures of light antinuclei make them promising probes for the QCD phase diagram in heavy ion collisions. In order to correctly interpret experimental data, however, a solid description of the formation process is needed.

In small interacting systems relevant for cosmic ray studies, such as dark matter annihilations or pp collisions, the production of (anti)nuclei is often described using coalescence models in momentum space. Here, two (or more) nucleons merge if they are seperated less than a distance p_0 in momentum space. Since the entire phase space is not considered, apparent energy and process dependencies of the coalescence momentum emerge, as seen in the left part of Fig. 1.

Motivated by the apparent process dependence of p_0 and the inacurate description of experimental data observed with the standard coalescence model, we deloped in [1] a new per-event coalescence model that takes into account both two-particle correlations and the nucleon emission volume in a semi-classical picture. This model was later refined and applied to cosmic ray studies and recent LHC data in [2, 3].

The physical interpretation of the free parameter of the new model, σ, is the size of the nucleon emission region. Therefore, one will expect its value to be close to 1 fm. This is exactly what one observes when comparing with experimental data, as seen in the right part of Fig. 1.

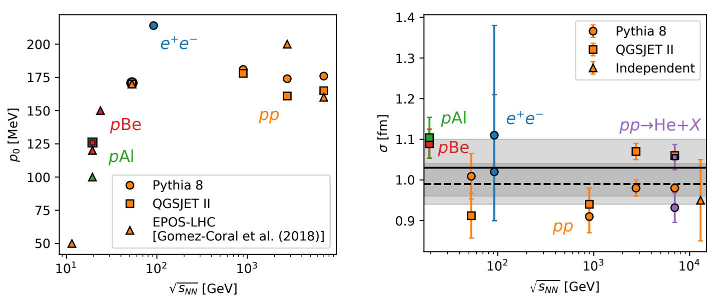

Figure 1: Coalescence momentum p_0 in the per-event coalescence model in momentum space (left) and parameter σ in the WiFunC model (right) obtained by fit to experimental data using different event event generators.

References

[1] M. Kachelrieß, S. Ostapchenko and J. Tjemsland, Eur. Phys. J. A **56** (2020) no.1, 4 doi:10.1140/epja/s10050-019-00007-9 [arXiv:1905.01192 [hep-ph]].

[2] M. Kachelrieß, S. Ostapchenko and J. Tjemsland, JCAP **08** (2020), 048 doi:10.1088/1475-7516/2020/08/048 [arXiv:2002.10481 [hep-ph]].

[3] M. Kachelriess, S. Ostapchenko and J. Tjemsland, Eur. Phys. J. A **57** (2021) no.5, 167 doi:10.1140/epja/s10050-021-00469-w [arXiv:2012.04352 [hep-ph]].