Light charged particle correlations in $^{78,86}Kr+^{12}C$

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The experiment to measure the asymmetry dependence of the nuclear caloric curve using fusion reactions of $^{78,86}Kr$ + 12C @ 15, 25, 35 MeV/u is a rich data set and can allow for other analysis. Light charged particles are measured with good energy and position resolution over a large angular range, which allows correlation functions to be investigated. Correlation functions with the DADL-upgraded FAUST [1,2] were used to measure proton-proton correlation functions.

Here, investigation of LCP correlations in the Kr+C data set begins with alpha-alpha pairs. The upper left panel of Fig. 1 shows in black the relative momentum distribution of alpha-alpha pairs from the $^{86}Kr+^{12}C$ @ 35 MeV/u. For events with more than two alpha particles, all pair-wise combinations are used. The peaks at roughly 20, 50, and 100 MeV/c correspond to ^{8}Be(g.s.), ^{9}Be(2.43MeV) and ^{9}Be(3.03MeV), respectively. The uncorrelated background due primarily to sequential alpha particle emission is assessed using the mixed event technique. Alpha particles are randomly paired with the requirement that the two did not come from the same event or hit the same detector. Crucial in this is the accounting of the alpha particles: each time an alpha particle is used to add a count to the true relative momentum distribution, it must also be added to the list for generating mixed events. Thus for an event with four alpha particles, each of these alpha particles must be added to the list for mixing three times, not

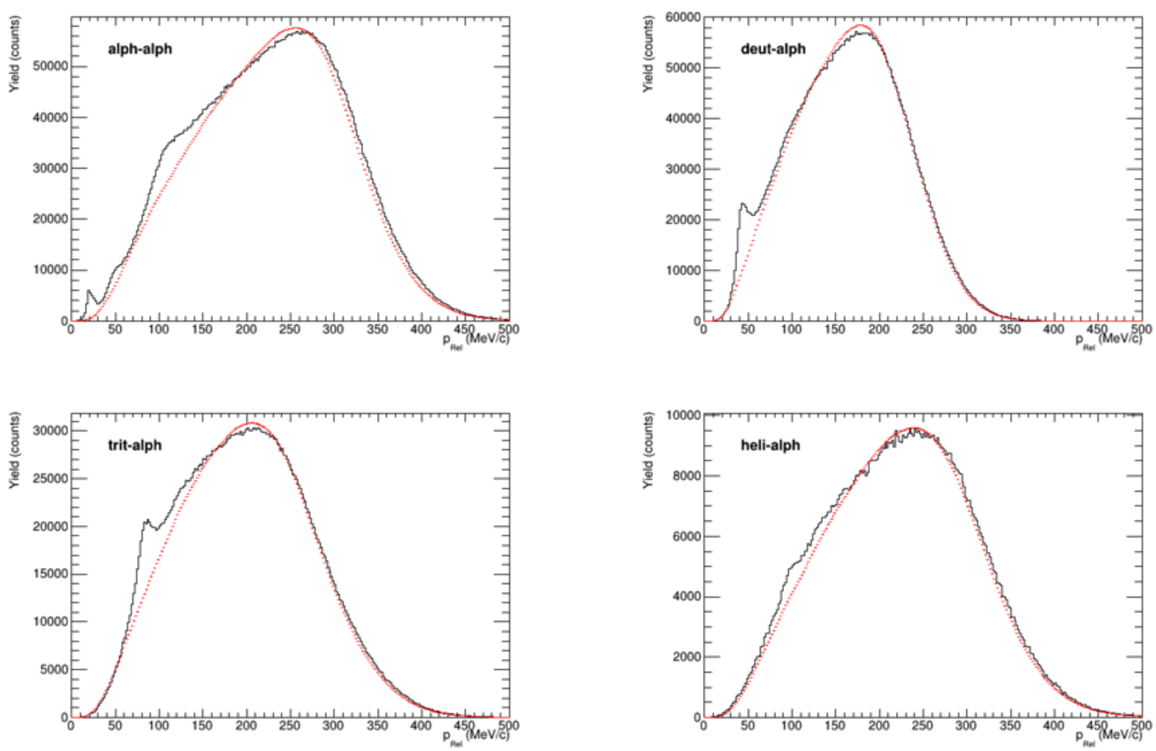

Fig. 1. Relative momentum distributions for four LCP pairs, and their mixed event background, for 86Kr+12C @ 35 MeV/u.

just one. Failure to account for the multiplicity in this way results in significant underprediction of the background at high relative momentum, and significant overprediction at low relative momentum, and is most severe for the lowest beam energies. The resulting mixed event background is shown in red. The three resonant states are clearly discernible over the mixed-event background. Fig. 1 also shows relative momentum distributions for other LCP pairs: d-a, t-a, and h-a. Each of these has a clear excess in yield at a known relative momentum [3]. These states are observed to somewhat lesser degrees as beam energy decreases. The yield of the ^{9}Be state is much reduced for the less neutron-rich beams. Resonant states can allow extraction of temperature through excited state populations (see e.g. [4] and references therein), or manifestation of tidal forces for short-lived states that decay in the field of the source that emitted them [5].

[1] L.A. McIntosh, Ph.D. Thesis, Texas A&M University, 2018.

[2] L.A. McIntosh, A.B. McIntosh, K. Hagel, M.D. Youngs, L.A. Bakhtiari, C.B. Lawrence, P. Cammarata, A. Jedele, L.W. May, A. Zarrella, and S.J. Yennello, Nucl. Instrum. Methods Phys. Res. **A985**, 164642 (2020).

[3] J. Pochodzalla, C.K. Gelbke, W.G. Lynch, M. Maier, D. Ardouin, H. Delagrange, H. Doubre, C. Grégoire, A. Kyanowski, W. Mittig, A. Péghaire, J. Péter, F. Saint-Laurent, B. Zwieglinski, G. Bizard, F. Lefèbvres, B. Tamain, J. Québert, Y. P. Viyogi, W.A. Friedman, and D.H. Boal, Phys. Rev. C **35**, 1695 (1987).

[4] H. Xi, W.G. Lynch, M.B. Tsang, W.A. Friedman, and D. Durand, Phys. Rev. C **59**, 1567 (1999).

[5] A.B. McIntosh, S. Hudan, C.J. Metelko, R.T. de Souza, R.J. Charity, L.G. Sobotka, W.G. Lynch, and M.B. Tsang, Phys. Rev. Lett. **99**, 132701 (2007).