Cluster-cluster correlation in intermediate heavy ion collisions

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Fragments and light clusters are copiously produced in various kinds of nuclear reactions such as in heavy-ion collisions. Formation of fragments and clusters is one of the essential features of these reactions, since they are produced in most of the events in these reactions with the participation of most of the nucleons in the system. Here we apply AMD-CC, an antisymmetrized molecular dynamics with cluster-cluster correlation [1], to the experimental results of the ^{12}C + ^{12}C reaction at 95MeV/nucleon [2].

In the implementation of two-nucleon collisions in most transport models, only the states of the two nucleons are changed under the assumption that these two nucleons are not correlated with the other nucleons in the system. On the other hand, if the correlations exist in the final states between the scattered nucleons and other nucleons, it is more reasonable to construct the final states, taking account of the correlations. Here the correlations mean that clusters with A = 2, 3 and 4 can propagate in the medium if it is allowed by the Pauli principle. In AMD, if several wave packets (with different spins and isospins) are placed at the same phase space point, these wave packets will tend to move together as a cluster by the equation of motion. On the other hand, if the wave packets are placed randomly in the phase space, the chance for these nucleons to form a cluster after propagation is small. Therefore, in order to respect the possibility of forming a cluster in the final state of a two-nucleon collision, the set of final states should be suitably constructed. In the early version of AMD-CC, these correlations are incorporated only for light clusters with A≤4 in the code. In the latest version of AM-CC, used in this work, the cluster correlations are extended to clusters with A≤10.

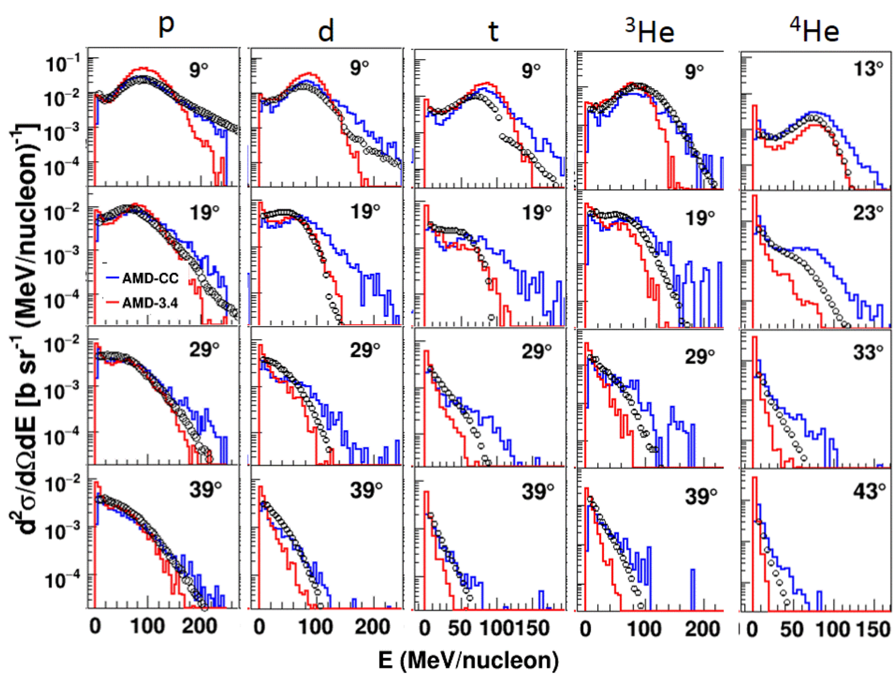

FIG. 1. Calculated energy spectra for LCPs from AMD-CC (blue histograms) and AMD (red histograms) are compared with the experimental data of ^{12}C+^{12}C at 95 A MeV [2] at four selected angles. From left to right column, p, d, t, ^{3}He and ^{4}He are plotted. The comparisons are made in an absolute scale.

The calculated results with AMD-CC (blue histograms) are compared to those of AMD without the correlations (red histograms) together with the experimental data (circles) for LCP in Fig.1 and IMFs in Fig.2 at selected angles. One can clearly see significant improvements in the reproduction of the most of the energy spectra by AMD-CC, especially for those of IMFs.

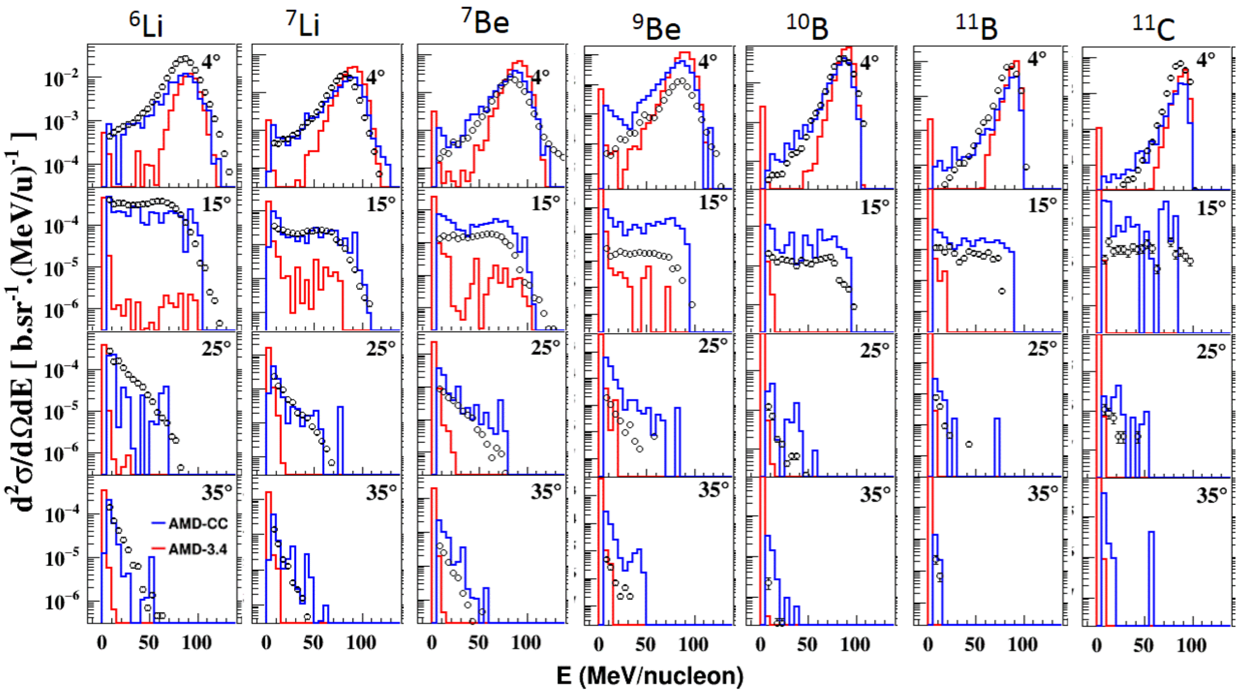

FIG. 2. Calculated energy spectra for IMFs from AMD-CC and AMD are compared with the experimental at four selected angles. Symbols and curves are same as those of Fig.1. The selected isotopes are indicated in the figure.

[1] A. Ono, Eur. Phys. J. Web of conference **122**, 11001(2016).

[2] J. Dudouet *et al.*, Phys. Rev. C **88**, 024606 (2013).