A statistical analysis of experimental multifragmentation events in ^{64}Zn + ^{112}Sn at 40 MeV/nucleon

R. Wada, W. Lin, H. Zheng, X.Liu, and M. Huang

A statistical multifragmentation model (SMM) is applied to the experimentally observed multifragmentation events in an intermediate heavy ion reaction. SMM is applied to the reaction ^{64}Zn + ^{112}Sn at 40 MeV/nucleon, using the experimental temperature and symmetry energy extracted from the isobaric yield ratio (IYR) method based on the modified Fisher model (MFM),

In SMM, the fragmenting system is in the thermal and chemical equilibrium at low density. A Markov chain is generated to represent the whole partition ensemble. In the version used in this study, a symmetry entropy term is added in the symmetry free energy F_{AZ} as,

$$F_{A,Z}^{sym} = E_{A,Z}^{sym} - TS_{sym}.$$

The experimental data from the reconstructed isotopes are compared with SMM simulated events. In our previous works [1,2], the primary isotope yields were experimentally reconstructed in the ^{64}Zn + ^{112}Sn reaction at 40 MeV/nucleon. These yields allow us to compare directly to the SMM primary fragments without an afterburner. The SMM calculations are performed with source size As = 60, charge number Zs = 27, which are extracted from the NN source component of the experimentally observed energy spectra for all particles, including neutrons [3]. The source excitation energy is calculated using the temperature from self-consistent analysis [1, 2] and the fragment multiplicities M_i as

$$E^* = \sum_i (3/2)TM_i - Q.$$

E* = 6.7 MeV/nucleon is obtained from the experimentally extracted temperature value of T = 5.9 MeV. γ = 20.7 MeV from the self-consistent analysis is used. The breakup volume of V= 4, 6, 10 V_0 are examined.

In Fig. 1 (a), mass distribution of the experimentally reconstructed isotopes (solid squares) is compared with the simulations. The results for SMM with and without the symmetry entropy are almost identical (open squares and circles). AMD results from Refs. [1,2] are also plotted (open triangles). All calculated yields are normalized to that of the reconstructed data at A = 15. They reproduce the experimental primary mass distribution for fragments with 10 < A < 30 reasonably well. The experimental mass distribution is compared with those from the SMM events at different breakup volumes in Fig. 1 (b) and at different breakup temperatures in Fig. 1 (c). The SMM mass distribution is not sensitive to the breakup density. On the contrary it is very sensitive to the breakup temperature. The best result is obtained at T = 6 MeV which is consistent to the experimentally determined temperature value of T = 5.9 MeV in Refs. [1, 2].

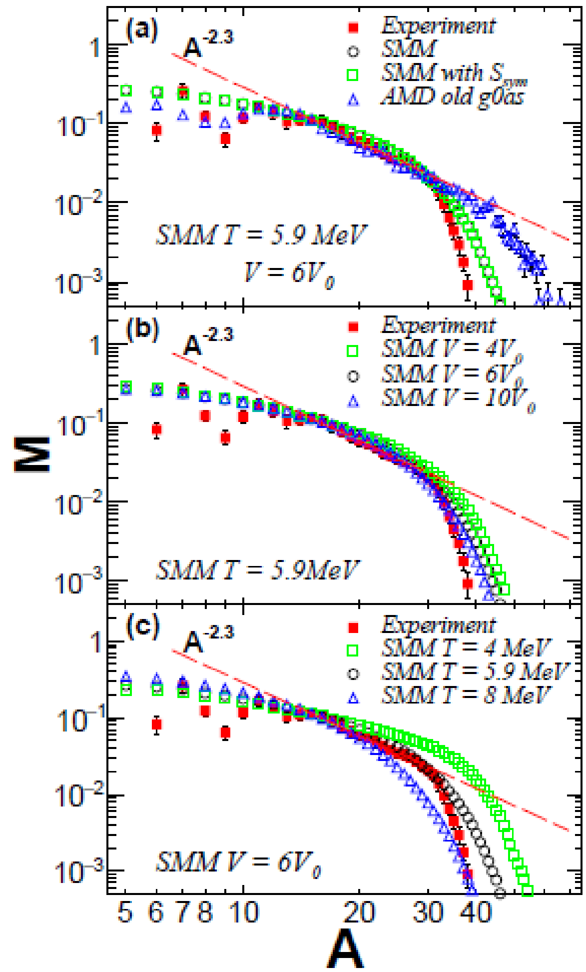

FIG. 1. (a) The experimental mass distribution (solid squares) is compared with that of SMM without (open circles) and with (open squares) the symmetry entropy at T = 5:9 MeV and the breakup volume of $6V_0$. The mass distribution of AMD from Refs. [1.2] is also shown by triangles. The distributions of the simulated results are normalized to the reconstructed data at A = 15. (b) The experimental mass distribution is compared with that of SMM with different breakup volumes at T = 5:9 MeV. (c) The experimental mass distribution is compared with that of SMM with different temperatures at $V = 6V_0$.

In Fig. 2 detail comparison of isotope yield distributions are carried out in an absolute scale for Z =3 to 14 between the experimentally reconstructed primary isotopes and the fragments from the SMM events at $V = 6V_0$ without (open circles) and with (open squares) the symmetry entropy. AMD results from Ref. [1] are also shown by open triangles. Reasonable agreements are found between the SMM calculations and the reconstructed data, but the widths of the SMM distributions are slightly wider than the experimental ones for all Z values, whereas those of AMD simulations reproduce the widths slightly closer to those of the experimental distributions. The significant differences in the simulated results for Z

= 4 are caused by the fact that ^{8}Be was missing among the final secondary products in the reconstruction, which is crucial for Z = 4 primary fragments.

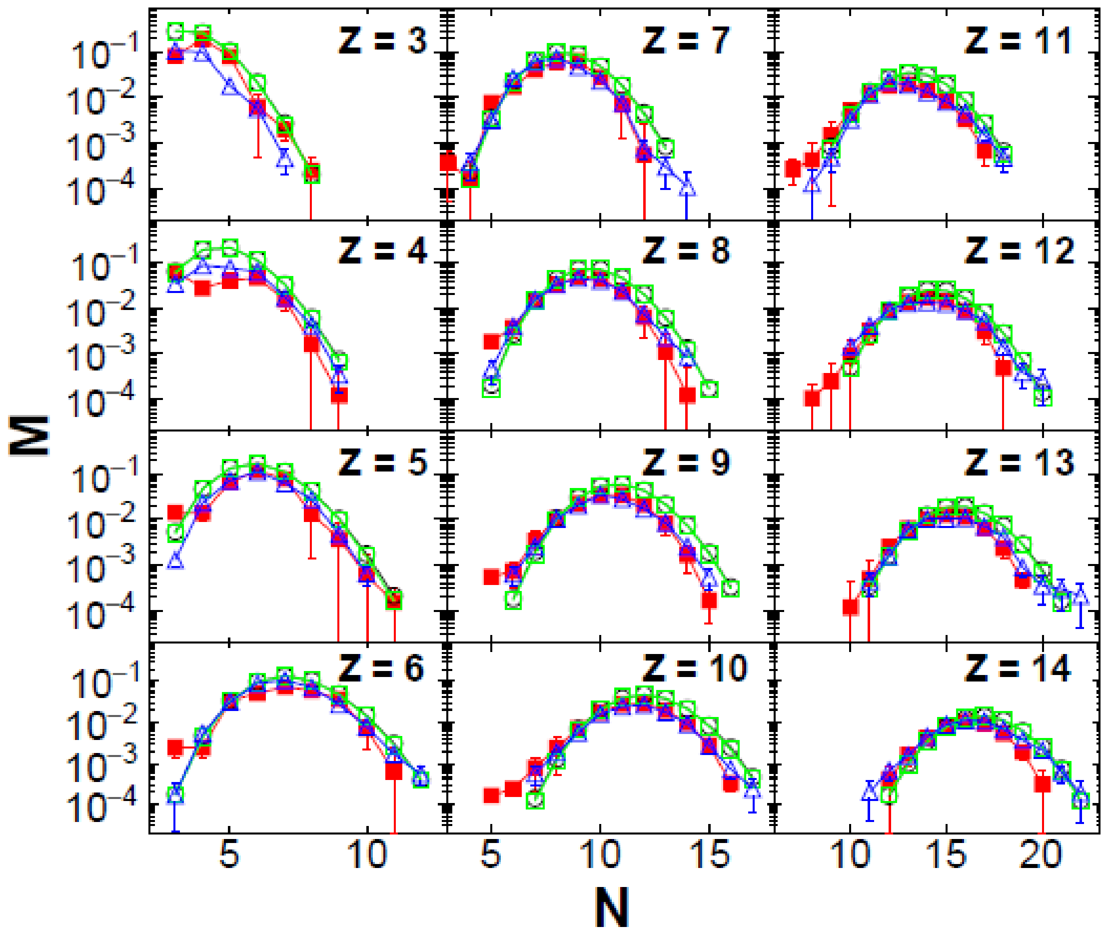

FIG. 2. Isotope distributions of the experimentally reconstructed primary fragments (solid squares) and those from SMM without (open circles) and with (open squares) the symmetry entropy at V = $6V_0$ are compared for Z = 3 to 14. AMD results from Refs. [1, 2] are also shown by open triangles. All results are plotted in an absolute scale.

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