Continuous Phase Transition and Negative Specific Heat in Finite Nuclei

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Mean-field models have often been employed to explore liquid-gas phase transition in infinite and finite nuclear systems. In this model, the phase transition is found to be continuous, both for asymmetric nuclear matter and also for finite nuclei. Though approximate, the model serves the purpose of giving an orientation for understanding some important features of the liquid-gas phase transition. Moreover, the vapor phase may not consist of only monomers, but may contain various clusters along with the nucleons; the influence of clusters on the caloric curve should also be explored.

The model we employ in our calculation is in the framework of mean-field theory. The excited nucleus is viewed as a charged liquid drop composed of N_0 neutrons and Z_0 protons with mass number $A_0 = N_0 + Z_0$. In its journey from the liquid to the gas phase, the depleted nucleus is taken to be in complete thermodynamic equilibrium with its own emanated vapor so that the total number of neutrons and protons are conserved. Besides nucleons, the vapor contains clusters that alter the equilibrium conditions, which will be reflected in the caloric curve and the resulting heat capacity.

It is found that in the liquid-vapor coexistence region the pressure is not a constant on an isotherm, indicating that the transition is continuous. At constant pressure, the caloric curve shows some anomalies; namely, the systems studied exhibit negative heat capacity in a small temperature domain. The dependence of this specific feature on the mass and isospin of the nucleus, Coulomb interaction, and the chosen pressure was studied. The effects of the presence of clusters in the vapor phase on specific heat have also been explored [1].

[1] J. N. De, S. K. Samaddar, S. Shlomo, and J. B. Natowitz, Phys. Rev. C **73**, 034602 (2006).