Nuclear Theory

Can We Rigorously Define Phases in a Finite System?

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Here we propose the generalized statistical multifragmentation model which includes the liquid phase pressure of the most general form. This allows us to get rid of the absolute incompressibility of the nuclear liquid. Also the present model employes a very general form the surface tension coefficient of nuclear fragments. Such a model is solved analytically for finite volumes by the Laplace-Fourier transform method to isobaric ensemble. A complete analysis of the isobaric partition singularities of this model is also done for finite volumes. It is shown that the real part of any simple pole of the isobaric partition defines the free energy of the corresponding state, whereas its imaginary part, depending on the sign, defines the inverse decay/formation time of this state. The developed formalism allows us to exactly define the finite volume analogs of gaseous, liquid and mixed phases of the class of similar models from the first principles of statistical mechanics and demonstrate the pitfalls of earlier works. The finite width effects for large nuclear fragments and quark gluon bags are also discussed.

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