The Canonical and Grand Canonical Models for nuclear multifragmentation.

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We assume that in equilibrium, nuclear matter at reduced density and moderate finite temperature, breaks up into many fragments. A strong support to this assumption is provided by data accumulated from intermediate energy heavy ion collisions. Many observables seen in intermediate energy heavy ion collisions can be explained on the basis of statistical equilibrium. Calculations based on the statistical equilibrium are implemented in this work in the canonical ensemble(temperature and number of particles are kept fixed) and grand canonical ensemble(fixed temperature and a variable number of particles but with an assigned average)[1]. A recursion relation has been developed which allows calculations with arbitrary precision for many nuclear problems.

The canonical thermodynamical model has been used to study and calculate the production of light and intermediate particles and properties of the largest fragment[2] resulting from heavy ion collisions and they nicely fit the experimental data. This model also reproduces the salient features of fragmentation cross sections of very neutron-rich nuclei[3] very well. The experimental data for isoscaling as well as the deviations from isoscaling is also reproduced by this canonical thermodynamical model[4]. It is also established that for finite systems the canonical ensemble is much more appropriate. The grand canonical model for multifragmentation[5] leads to a phase transition for nuclear matter. In a range of temperature and density first order transition occurs. The gas and liquid phases can be clearly identified. There is a subtle but important difference between the physics addressed in the two models. It can be shown that if we reformulate the parameters in the canonical model to better appromate the physics addressed in the grand canonical model, calculations for observables in both the ensembles converge[6].

References

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