Flow Effects on Multifragmentation in the Canonical Model

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In intermediate energy heavy ion reactions the colliding nuclei get compressed in the initial phase with subsequent decompression thereby generating collective flow energy. At energies around 100 MeV per nucleon or above, large radial collective flow has been observed in many experiments. In a hydro dynamical model with site-bond percolation, it has been shown that compression is very effective in multifragmentation. Such a conclusion is further reached in microscopic BUU-type formulations as well as in a grand canonical thermodynamic calculation. It's crucial importance on the extracted value of the freeze-out density from yield ratios of fragment isotopes differing by one neutron in a statistical fragmentation model was also pointed out [1].

We have performed calculations [2] for multifragmentation of a heated nucleus in a canonical model with incorporation of flow both at constant volume as well as at constant flow pressure. It may be pointed out that under the experimental conditions none of these constraints may exist. In the absence of any definite knowledge of the actual scenario, the calculations were done with these constraints imposed. It is found that the average multiplicity increases with flow; the average intermediate mass fragments (IMF) multiplicity shows a rise and fall with excitations commensurate with the experimental data. The calculated caloric curves also follow the experimental trend very closely. The plateau in the caloric curve and the peaked structure of the corresponding heat capacity at temperature around 5-6 MeV signal a liquid-gas phase transition in the finite nuclear systems. At constant flow pressure, the caloric curve shows a negative slope in a small domain of temperature and gives rise to negative heat capacity. Negative heat capacity at constant thermal pressure has been observed in the same model without flow; it is interpreted as arising in regions of mechanical instability where the isobaric volume expansion coefficient is negative. The same effect is seen to persist with incorporation of flow. A sudden jump in entropy is also seen, both at constant volume and at constant pressure. It is interesting to note that the maximum in the average number of IMF $\langle N_{IMF} \rangle$, the peak in the heat capacity at constant volume C_v, the discontinuity in the heat capacity at constant pressure C_p and the sudden jump in entropy are all around the same temperature signaling a liquid-gas phase transition.

[1] S. Shlomo, J.N. De and A. Kolomiets, Phys. Rev. C **55**, R2155 (1997).
[2] S.K. Samaddar, J.N. De, and S. Shlomo, Phys. Rev. C (in press).