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Statistical proporties of small systems

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Statistical mechanical treatment of macroscopic systems consisting of an assembly of particles starts with the Boltzmann formula along with the use of a statistical ensemble averaging techniques for the probability distribution of particles in the system. The relationship between thermodynamics and statistical physics is valid in the thermodynamic limit - when the number of particles involved becomes very large. Here we study statistical proporties in the opposite regime - at both the nano scale, and when deviation from Boltzman formula become important.

The question of the issue of the application of thermodynamics on the nanoscale began to emerge after the nucleation reaction was discovered in the early 1930s and continues to be asked to this day. It was clear right from the beginning that as the system size decreases one has to deal with fluctuations. In this context, the first such considerations were on temperature fluctuations. As the result Tsallis distribution repleaces Boltzman formula. We discuss statistical proporties of small system and demonstrate that Tsallis distribution is the natural description of such system.

Fluctuations in systems containing a relative small number of constituents have been studied to examine how those differ from their macroscopic counterparts. We analyze ensemble in which energy (E), temperature (T) and multiplicity (N) can all fluctuate and with the help of nonextensive statistics we consider relation connecting all fluctuating variables. In particular fluctuations of energy and multiplicity has been considered. Dependence of heat capacity on the size system (characterized by the number od particles N) is discussed. Fluctuations of the energy are, in general, given by the sum of two components: one obtained in the case of no fluctuations (the kinetic component) and one originating by fluctuations (the potential component). Deviation from $Var(N) \sim 1/N$ relation has been demonstrated in multiparticle production processes where the sub-Poissonian distribution (for small N) as well as super-Poissonian distributions (for larger N) are observed.