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A New Formalism for Nonextensive Physical Systems: Tsallis Thermostatistics

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Abstract: Although Boltzmann-Gibbs (BG) statistics provides a suitable tool which enables us to handle a large number of physical systems satisfactorily, it has some basic restrictions : (i) the range of the microscopic interactions must be small compared to the linear size of the macroscopic systems (short-range interactions) , (ii) the time range of the microscopic memory must be small compared to the observation time (Marcovian processes) and (iii) the system must evolve in an Euclidean-like space-time. In the case of a breakdown in one and/or the others of these restrictions, BG statistics fails. More precisely, the situation could be classified in a general manner as follows: (i) For an Euclidean-like space-time, if the forces and/or the memory are long-ranged, as far as we are interested in an equilibrium state, the BG statistics is weakly violated, therefore BG formalism can be used. On the other hand, whenever a meta-equilibrium state is considered, the BG statistics is strongly violated, hence another formalism must be needed. (ii) For a (multi)fractal space, BG formalism is strongly violated again and a new formalism is needed. The way out from these problems seems to be Nonextensive Statistical Thermodynamics which must be a generalization of the BG statistics in a manner that allows a correct description of the nonextensive physical systems as well. Recently a nonextensive thermostatistics has been proposed by C.Tsallis to handle the nonextensive physical systems and up to now, besides the generalization of some of the conventional concepts, the formalism has been prosperous in some of the physical applications. In this study, our effort is to introduce Tsallis thermostatistics in some details and to emphasize its achievements on physical systems by noting the recent developments on this line.

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