# Classical Spin Systems with Long-Range Interactions: The Role of the Lattice Dimension in the Nonextensive Behavior

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Preliminary numerical analysis of a $d$-dimensional Hamiltonian system composed by $N$ classical localized XY- and Heisenberg-like spins $\mathbf{S}_i$'s is presented. The model has a two-body interaction $\Phi(r_{ij})$ between spins at sites $i$ and $j$ that decays with distance $r_{ij}$ as a power-law, *i.e.*, $\Phi(r_{ij}) \propto \mathbf{S}_i \cdot \mathbf{S}_j / r_{ij}^{\alpha}$ with $\alpha \geq 0$. The parameter $\alpha$ controls the interaction range and both the fully-coupled and nearest-neighbor-interaction models are recovered in the particular limits $\alpha = 0$ and $\alpha \to \infty$, respectively. The dynamics and thermostatistics of the system are investigated through molecular dynamics simulations in $d = 1$, 2 and 3 dimensional lattices.

Previous $d = 1$ studies revealed that anomalous behaviors emerge when the system is in the long-range regime ($\alpha < 1$), such as long-lived non-Boltzmannian quasi-stationary states, ergodicity breaking and non-Maxwellian velocity distributions [see J. Stat. Mech.: Theor. Exper. **4**, P04012 (2015) and references therein]. On the other hand, in the short-range regime ($\alpha > 1$) there are no anomalous behaviors: all the standard Boltzmann-Gibbs results are recovered. It has been shown that these non-Maxwellian velocity distributions in the long-range regime actually can be well described by $q$-Gaussians, a function which is one of the landmarks of the nonextensive statistical mechanics build on the nonadditive entropy $S_q$. We are primarily interested in the influence of $d$ on the velocity distributions, *i.e.*, in see how higher values of $d$ modify the previous $d = 1$ results. More specifically, we want to verify a possible universal scaling law in the velocity distribution ruled by the $\alpha/d$ ratio as preliminary results have already pointed out. Scaling laws linking the spatial dimension ($d$) and the interaction range ($\alpha$) frequently appear in complex/nonextensive systems.

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