Second lecture:

Transitions to chaos and dynamics at criticality and glass formation

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Abstract:

The physical area of application of q-statistics is further probed in this lecture by considering the dynamics of critical fluctuations and of glass formation in thermal systems. In both cases a connection is made with critical attractors in unimodal maps. Two specific examples have been recently developed. In one case the dynamics at the tangent bifurcation has been shown to be related to that at of fluctuations at thermal critical states. In the second case the noise-perturbed dynamics at the period-doubling onset of chaos has been demonstrated to be closely analogous to the glassy dynamics observed in supercooled molecular liquids. For the first example we look at both static (fractal) and dynamical (intermittent) properties of large clusters of order parameter, or magnetization, at critical points in thermal systems and highlight their association to q-statistics. These properties are examined by considering a partial occupation of reduced (magnetization) phase space. We obtain: A faster than exponential growth of magnetization with cluster size that implies extensivity of the q-entropy. And a link between size extensivity of cluster q-entropy and linear time growth of the q-entropy associated to the sensitivity to initial conditions of the intermittent nonlinear map for the time evolution of magnetization. For the second example we explain the strong parallelisms that exist between the dynamics at the noise-perturbed period-doubling onset of chaos in unimodal maps and the dynamics observed in supercooled liquids close to vitrification. Four major features of glassy dynamics in structural glass formers, two-step relaxation, aging, a relationship between relaxation time and configurational entropy, and evolution from diffusive to subdiffusive behavior and finally arrest, are shown to be displayed by the properties of orbits with vanishing Lyapunov coefficient. The previously known properties in control-parameter space of the noise-induced bifurcation gap play a central role in determining the characteristics of dynamical relaxation at the chaos threshold.