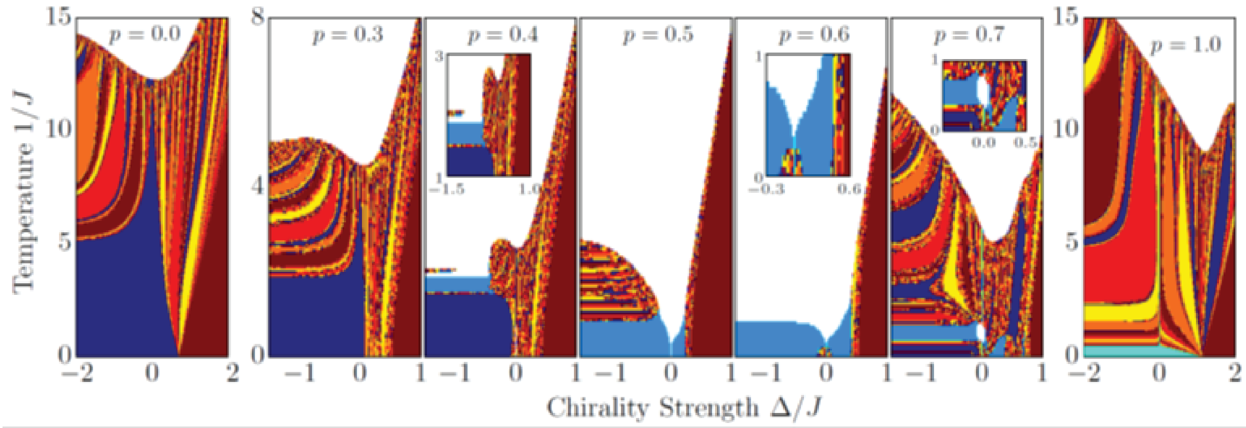
Faculty of Science
Department of Physics

İhsan Doğramacı Bilkent University

Bilkent fizik



Colloquia

FALL 2016

Nihat Berker

Sabancı University and MIT

Chiral spin-glass phases, fibrous microreentrances, nano-controlled frustration, multiple chaos, and Holywood goes to statistical mechanics

day	location	time
DEC 14, 2016 WED	EE01	15:40

ABSTRACT

After a pedagogical introduction, recent results will be given. A spin-glass phase is obtained, for the first time, from competing chirality interactions and comes with novel phase transition phenomena.[1] The global phase diagram of this frozen-disordered chiral 3-state Potts system in d=3 spatial dimensions is calculated by renormalization-group theory, in temperature, chirality concentration p, and chirality-breaking concentration c, with distinct determination of phase chaos and phase-boundary chaos. The system has ferromagnetic, left-chiral, right-chiral, chiral spin-glass, and disordered phases. The phase boundaries to the ferromagnetic, left- and right-chiral phases show, differently, an unusual, fibrous patchwork (microreentrances) of all four (ferromagnetic, left-chiral, right-chiral, chiral spin-glass) ordered phases, especially in the multicritical region. The chaotic behavior of the interactions under scale change are determined in the chiral spin-glass phase and on the boundary between the chiral spin-glass and disordered phases, showing Lyapunov exponents in magnitudes unexpectedly reversed from ferromagnetic-antiferromagnetic spin-glass systems. The latter, in which ferromagnetic and antiferromagnetic interactions do not match and local odd-clock degrees of freedom inject entropy, are also studied by renormalization-group theory in various integer and fractional spatial dimensions.[2] We show that with nano-rearrangements of ferromagnetic and antiferromagnetic interactions, the interaction non-matching (aka frustration) can be tuned without changing the material components. Thus, the spin-glass phase never before seen in d=2 dimensions has been obtained and, in the opposite direction, the spin-glass phase always seen in three dimensions has been removed. In the spin-glass phase in even-q-state clock spin models, we show the equivalence of the chaotic distribution of interactions at a given position appearing under consecutive scale changes and the chaotic distribution of interactions in all positions of the system at a given scale. A universality has been found across the different q values. In odd-q-state clock spin models, differently, asymmetric phase diagrams, as in quantum spin-glass systems, and many phases in which every point is a critical point have been found. 23 sequenced hierarchical models have been solved and the lower-critical dimension where the spin-glass phase disappears has been precisely determined with the non-simple non-integer value of 2.5210 [3], which also appears to be obeyed by chiral spin-glass ordering. In very recent work [4], ferromagnetic/antiferromagnetic right/left chiral clock spin-glass systems have been studied, showing rather rich phase diagram sequences, one example of which is shown above. In this connection, several obtained phase-diagram-morphing video movies will be shown.

[1] T. Çağlar and A.N. Berker, Phys. Rev. E 94, 032121 (2016).

[2] E. Ilker and A.N. Berker, Phys. Rev. E 87, 032124 (2013); 89, 042139 (2014); 90, 062112 (2014).

[3] M. Demirtaş, A. Tuncer, and A.N. Berker, Phys. Rev. E 92, 022136 (2015).

[4] T. Çağlar and A.N. Berker, manuscript in preparation (2016).

The Physics Colloquia are designed to address a non-specialist, broad audience and introduce topics of contemporary research through lectures by leading experts. We warmly invite all members of the student body, including undergraduates enrolled in any programme.