Trajectories with my friends: Global phase diagrams plus high-temperature superconductivity and e-supermarket delivery optimization

I have been deeply thankful to my students and collaborators from day one of my academic career. For this special occasion, I would like to especially thank the Organizers of the "Friends and Trajectories" Symposium at MIT, Mehran, David, and Susan, and the Editors of this companion Volume, Joseph and Miron. I also thank all the attendees of the Symposium and the authors of the Volume, who have created such a singular memory.

The setting for individual happiness and productivity is provided by highly diversified and accepting communities. My experience in such settings is my home town Istanbul, a world city that many of my international friends have explored with me (Fig. 1), and the statistical physics community. A city or a scientific field is only as good as the people in it and from this point of view I have been very lucky. I am therefore deeply grateful to my friends, colleagues, and students. I have started in statistical physics research 40 years ago and my first dent was made with the renormalization-group calculation of the global phase diagram of a multicritical system (Fig. 2). As many know, such calculations have remained a love of mine, but I have been also enjoying research in systems as diverse as supermarket food distribution optimization (Fig. 3) and high-temperature superconductor models (Fig. 4). In these forty years, I have listened to, interacted with, and collaborated with theorists and experimentalists; scientists and engineers; academicians and non-academicians; physicists, chemists, mathematicians, biologists, geologists, philosopher, . . . , in this world-spanning city that is statistical mechanics. Our diversity and embrace of different backgrounds and methods is the dynamic of the never-ending vibrancy and astounding success of our field. It continues to be a great ride. I therefore thank again, with all my heart, my friends, colleagues, and students, three groups that are really one.

A. Nihat Berker, Istanbul, February 2010

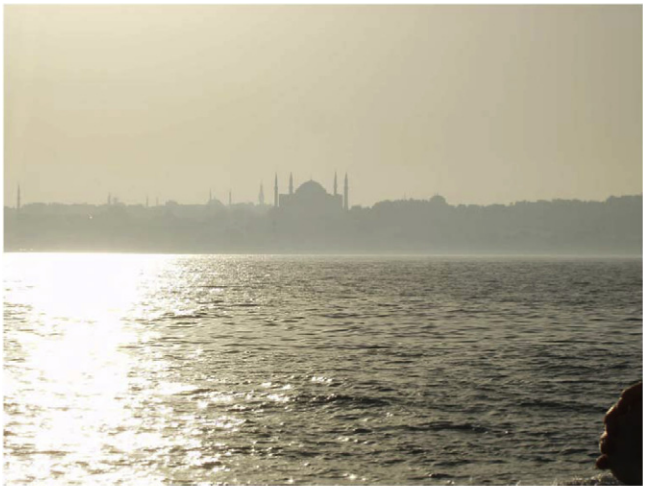

Fig. 1. Istanbul (photo by Leonard M. Sander, Department of Physics, University of Michigan), officially Cultural Capital of Europe for 2010, a civilization capital of the world for always.

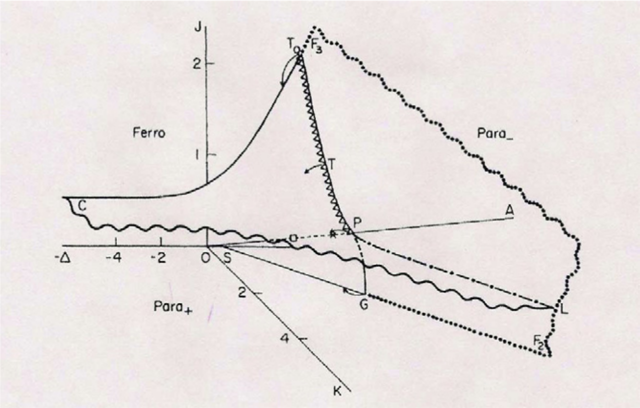

Fig. 2. The BEGP global phase diagram obtained with the position-space renormalization-group method, from A.N. Berker and M. Wortis, Phys. Rev. B **14**, 4946 (1976). Critical and first-order phase transitions are, respectively, drawn with dark full and dotted lines. Wavy lines denote smooth continuation of surfaces. The two coexisting ferromagnetic phases (Ferro) and each of the two paramagnetic phases (Para$_\pm$) are separated by the critical surface CT_0PL and by the first-order surfaces F_3T_0PL (three-phase coexistence) and F_2GPL (two-phase coexistence). T_0P is an ordinary tricritical line (triangles), GP is an isolated critical line, and PL is a critical endline (dash-dotted). T_0 is the intersection of the tricritical line with the $K = 0$ (Blume–Capel) plane. P is a special tricritical point corresponding to the three-state Potts phase transition.

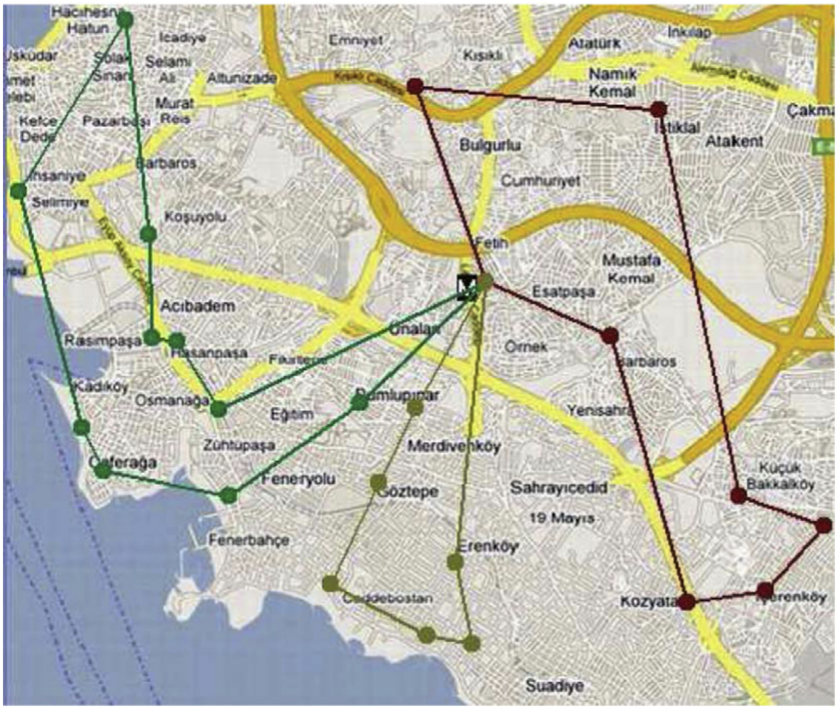

Fig. 3. Supermarket food distribution optimization of repartition and routing for 3 vehicles, for a particular store, using an imbedded double simulated annealing. From A. Erbaş, M.S. Thesis (Koç University, Istanbul, 2007).

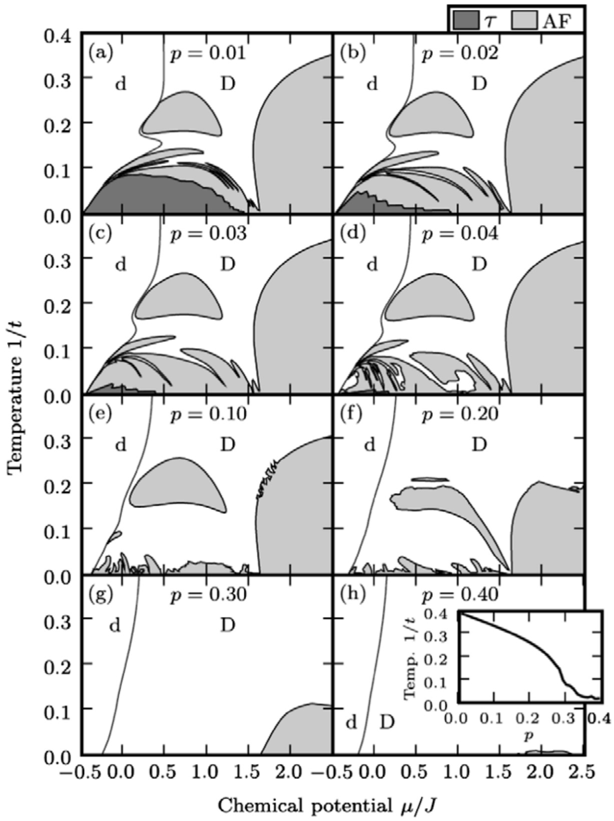

Fig. 4. Calculated phase diagrams of the $d = 3$ tJ model, with $J/t = 0.444$, for various values of the quenched nonmagnetic impurity concentration p, plotted in terms of temperature $1/t$ vs. chemical potential μ/J, from "Finite-temperature phase diagram of nonmagnetic impurities in high-temperature superconductors using a $d = 3$ tJ model with quenched disorder", M. Hinczewski and A.N. Berker, Phys. Rev. B **78**, 064507 (2008). The phases depicted in the figures are: dilute disordered (d), dense disordered (D), antiferromagnetic (AF), and τ. The inset shows AF transition temperatures for the near-half-filled system ($\mu/J = 100$) as a function of p. It is seen that (1) the τ phase disappears at 5% impurity concentration; (2) by contrast, the antiferromagnetic phase disappears at 40% impurity concentration; (3) at low (random) impurity concentrations, the antiferromagnetic phase actually expands. All three of these distinctive features are in close agreement with experiments. The calculation uses no adjustable parameter.