

Statistical Physics of Disordered Systems: from real materials to optimization and codes

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PREFACE

Statistical Physics of Disordered Systems: from real materials to optimization and codes

When we called for contributions to this special issue we stressed the fact that we were interested in having the topic interpreted broadly. We asked for contributions ranging from equilibrium and dynamical studies of spin glasses, glassy behaviour in amorphous materials and low temperature physics, to applications in non-conventional areas such as error-correcting codes, image analysis and reconstruction, optimization and algorithms based on statistical mechanical ideas. This was because we believe that we have arrived at a very exciting moment for the development of this multidisciplinary approach, and that this issue should bear witness to, and summarize, such an exciting situation.

Even a cursory look at the index of this issue shows, we believe, that our hopes have been completely fulfilled; we have a large variety of papers giving new insights into the whole range of fields. Our hope is that it will play a double role. On the one hand it will carry, as good journals always should, a number of good physics papers containing important results. On the other it should be a good summary of the state of the art for some time.

The larger section of the issue is about slow dynamics. This is understandable, since slow dynamics is such a ubiquitous phenomenon. Here recent progress deals with glasses, spin glasses and far more general situations. Modifications of the celebrated fluctuation–dissipation theorem also play a crucial role.

Finite dimensional systems (mainly spin glasses) are attracting a lot of attention since their behaviour is not yet well defined from a theoretical point of view. Here we have papers about Ising, Heisenberg and Potts spin glasses, together with the discussion of different types of disorder.

Even if the mean field theory of spin glasses is well understood, important questions (about, for example, the value of the *complexity* and the detailed nature of the solution of the model) are still open, and they are discussed in this issue.

This period has also seen very rich developments in rigorous results concerning complex disordered systems. We present some new rigorous results in this issue.

As we have said before, we have focused on the strong paradigmatic and interdisciplinary nature of the recent developments in the subject. Maybe the spin glass theory is more important to some people since it allows us to study error-correcting codes and similar problems than because of the study of the spin glass materials themselves. Here we present a number of new results in many of these emerging directions.

We then have new developments in image processing. One uses the mean field theory, the Bethe approximation and ideas from the dynamical approach.

Also very important is the relation among statistical mechanics of disordered systems and optimization. We have here new results about colouring and the analysis of disordered systems ground states, together with a short review on vertex covering. The same ideas applied to codes are also finding many applications; here we have new work about low-density parity check codes and CDMA multi-user detection codes.

Finally we have new results about the application of statistical mechanical ideas to game theory and to the so-called *econophysics*. We believe that this topic is also experiencing a fast and solid progress, and we are happy to be able to witness it here.

We thank the authors who have been collaborative, open-minded toward improvements and punctual (as much as one could hope). We also appreciate the efforts of the referees who have worked hard towards ensuring high quality; we believe they have succeeded. We thank all the staff of *Journal of Physics A: Mathematical and General* for their exceptional work. Without all that this issue would not have been possible.

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Guest editors