SONIFICATION OF PHYSICAL OBSERVABLES ACROSS PHASE TRANSITIONS: FROM QCD TO POLYMERS

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Sonification is defined as the use of non-speech audio to extract information from data and it represents the sound analogue to graphical visualization. The method is applied in several disciplines from economy to medicine to physics. Sonification might also help in analyzing critical phenomena. It could assist, together with graphical display, to examine the behavior of physical observables as a function of parameters like temperature, couplings and other variables of the system. In order to demonstrate the methodology for quantum chromodynamics (QCD) we analyzed the eigenvalues of the Dirac operator as a function of temperature from the confinement to the quark-gluon-plasma phase. An evaluation of data for the specific heat in the rich phase structure of polymers is devoted to the CompPhys05 Workshop. We are adapting program packages for audio browsing developed at the University of Graz within the interdisciplinary research project SonEnvir (http://sonenvir.at/).

1 Polymers with attractive substrate

Monte Carlo simulations can be used not only for lattice QCD but have been designed generally for thermodynamic systems and their phase transitions. In this demonstration of sonification, we rely on a detailed study of the solubility-temperature phase diagram of a polymer in a cavity with an attractive substrate.[1] The (pseudo)phase diagram Fig. 1 is based on the profile of the specific heat C_V as a function of temperature T and reciprocal solubility s. Although this profile allows for the identification of phases and their boundaries it tells little about the conformational transitions between the phases. For this purpose expectation values and fluctuations for the numbers of monomer-surface contacts, n_s, and intrinsic monomer-monomer contacts, n_m, were considered separately, see Fig. 2. These contact numbers turned out to be sufficient to describe the macrostate of the system and therefore are useful to describe the conformations dominating the different phases.[1]

2 Sonification

A sonification demonstration of the data was performed at the CompPhys05 workshop in Leipzig.[2] Listening to the result for the specific heat of the polymers along the T axis for $s = 1$ we experience the spike and the shoulder from the probably first-order transitions around $T \approx 0.34$ and $T \approx 2.44$, respectively. The SonEnvir project-group in Graz has also written a sonification tool for moving around the polymer landscape so that one can hear the polymer structure in the vicinity of the current position. Sample files are stored on the SonEnvir server.[3]

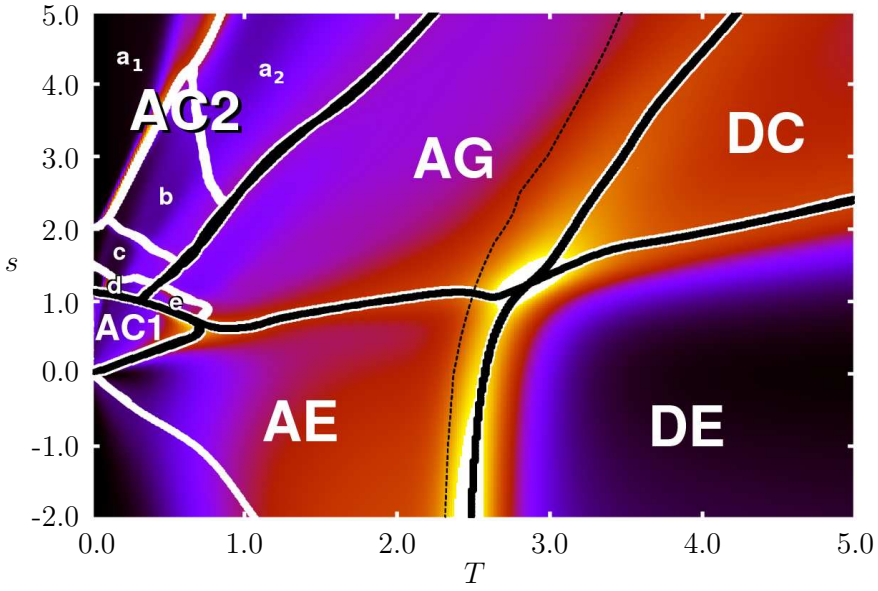

Figure 1: Solubility-temperature pseudophase diagram of a 179-mer simulated by the Leipzig group. The color codes the specific heat as a function of reciprocal solubility s and temperature T.

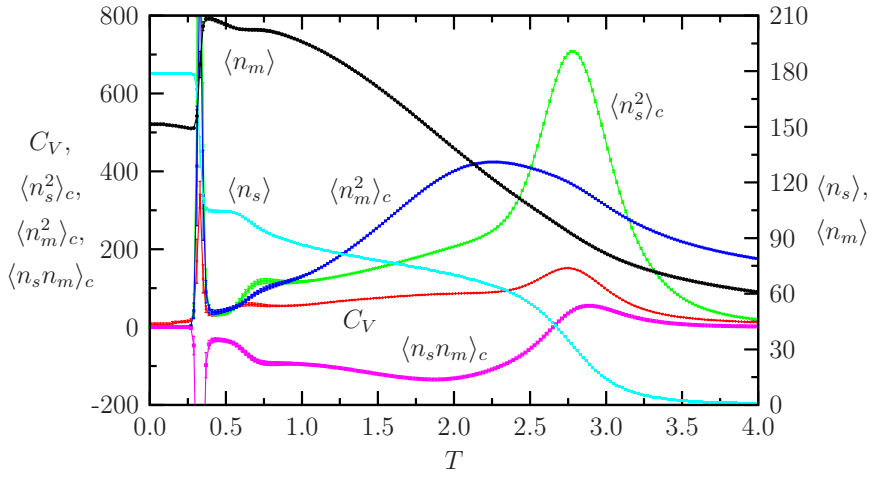

Figure 2: Expectation values, self- and cross-correlations of the contact numbers n_s and n_m as functions of the temperature T in comparison with the specific heat C_V for a 179-mer in solvent with $s = 1$. The specific heat from these results of the Leipzig group is taken for sonification.

Acknowledgments

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References

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3. http://www.sonenvir.at/downloads/LatticeQCD