## **Gradient Gibbs Measures: Statistical Mechanics and Nonlinear Elasticity**

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**Abstract:** It is a natural task to try to obtain nonlinear elasticity at nonzero temperatures directly from microscopic models studied by methods of statistical physics. We will discuss prospects and limitations of such an approach, concentrating eventually on the case random gradient vector fields with Gibbs probability distribution. There are technical difficulties arising from a slow decay of their correlations that prevent any use of straightforward perturbation techniques. We will explore the main idea, based on multi-scale analysis, of overcoming these difficulties. Finally, we will turn to a substantiation for the variational characterization of nonlinear elasticity in an appropriate scaling limit. We will derive a quasiconvex free energy of elastic deformation and show how to get the variational principle in terms of large deviations of random gradient fields.