# Statistical Physics of Athermal Elastic Constants of Amorphous Solids

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We study the elastic theory of amorphous solids made of particles with finite range interactions in the thermodynamic and zero temperature limits. For the elastic theory to exist one requires all the elastic coefficients, linear and nonlinear, to attain a finite thermodynamic limit. We show that for such systems the existence of non-affine mechanical responses results in anomalous fluctuations of all the nonlinear coefficients of the elastic theory. While the shear modulus exists, the first nonlinear coefficient $B_2$ has anomalous fluctuations and the second nonlinear coefficient $B_3$ and all the higher order coefficients which are non-zero by symmetry diverge in the thermodynamic limit. These results put a question mark on the existence of elasticity (or solidity) of amorphous solids at finite strains, even at zero temperature. We discuss the physical meaning of these results and propose that, in these systems, elasticity can never be decoupled from plasticity: the nonlinear response must be very substantially plastic.

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