

Reply to “Comment on ‘Elastic constants from microscopic strain fluctuations’”

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We agree with Coupier *et al.* [Phys. Rev. E **81**, 013101 (2010)] that their technique for extracting elastic constants from microscopic strain fluctuations improves upon ours because of a more accurate computation of the integral of the elastic correlation function over sub-blocks. However, we believe that their interpretation of the physical relevance of the elastic correlation length extracted from the fits is misleading.

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In a comment to our earlier work [1], Coupier *et al.* showed [2] that it is possible to improve our technique for extracting elastic constants (and elastic correlation lengths) from particle configurations obtained in simulations or experiments by going beyond the approximations used in [1] (and [3]). Using an accurate representation for the integral of the elastic correlation function over finite sized blocks, the authors obtain a new finite-size scaling form. Fits using this new form then yields slightly altered values of the quantities of interest, the elastic constants. As, is clear from their comment, the result of using the improved analysis for large systems is minimal for the large system sizes we used in our work [1,3] and our essential conclusions are unaltered. There is, however, some quantitative difference when the technique is used to analyze small systems, typically those obtained from experiments. We also believe that the considerations expressed in the comment become more important in higher dimensions where it is difficult to obtain samples of sufficiently large size. Overall, we believe that the improvement of the technique, as suggested in [2] will enable experimentalists to use the method to obtain detailed elastic information for small samples, or small local regions in two and three dimensions.

One of the more surprising conclusions of [2], is the fact that, in contrast to [1], the elastic correlation length extracted using the same method, turns out to be smaller than even a lattice parameter, implying the seemingly paradoxical con-

clusion that elasticity remains valid to distances smaller than the unit cell!! We believe that this conclusion results from an incorrect interpretation of the role of the elastic correlation function. Recent work [4–6] undertaken by some of us shows that the situation is far more subtle than was assumed in [1–3]. First, the true elastic correlation function is very different from the simple Ornstein-Zernike form used in [1–3]. In reality, it is highly anisotropic with a correlation length which is a strong function of direction, making it impossible to describe the decay of elastic correlations by a single number. Second, we have shown that the correlation function (in momentum space) has a nontrivial wave-number dependence, which implies multiple (angle dependent) correlation lengths. Last, but not the least, we have shown that the elastic description breaks down below a typical “*coarse-graining length*” which is *necessarily larger than the lattice parameter*. Below this length, the contribution of “*nonaffine*” fluctuations, viz. fluctuations of particle coordinates which cannot be described by an affine, elastic, strain on an ideal reference lattice, becomes important. In real experimental systems, there may also be surface stresses which further complicate the analysis. Most, if not all, of these issues have been dealt with in some detail in [5,6].

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