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Soft modes and elasticity of nearly isostatic lattices: randomness
and dissipation\textsuperscript{1} XIAOMING MAO, TOM LUBENSKY, Department of Physics
and Astronomy, University of Pennsylvania — Isostatic periodic lattices, such as
the square and kagome lattices in spatial dimension $d = 2$, are systems at the on-
set of rigidity. They are marginally stable with coordination number $z = 2d$, and
they may exhibit a non-extensive number of soft modes that can be removed by
adding an infinitesimal number of additional bonds. Randomly packed frictionless
spheres at the jamming point $J$ represent an important isostatic system that, be-
cause of its randomness, exhibits complexities beyond those of periodic systems.
To study the effects of randomness on phonon response, propagation, and damp-
ing, we constructed model lattices near isostaticity by adding randomly distributed
next-nearest and second-nearest neighbor bonds to the isostatic square and kagome
lattices, respectively. We calculated a number of properties of these models using
the CPA approximation and found them to resemble those of jammed solids near
the point $J$. In particular, the phonon density of states crosses over from Debye-like
at low frequency $\omega$ to the flat frequency-independent behavior of a one-dimensional
systems at a characteristic frequency $\omega^*$ that scales as the density of additional ran-
don bonds $\Delta z$. The real and imaginary part of the effective random-bond spring
constants become equal at $\omega^*$. We also identify a characteristic length that scales
as $(\Delta z)^{-1}$.

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