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Jamming of Ellipsoids: Abundance of Zero-Frequency Modes and What to Do With Them

ZORANA ZERAVCIC, University of Leiden

As spheres are distorted into ellipsoids of revolution, their aspect ratio, ϵ departs from the symmetric value, $\epsilon = 1$. At the jamming transition, the average number of contacts per particle, $Z(\epsilon)$, increases *continuously* from the isostatic value for spheres, $Z_{\rm iso}(\epsilon = 1) = 6$, as $|\epsilon - 1|$ is increased. This leads to an apparent paradox: as soon as ϵ departs from unity, the number of contacts is considerably less than that needed for stability according to the Maxwell rigidity criterion: $Z_{\rm iso}(\epsilon \neq 1) = 10$. There are therefore many unconstrained and nontrivial rotational degrees of freedom that give rise to new features in the vibrational spectrum: zero-frequency modes are gradually mobilized into a new rotational band as $|\epsilon - 1|$ is increased. For small $|\epsilon - 1|$, this rotational band is separated by a gap from the translational band found for simple spheres. Like many singular points, the spherical jamming transition controls a broader class of behavior but in an unusual and nontrivial way. At larger distortions, the two bands merge producing vibrations with a mixed character. Here I present detailed studies of the evolution of the spectrum and the implications for the mechanical properties of these packings [1]. [1] Z. Zeravcic, N. Xu, A. J. Liu, S. R. Nagel and W. van Saarloos, *Europhys. Lett.* 87, 26001 (2009).