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Elastic Instability and Sound Dispersion in Amorphous Solids

ERIC DEGIULI, ADRIEN LAVERSANNE-FINOT, GUSTAVO DURING, EDAN LERNER, MATTHIEU WYART, Center for Soft Matter Research, NYU — Connectedness and applied stress are key characteristics of amorphous solids at zero temperature. Rigidity can be lost either through unjamming as connectedness is decreased, or buckling as stress is increased. We present an effective medium theory which describes elastic behaviour in proximity to both unjamming and buckling. The theory successfully predicts (i) the dependence of the boson peak on pressure and coordination, (ii) negative sound dispersion and a kink in sound attenuation near the boson peak, as observed experimentally in molecular glasses, (iii) a characteristic frequency ω_0 that vanishes at a critical pressure, and (iv) the previously derived stability diagram for $T = 0$ amorphous solids. Our predictions for sound dispersion are similar to disorder-based approaches to the boson peak, however we resolve two inconsistencies of these approaches: (i) since disorder is secondary to connectedness and stress in our theory, we explain why some crystals and glasses have similar elasticity, and (ii) we explain the natural emergence of a mesoscopic length scale visible in response, which is absent in static structure.

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