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Role of Structural Hierarchy in 2D Athermal Network Mechanics JONATHAN MICHEL, PETER YUNKER, Georgia Institute of Technology — Hierarchical materials are common in nature [1], and are of interest for various technical applications [2]. We assess the applicability of frame stiffness criteria pioneered by Maxwell and refined by Calladine when multiple, disparate length scales exist. We consider in particular a case in which an individual large-scale bond has a finer network structure with the same vertex arrangement as the large scale, but not necessarily equal connectivity. We present an experimental and computational study of the effect of connectivity at two scales on tensile stiffness for two-dimensional, dilute, hierarchical triangular lattices, and discuss observed energy storage at failure. For full connectivity on the small scale, behavior as large bonds are removed resembles theoretical results for a single-scale triangular filamentous lattice [3]. Small-scale dilution causes far more abrupt softening, and an accompanying collapse of energy storage at failure.

[1]Piechocka, I. et al., "Structural Hierarchy Governs Fibrin Gel Mechanics", *Biophysical Journal* 98, Issue 10, 2281-2289
[2]Zheng, X. et al., "Multiscale metallic metamaterials", *Nature Materials* 15: 1100-1106
[3]Mao, X., et al., "Elasticity of a filamentous kagome lattice", *Phys. Rev. E*, 87:042604

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