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Nematic elastomers: From a microscopic model to macroscopic elasticity theory PAUL GOLDBART, University of Illinois at Urbana-Champaign, XIANGJUN XING, Syracuse University, STEPHAN PFAHL, University of Mainz, SWAGATAM MUKHOPADHYAY, Rutgers University, ANNETTE ZIPPELIUS, University of Goettingen — A Landau theory is constructed for the gelation transition in cross-linked polymer systems possessing spontaneous nematic ordering, based on symmetry principles and the concept of an order parameter for the amorphous solid state. This theory is substantiated with help of a simple microscopic model of cross-linked dimers. Minimization of the Landau free energy in the presence of nematic order yields the neo-classical theory of the elasticity of nematic elastomers and, in the isotropic limit, the classical theory of isotropic elasticity. These phenomenological theories of elasticity are thereby derived from a microscopic model, and it is furthermore demonstrated that they are the universal mean-field descriptions of elasticity for all chemical gels and vulcanized media.

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