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Elastic theory of origami-based metamaterials[1] FREDERIC LECHENAULT, Laboratoire de Physique Statistique, ENS, Paris, V. BRUNCK, Lab. de Physique Statistique, Ecole Normale Superieure, UPMC, Univ. Paris 06, Univ. Paris-Diderot, CNRS, Paris, France, A. REID, Lab. de Physique Statistique, Ecole Normale Superieure, UPMC, Univ. Paris 06, Univ. Paris-Diderot, CNRS, Paris, France NC State Univ, M. ADDA-BEDIA, Lab. de Physique Statistique, Ecole Normale Superieure, UPMC, Univ. Paris 06, Univ. Paris-Diderot, CNRS, Paris, France — Origami offers the possibility for new metamaterials whose overall mechanical properties can be programmed by acting locally on each crease. Starting from a thin plate and having knowledge about the properties of the material and the folding procedure, one would aim to determine the shape taken by the structure at rest and its mechanical response. We introduce a vector deformation field acting on the imprinted network of creases, that allows to express the geometrical constraints of rigid origami structures in a simple and systematic way. This formalism is then used to write a general covariant expression of the elastic energy of n-creases meeting at a single vertex, and then extended to origami tesselations. The generalized waterbomb base and the Miura-Ori are treated within this formalism. For the Miura folding, we uncover a phase transition from monostable to two metastable states, that explains the efficient deployability of this structure for a given range of geometrical and mechanical parameters.

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Frederic Lechenault
Laboratoire de Physique Statistique, ENS, Paris

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