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Pattern formation in the Structural Scales of the Morpho Butterflies YICHEN SHEN, Johns Hopkins University — In this project, we study the pattern formation of structural scales on butterflies' wings from a mechanical view. Our model can be described by a two layers spring system, with transversal springs of spring constant k_1, and longitudinal springs with spring constant k_2. The transversal springs act as cross-ribs connecting particles in each layer, while the longitudinal springs act as pillars connecting both layers. After doing a stability analysis by imposing sinusoidal plane waves to the upper layer, we found that surface roughening is possible to occur even when the interaction force between atoms obeys Hook's law. When the compression of spring system exceeds a certain value (threshold), the whole system will buckle. If we define the pertinacity $r=k_2/k_1$, the buckling is less likely to occur when r is high, and vice versa. To further investigate the preferred wavelength, we allow the particles move freely in 2 dimensions instead of 1 dimension. A c++ program with conjugate gradient algorithm inside was developed to study the uniform compression case. We found the wavelength is actually determined by the compression rate solely, while the maximum compression rate is determined by the translational and longitudinal spring constant.

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