ETOPIM-13 Keynote Talk

Mechanism-Based Mechanical Metamaterials

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The design and analysis of mechanism-based mechanical metamaterials is a relatively new and rapidly growing research area. It studies artificial "materials" that take advantage of "mechanisms" (that is, nontrivial energy-free deformations) to achieve interesting macroscopic behavior. The relevant mechanics is nonlinear, since mechanisms involve large rotations. While there have been insightful studies of specific examples, many questions remain poorly understood. I will focus on the existence and characterization of *soft modes*. Roughly speaking, soft modes are macroscopic deformations that are not mechanisms, but that nevertheless require very little elastic energy. In simple examples (such as the "rotating squares metamaterial") they are achieved by modulating a mechanism. However there are systems (such as the "Kagome metamaterial") with many mechanisms. For such systems a different approach is needed. I will present a homogenization-based perspective developed in recent work with Xuenan Li. Using this approach, I'll explain in particular why the only soft modes of the Kagome metamaterial are compressive conformal maps. The Kagome example is interesting because it has a huge amount of microstructural freedom, yet its macroscopic behavior is well-defined and fits into the framework of nonlinear elasticity.