Physical Mathematics Seminar

Compatibility in helical structures and in origami

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ABSTRACT:

In bulk crystalline solids, the presence of compatible interfaces at microscopic scales is related to the lattice parameters describing the periodicity of their crystalline phases. Recent efforts in the tuning of such parameters to achieve *compatibility of phases* have led to remarkable macroscopic properties, including near-zero thermal hysteresis for such solids undergoing phase transformation. Can this line of thinking can be applied more generally? The structure of matter in many examples—in, for instance, nanoscience and biology—is that of discrete symmetries that are not inherently periodic: single wall carbon nanotubes of any chirality, BCN, GaN, MoS_2, WS_2, non-animal viruses such as the tail sheath of bacteriophage T4, bacterial flagella, and microtubules, to name a few. These are helical structures.

In this talk, I will discuss phase transformations from one helical structure to another and describe the necessary and sufficient conditions on the structural parameters of the two helical phases such that they are compatible. These results provide a basis for the tuning of helical structural parameters so as to achieve compatibility of phases. Compatible helical transformations with low hysteresis and fatigue resistance would exhibit an unusual shape memory effect involving twist and possibly extension, and may have potential applications as new artificial muscles and actuators.

Compatibility is an ubiquitous concept. In a different direction, I will describe the role of compatibility in the design of origami. I will then use this description to completely characterize all quadrilateral mesh (isometric) origami deformations from a flat sheet, and I will show how this enables efficient algorithms to compute their designs and deformations.

TUESDAY, NOVEMBER 20, 2018
2:30 pm
Building 2, Room 136

Reception following in Building 2, Room 290
(Math Dept. Common Room)

http://math.mit.edu/seminars/pms/

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