160th MSS-Seminar
Wednesday, January 25th, 15:30 hrs,
Room 04.023,
Cauerstraße 7, Erlangen.

Contributions of cutting-and-shuffling to mixing in granular systems: analysis of a model system and outlook for optimization

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Granular materials are a common industrial intermediate and product. The final homogeneity of a mixing process is important to the quality of a product or material. Well-studied fluid-like approximations capture a limited view of these materials. Mixing by cutting-and-shuffling (like that for a deck of cards or a Rubik's cube) is a paradigm that has not been studied in detail but can be applied in a variety of situations, particularly for understanding the mixing of granular materials. Mathematically, cutting-and-shuffling is described by piecewise isometries (PWIs), which rearrange solid pieces cut from an original object. Here, mixing is created by the cut discontinuities in the PWI. The accumulated discontinuities due to a PWI create an intricate fractal structure that estimates the potential for mixing in a simple spherical tumbler of granular material, but this potential for mixing does not always result in real mixing. However, cut-and-shuffle dynamics can be used to locate barriers to mixing. The discontinuous nature of mixing from cuts or discontinuities in these systems makes formulating the cut-and-shuffle mixing problem for optimization challenging, but an application of supervised learning for copying an existing mixing methodology shows a promising future for the improvement of cut-and-shuffle mixing using machine learning methods.