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Network Analysis of Granular Flows

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The flow of granular materials is important to many natural and industrial processes, yet connecting microscale materials properties of grains to bulk flow behavior has remained a challenging task. Our work leverages tools from complex network theory to study granular flow at multiple scales. By characterizing the statistical properties of time-evolving contact networks using metrics like average path length, giant component size, and modularity, we are able to identify how macroscale system features like the loss of reversibility are connected to micro- and meso- scale rearrangements in the contact network. In addition, we employ a network-based approach to explore the role of rotations in facilitating cooperative rearrangements. For both the reversibility and rotation studies, we apply network analysis to time-dependent contact network data obtained from both experiments and simulations and show that this approach can provide new insights on how bulk system properties are connected to particle-scale motion.