

# **Nathan Berry**

## How contact lifetimes shape stress in granular flows

Many models of granular rheology rely on the approximation that inter-particle interactions are effectively instantaneous. While this assumption is appropriate for dilute, collision-dominated flows, it becomes inadequate in dense granular materials, where contacts persist over finite and broadly distributed timescales. Using discrete element method simulations, we study steady-state simple shear flows of dense granular materials with cohesive and non-cohesive interactions, spanning classically stiff to soft particle regimes, above and below the jamming transition. By tracking every particle contact over its full lifetime, we decompose the steady-state pressure and shear stress into contributions resolved by contact duration. We find that rare, long-lived contacts can contribute disproportionately to macroscopic stress, with their relative importance depending on flow conditions and interaction parameters.

These results provide new insight into how variations in contact lifetimes shape macroscopic granular behaviour and offer a framework for interpreting flows across different regimes.