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The physics of high-density crowds: mode analysis sheds light on crowd disasters

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When people gather in large groups like those found at Black Friday sales events, pilgrimages, heavy metal concerts, and parades, crowd density often becomes exceptionally high. In these situations, social norms and global coordination happen sometimes to break down, giving rise to unusual and occasionally tragic collective motions known as “crowd turbulence”. While active particle simulations can reproduce most phenomenology of human collective motion, the mechanisms underlying the emergence of such collective motions from purely physical interactions between contacting bodies are poorly understood.

Here, we take inspiration from techniques developed in the context of jammed granular materials to study an active matter model inspired by situations when large groups of people gather at a point of common interest. Our analysis identifies Goldstone modes, soft spots, and stochastic resonance as structurally-driven mechanisms for potentially dangerous emergent collective motions.

Presenter: BOTTINELLI, Arianna (Nordita)