Identifying Phases in Low-Speed Human Movement

By observing the motion of preschool children, researchers have developed a thermodynamic description of human movement that pinpoints collective phases emerging when social interactions are strong.

By **Ryan Wilkinson**

Over the past few decades, physicists have shown that the collective motion of animals can exhibit thermodynamic-like phases. But empirical studies of such phases in human motion have been limited to fast-moving crowds, with average speeds above 1 m/s. Now Chaoming Song at the University of Miami and his colleagues have used observations of preschool children to study lower-speed settings, where social interactions are more relevant [**1**]. The researchers' data analysis allowed them to identify two collective phases arising at average speeds below 1 m/s. The obtained insights on how social interactions affect human movement have potential implications for behavioral science, biology, and epidemiology.

Using radio-tracking technology, Song and his colleagues collected high-resolution data on the movement of preschoolers in four different classroom and playground settings. The researchers identified a gas-like phase in which the children moved freely and independently, without forming small social groups. They also spotted a phase in which some children formed small social groups, resembling liquid droplets, while others freely entered and exited these groups, behaving like gas particles. Relative to the gas-like phase, this liquid–gas coexistence phase was associated with a lower average speed and a higher density of children.

Credit: Oksana Kuzmina/stock.adobe.com

Based on their empirical data, Song and his colleagues developed a statistical-physics model that reproduced the two identified phases. The researchers then used this model to create a phase diagram for collective human motion at average speeds below 1 m/s. They say that their radio-tracking technology could be used to produce analogous phase diagrams for the dynamics of other active-matter systems, such as swarms of microrobots.

Ryan Wilkinson is a Corresponding Editor for *Physics Magazine* based in Durham, UK.

REFERENCES

1. Y. Zhang *et al.*, "Emergence of social phases in human movement," **Phys. Rev. E 110, 044303 (2024).**