An equation of state for a gas of self-propelled spheres is a step towards a thermodynamic description of “active” matter, such as bird flocks and tissue.
approaching a traffic jam. This contribution is the most interesting one, since it vanishes in the absence of self-propulsion and is thus a genuine nonequilibrium effect.

This model active matter system shares a similarity with equilibrium matter: It can form a phase-separated state with different densities, and the calculated pressures in these states have equal values. Yet, although the pressure calculated by Solon et al. seems to have the required properties of a thermodynamic quantity, the analogy is not complete: The densities of the two phases fail a standard thermodynamic test for the stability of two coexisting phases (the Maxwell construction). As such, we should not think of the pressure exerted by the active spheres as equivalent to a pressure in an equilibrium system.

In addition to its conceptual interest, the work by Solon et al. predicts the osmotic pressure that should be exerted on a container by actual active colloids in a solution. This quantity could potentially be compared to experiments, for example, with colloidal particles that start moving when exposed to light [6], or because they have two faces with different coatings [7]. A more accurate model should, however, account for the forces between particles that are mediated by the fluid (hydrodynamic interactions).

Physicists are far from having a full statistical physics framework that can describe active matter. It is unclear, for example, if it will be possible to define thermodynamic quantities like free energy, temperature, or chemical potential in a consistent way, or even if these quantities offer the most useful description of active matter. Recent progress describing active matter is reminiscent of the early days of statistical mechanics more than a century ago: Physicists derived the kinetic theory of gases first and only later connected these ideas to thermodynamics. Similarly, the recently developed kinetic theory of interacting self-propelled particles can predict collective motion and pattern formation, but it has not been related to thermodynamic notions. The work of Solon et al. and other researchers [8][10], paves the way to new approaches in the statistical physics of active matter that are more focused on a thermodynamic description.

This research is published in *Physical Review Letters*.

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