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**Thermodynamics of the motility-induced phase separation** ALEXANDRE SOLON, Massachusetts Institute of Technology, USA, JOACHIM STENHAMMAR, Lund University, Sweden, MICHAEL CATES, University of Cambridge, UK, JULIEN TAILLEUR, Universit Paris Diderot, France — Self-propelled particles are known to accumulate in regions of space where their velocity is lowered. In addition, if their velocity diminishes when the local density increases (for example due to crowding effects), a positive feedback loop leads to the now well-established motility-induced phase separation (MIPS) between a dense immotile phase and a dilute motile phase. Understanding the phase equilibrium of MIPS is still a matter of debate. Although, depending on the models used to study the transition, a chemical potential or a pressure can be defined, these quantities do not play their usual thermodynamic role. In particular, the usual common tangent or equal-area constructions fail in these systems. Indeed, we will show that describing the phase equilibrium of MIPS necessitates generalized thermodynamics that include non-equilibrium contributions. This approach allows us to predict correctly the phase diagram of MIPS and to gain insight into the thermodynamics of active systems. It also sheds light on the (in)equivalence of statistical ensembles for these systems, paving the way for more efficient computational studies.

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