Long-ranged velocity correlations in dense systems of self-propelled particles

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Model systems of self-propelled particles reproduce many phenomena observed in laboratory ac- tive matter systems that defy our thermal equilibrium-based intuition. In particular, in stationary states of self-propelled systems, it is recognized that velocities of different particles exhibit non- trivial equal-time correlations. Such correlations are absent in equivalent equilibrium systems.

Recently, researchers found that in solid-like, ordered [1] and amorphous [2], systems of self-propelled particles the range of the velocity correlations increases with increasing persistence time of the self-propulsion and can extend over many particle diameters.

Here [3] we demonstrate that the long-ranged velocity correlations are also present in dense fluid-like systems. We show that the range of velocity correlations in dense systems of self-propelled particles is determined by the combination of the self-propulsion and the virial bulk modulus that originates from repulsive interparticle interactions.

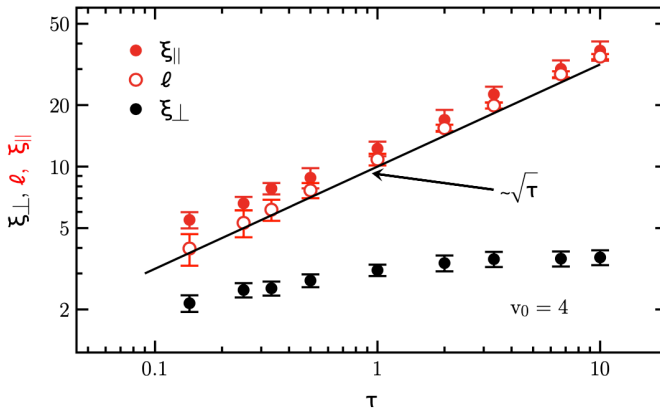

Fig. 1: *The longitudinal (filled red circles) and transverse (filled black circles) velocity correlation length. The longitudinal length grows approximately as square root of the persistence time (solid line is to guide the eye), while the transverse length is almost unchanged. The open red circles are results of the approximate theory.*

References:

[1] L. Caprini, U.M.B. Marconi and A. Puglisi, *Phys. Rev. Lett*. **124**, 078001 (2020).
[2] S. Henkes, K. Kostanjevec, J.M. Collinson, R. Sknepnek. and E. Bertin, *Nat. Commun*. **11**, 1 (2020).
[3] G. Szamel and E. Flenner, *EPL* **133**, 60002 (2021).