Universal winding laws in chiral active motion

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Chiral active systems provide paradigmatic examples of matter operating far from equilibrium, yet identifying universal principles governing their stochastic dynamics remains a central challenge. We show that winding properties of particle trajectories establish a universal geometric framework for characterizing chiral active motion. Combining theoretical predictions with experiments tracking individual active Brownian particles and numerical simulations, we demonstrate that the winding angle and area swept by trajectories exhibit universal growth and fluctuation statistics that are independent of propulsion details or noise sources. By uncovering experimentally verified winding laws, our work identifies a new class of nonequilibrium universal observables and provides a unifying description chirality in active systems.