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| | Soggetti | Soft condensed matter<br>Mathematical physics<br>Chemistry, Physical and theoretical<br>Nonlinear optics<br>Dynamics<br>Nonlinear theories<br>Soft and Granular Matter<br>Theoretical, Mathematical and Computational Physics<br>Physical Chemistry<br>Nonlinear Optics<br>Applied Dynamical Systems |
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| | Nota di contenuto | General Introduction -- Standard Models on Collective Motion -- Collective Motion of Filamentous Bacteria -- Active Turbulence -- Encounter of Bacterial Turbulence with Periodic Structures -- General Conclusion and Outlook. |
| | Sommario/riassunto | This thesis focuses on experimental studies on collective motion using swimming bacteria as model active-matter systems. It offers comprehensive reviews of state-of-the-art theories and experiments on collective motion from the viewpoint of nonequilibrium statistical physics. The author presents his experimental studies on two major classes of collective motion that had been well studied theoretically. |

Firstly, swimming filamentous bacteria in a thin fluid layer are shown to exhibit true, long-range orientational order and anomalously strong giant density fluctuations, which are considered universal and landmark signatures of collective motion by many numerical and theoretical works but have never been observed in real systems. Secondly, chaotic bacterial turbulence in a three-dimensional dense suspension without any long-range order as described in the first half is demonstrated to be capable of achieving antiferromagnetic vortex order by imposing a small number of constraints withappropriate periodicity. The experimental results presented significantly advance our fundamental understanding of order and fluctuations in collective motion of motile elements and their future applications.