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Predesigned surface patterns and topological defects control the active matter.[1] TARAS TURIV, CHENHUI PENG, YUBING GUO, QI-HUO WEI, OLEG LAVRENTOVICH, Kent State University Liquid Crystal Institute —
Active matter exhibits remarkable patterns of never-ending dynamics with giant fluctuations of concentration, varying order, nucleating and annihilating topological defects. These patterns can be seen in active systems of both biological and artificial origin. A fundamental question is whether and how one can control this chaotic out-of-equilibrium behavior. We demonstrate a robust control of local concentration, trajectories of active self-propelled units and the net flows of active bacteria *Bacillus Substilis* by imposing pre-designed surface patterns of orientational order in a water-based lyotropic chromonic liquid crystal. The patterns force the bacteria to gather into dynamic swarms with spatially modulated concentration and well-defined polarity of motion. Topological defects produce net motion of bacteria with a unidirectional circulation, while pairs of defects induce a pumping action. The qualitative features of the dynamics can be explained by interplay of curvature and activity, in particular, by ability of mixed splay-bend curvatures to generate threshold-less active flows. The demonstrated level of control opens opportunities in engineering materials and devices that mimic rich functionality of living systems.

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