

Supplementary information

Video 1 demonstrates the temporal evolution of the director and scalar order parameter fields for active turbulence with $W = -3.25$, where a snapshot of it is depicted in Fig. 2a. $+1/2$ and $-1/2$ defects are indicated by red and cyan dots respectively.

Video 2 demonstrates the temporal evolution of the velocity and vorticity fields for active turbulence with $W = -3.25$, where a snapshot of it is depicted in Fig. 2b.

Video 3 demonstrates time evolution of the velocity and vorticity fields in the transient state for parameters $\Lambda = 0.6$ and $\delta = 0.12$, where two snapshots of it are depicted in Fig. 12.

Video 4 demonstrates time evolution of the velocity and vorticity fields in the isotropic turbulence state for parameters $\Lambda = 0.6$ and $\delta = 0.16$.

Video 5 demonstrates time evolution of the velocity and vorticity fields in the multi-lane state for parameters $\Lambda = 0.6$ and $\delta = 0.04$, where a snapshot of it is depicted in Fig. 7a.

Video 6 shows dynamic of director and scalar order parameter fields for trapped vortex state for parameters $\Lambda = 1.0$ and $\delta = 0.04$, where one snapshot of it is depicted in Fig. 13b.