

Supplementary Materials for
Logic operations with active topological defects

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Movies S1 to S7

I. ANALYSIS DETAILS OF $-1/2$ DEFECTS NEAR AN ACTIVITY BOUNDARY

Here we discuss the behavior of $-1/2$ defects near a flat activity boundary. Specifically, we calculate activity gradient induced local force when a $-1/2$ defect is pointing to or away from the passive region, and in active or passive region (Fig. S1A-D). We introduce an angle ϕ to represent the smallest angle one branch of the $-1/2$ defect can make with the $+x$ direction. Therefore, $0^\circ \leq \phi \leq 60^\circ$. Because $-1/2$ defects tend to accumulate near activity boundaries [1]. For small ϕ , the $-1/2$ defect will impose an effective normal anchoring condition to the passive LC region (Fig. S1A, B). For large ϕ , however, it will provide an effectively planar anchoring condition to the passive LC (Fig. S1C, D). Our calculations show that activity gradient can provide an attractive local force to $-1/2$ defects when they are facing the passive region with $\phi < 30^\circ$, regardless of its position with respect to the activity boundary (Fig. S1A, B). However, a $-1/2$ defect pointing away from the passive region with $\phi > 30^\circ$ will feel a repulsive force by the activity boundary. This implies that $-1/2$ defects with $\phi < 30^\circ$ will be able to accumulate near the activity boundary. Our simulation data confirm this theoretical analysis, in that ϕ distribution shows a peak near 0° for those near the activity boundary, and becomes relatively flat in $[0^\circ, 60^\circ]$ when deep in the active region (Fig. S1E). We therefore provide a possible rationale for the anchoring effect observed in simulations. A similar theoretical analysis has been used to understand confinement effect of $+1/2$ defects on an activity pattern [1].

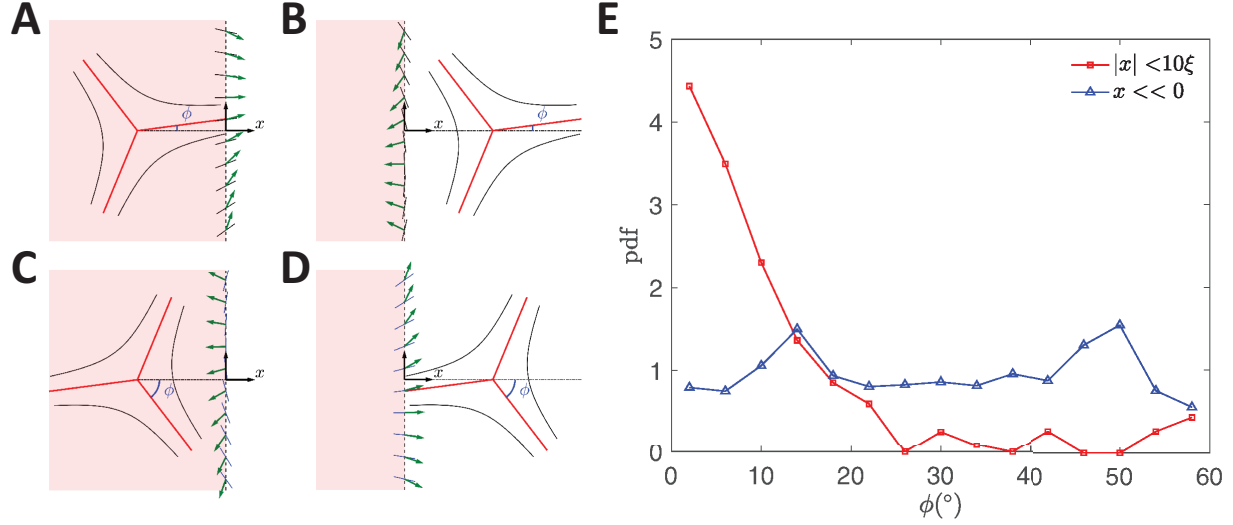


Figure S 1. A $-1/2$ Defect Near an Activity Boundary. (A-B) $-1/2$ defect pointing towards the passive region. (C-D) $-1/2$ defect pointing away from the passive region. Green arrows indicate activity gradient induced local forces; Red shadowed region indicates active region; black lines indicate local director field. (E) Probability distribution function of angle ϕ in hydrodynamic simulations for $-1/2$ defects near and away from the activity boundary.

II. SUPPLEMENTARY MOVIE LEGENDS

Movie S1: Active defect turning at an intersection. $+1/2$ defect making a turn on a cross pattern of activity $\alpha = 0.0035$ inside a cross channel. Channel width and pattern width are 60 and 20, respectively. This movie corresponds to Fig. 2C.

Movie S2: Active defect forced to cross an intersection. $+1/2$ defect transport following a vertical straight pattern of activity $\alpha = 0.0035$ inside a cross channel. Channel width and pattern width are 60 and 20, respectively. This movie corresponds to Fig. 2B.

Movie S3: Active defect forced to cross an intersection. $+1/2$ defect transport following a horizontal straight pattern of activity $\alpha = 0.0035$ inside a cross channel. Channel width and pattern width are 60 and 20, respectively.

Movie S4: Control of defect by the passage of a second defect. When an initial defect guided by a horizontal pattern passes through the cross channel, the second defect guided by a vertical activity pattern is blocked. Channel width and pattern width are 60 and 20, respectively. Activity level on the pattern is $\alpha = 0.0035$. This movie corresponds to Fig. 3.

Movie S5: Defect tunneling. A $+1/2$ defect is shown tunnel into the right side of a closely spaced array of triangles, with each triangle of base length 18 and height 54. Channel width is 80. Activity level $\alpha = 0.022$ on the pattern. This movie corresponds to Fig. 4A.

Movie S6: Defect gating. Top: a $+1/2$ defect is moving through a non-active gate of gap width 80, played 5X faster. Bottom: a $+1/2$ defect is gating the same gap by a triangular pattern of activity $\alpha = 0.022$. The triangle has base length 18 and height 54. Activity level is $\alpha = 0.001$ outside the gate. This movie corresponds to Fig. 4B.

Movie S7: Defect amplifiers. The passage of a $+1/2$ defect in the bottom corridor induces the birth of three $+1/2$ defects. Channel width and pattern width are 50 and 25, respectively. Activity level on the pattern is $\alpha = 0.004$. This movie corresponds to Fig. 5.

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