Science Advances
AAAS

advances.sciencemag.org/cgi/content/full/6/32/eaay7682/DC1

Supplementary Materials for

Traveling and standing waves mediate pattern formation in cellular protrusions

Sayak Bhattacharya, Tatsat Banerjee, Yuchuan Miao, Huiwang Zhan, Peter N. Devreotes, Pablo A. Iglesias*

*Corresponding author. Email: pi@jhu.edu

Published 7 August 2020, *Sci. Adv.* **6**, eaay7682 (2020)
DOI: 10.1126/sciadv.aay7682

The PDF file includes:

Other Supplementary Material for this manuscript includes the following:

(available at advances.sciencemag.org/cgi/content/full/6/32/eaay7682/DC1)

Movie Legends:

Movie S1. Nullcline dynamics in traveling to standing transformation. The four panels correspond to four spatial locations on the kymograph from Fig.1B. The nullclines move owing to changing diffusion gradients. Panel 'a' is the initial trigger with a short-lived gradient. In panel 'b', 'c' and 'd', the inhibitor nullcline first moves to the left owing to an increase in threshold from the surrounding diffusing inhibitor. After the trigger reaches the spatial point (activator nullcline moves upwards), the negative diffusion gradient causes threshold to be momentarily lowered resulting in the nullcline moving towards the right. The topmost panel reflects the moment of wave stopping when the state shifts to the new equilibrium.

Movie S2. Amoeboid cell. Dynamics of an amoeboid *Dictyostelium* cell expressing LimE-RFP. Movie is 5 seconds per frame.

Movie S3. PTEN-null cell. Dynamics of a PTEN- *Dictyostelium* cell lacking expressing LimE-RFP. Movie is 5 seconds per frame.

Movie S4. Simulated amoeboid cell. Level set simulations of a cell with normal model working parameters, with the protrusive force shown in red, resembling a wild-type cell.

Movie S5. Simulated PTEN-null cell. Level set simulations of a cell with standing waves, with the protrusive force shown in red, resembling a PTEN-null cell.

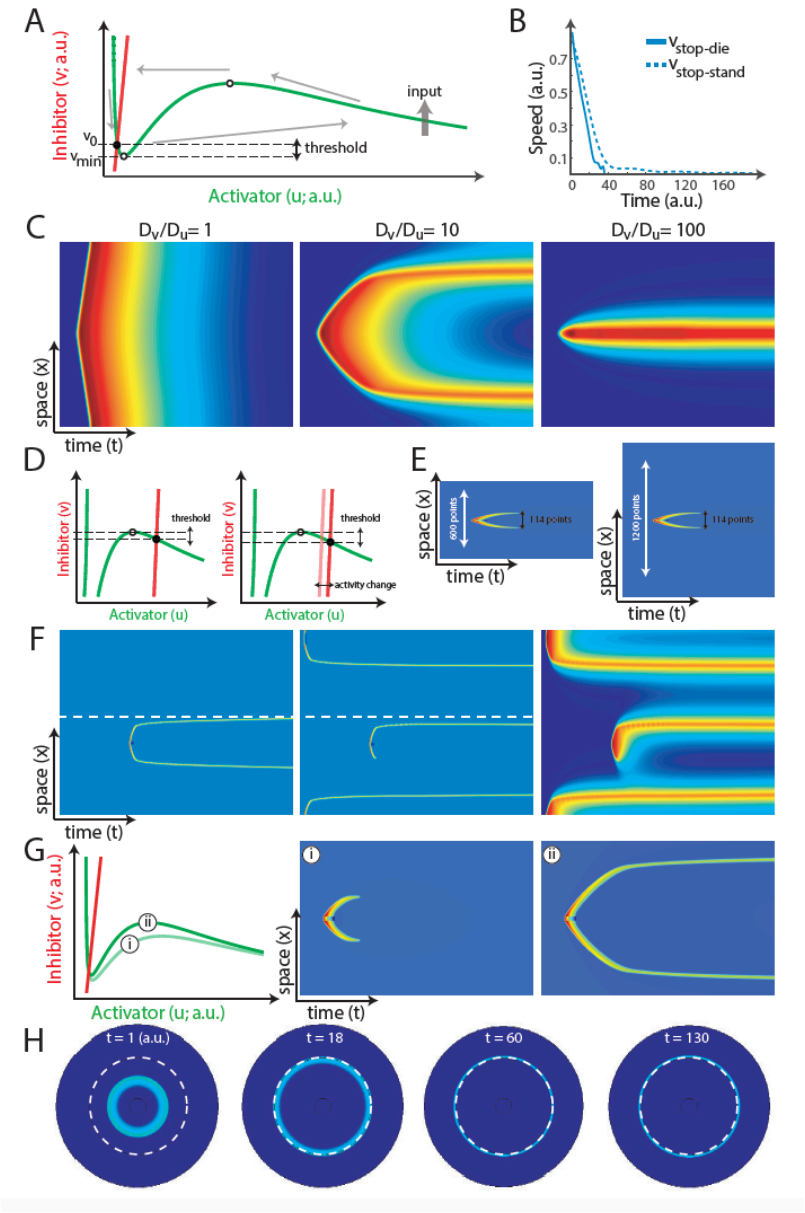
Movie S6. Two-dimensional pattern formation simulation. Simulation in which the wave is triggered at the center. The wave spreads, stops, and breaks into small standing waves that ultimately rearrange over a longer time-scale to form a pattern.

Movie S7. Two-dimensional simulation with a boundary. Simulation in which the triggered wave is forced to stop at a boundary after which activator diffusion is limited.

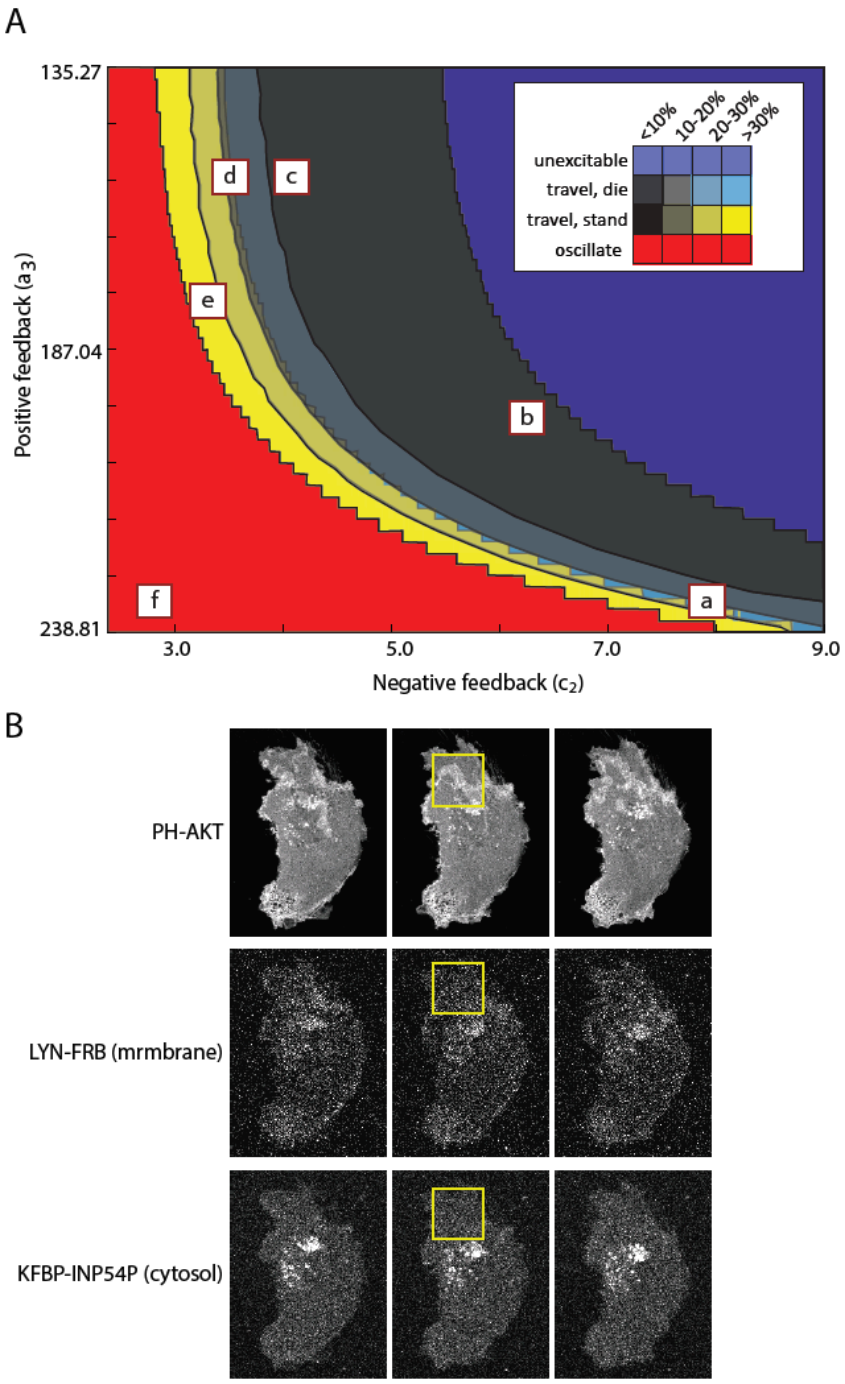
Movie S8. Traveling waves in a transformed MCF-10A cell. Traveling wave activity shown in a cancerous cell expressing PH-AKT. Movie is 2 minutes per frame.

Movie S9. Standing waves in a transformed MCF-10A cell. Standing wave activity shown in a cancerous cell expressing PH-AKT. Movie is 2 minutes per frame.

Movie S10. Two-dimensional stochastic wave simulations. Stochastic two-dimensional simulation showing spontaneously generated wave activity.



Supplemental Figure 1: **Other simulations using parameter alterations**. **A**. The nullclines of the activator (green) and inhibitor (red) showing the threshold and a typical excursion in phase space. **B**. Plot of wave speed for a wave that traveled, stopped and got extinguished (solid line), and a wave that traveled, stopped and transformed into a standing wave (dashed line). **C**. Kymographs showing wave dynamics for different diffusion ratios of the activator (u) and inhibitor (v). **D**. Nullclines depicting different stability levels of the new equilibrium depending upon size of new threshold. **E**. Simulation showing how wave size is unaffected on changing simulation domain size. **F**. Kymographs demonstrating the different dynamics of traveling and standing waves. The horizontal dashed line is used as a fiduciary to illustrate that the standing wave in the middle panel gets deflected away owing to the standing wave above. The right panel shows the extinguishing of a traveling wave owing to the inhibitor shield of a standing wave without actual contact. **G**. Simulation showing how increasing positive feedback (dark green nullcline) can cause a standing wave to form. **H**. The formation of a stable standing ring at the boundary (dashed white circle).



Supplemental Figure 2: **Alternative phase diagram and membrane-marker control. A**. Phase diagram similar to Fig. 5A, but varying positive feedback and negative feedback. The wave phenotypes 'a-f' are taken from 5A. **B**. Signaling marker (top), membrane marker (middle) and cytosol marker (bottom) experimental snapshots of transformed cells with the yellow box showing a region where PH-AKT shows waves while the other markers do not.