Electronic Supplementary Information (ESI): Propagation of active nematic-isotropic interfaces on substrates

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In the following we describe the movies included in the ESI and additional figures that complement the results of the main paper.

1 Description of movies

The four movies illustrate the temporal evolution of the fields for two propagating interfaces of the hydrodynamic active nematic multiphase or Q tensor model, in the active turbulent regime on substrates with friction $\chi = 0.1$. The activity is $\zeta = 0.007$ and the other parameters and initial conditions of the simulations are described in Sec. *Propagation of the interface* of the main text.

circle-order.mp4. Scalar order parameter for the circular nematic-isotropic interface.

circle-velocity.mp4. Magnitude of the velocity for the circular nematic-isotropic interface.

flat-order.mp4. Scalar order parameter for the flat nematic-isotropic interface.

flat-velocity.mp4. Magnitude of the velocity for the flat nematic-isotropic interface.

2 Supplementary figures

In the following we report results that support the arguments in the main text, but are not the main findings. Figs.1, 2 and 3 pertain to Sec. *Characterization of the turbulent active nematic phase* of the main text where the parameters and initial conditions are described. Fig. 1 illustrates the velocity and vorticity fields of the entire system for a particular activity and time (snapshots). This figure reveals in a visual manner that these fields have a characteristic length that is described quantitatively through the spatial correlation functions shown in Fig. 1 of the main text. Fig. 2 illustrates systems where the active turbulence is not fully developed: one due to finite size effects and the other due to the suppression of defects generation at very high activities, $L_A << L_N$. In either case the scaling of the correlation functions with the active length is not observed. Fig. 3 illustrates the difference between the spatial correlation functions of the vorticity and the velocity fields. In Fig. 4 we show the time evolution of the interfacial width discussed in Sec. *Flat interface* of the main text. Finally, in Fig. 5, we plot the energy spectrum of the active turbulent phase of systems with different substrate frictions, reported in Sec. *Effect of friction* of the main text.

3 Units

Some of our results are given in simulation units, referred as “l.u.” (lattice units), i.e., in units such that the lattice spacing $\Delta x = 1$ and of the time step $\Delta t = 1$. There are many ways to convert from simulation to physical units. For instance, Refs.[1,2] choose a set of non-dimensional numbers (Reynolds, Ericksen, etc), which must be the same in the experiments and simulations. The problem with this approach is that many quantities are not known for the bacteria. Instead, to have an idea of the underlying scales, we consider as a reference values reported in Ref.[3]. For the length scale, we consider the characteristic length defined as the first zero of the correlation function: $L^S_{ch} \approx 0.45\,\zeta^{-1/2}$ l.u. (Sec. 3 of the main paper), which has been reported to be $L^E_{ch} \approx 20\,\mu$m (Supplementary Materials of Ref.[3]). Thus, the lattice spacing is $\Delta x \approx 44.4\,\zeta^{1/2}\,\mu$m, where ζ is in l.u. (e.g., for $\zeta = 0.009$, $\Delta x = 4\,\mu$m). For the time scale, we consider the first zero of the time correlation function. Numerically, we found $\Delta t \approx 0.3\,\zeta^{3/2}$ s (for $\zeta = 0.009$, $\Delta t \approx 2.6\times 10^{-4}$ s). A third quantity to close the system of units is not available in the measurements of Ref.[3]. So, following Ref.[4], we keep all quantities in terms of the activity.

Notes and references

1 A. Doostmohammadi, J. Ignés-Mullol, J. M. Yeomans and F. Sagués, *Nature Communications*, 2018, **9**, 3246.
2 A. Doostmohammadi, M. F. Adamer, S. P. Thampi and J. M. Yeomans, *Nature Communications*, 2016, **7**, 10557.
3 A. E. Patteson, A. Gopinath and P. E. Arratia, *Nature Communications*, 2018, **9**, 5373.
4 E. J. Hemingway, P. Mishra, M. C. Marchetti and S. M. Fielding, *Soft Matter*, 2016, **12**, 7943–7952.

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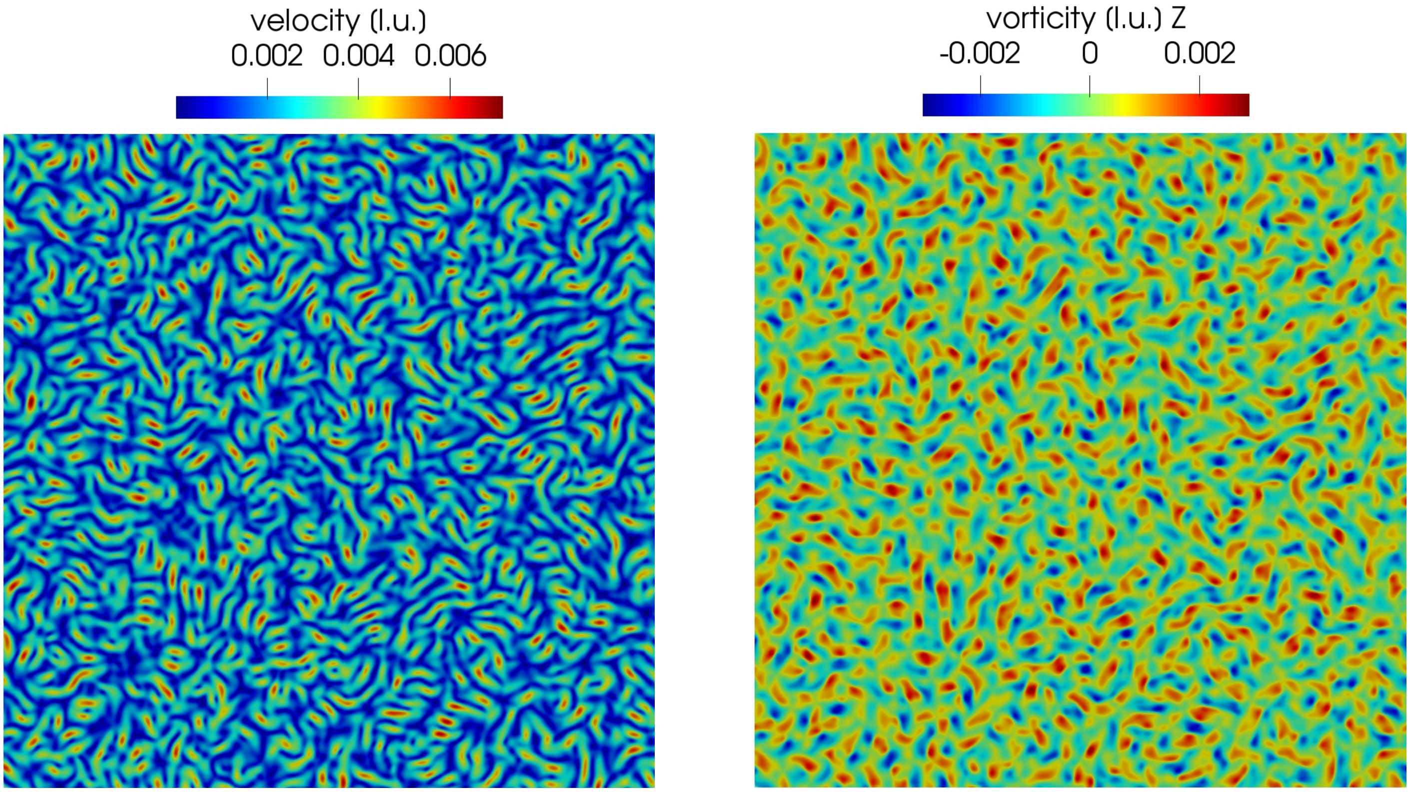

Fig. 1 Magnitude of the velocity (left) and z-component of the vorticity field (right) for an active nematic with activity $\zeta = 0.005$ at $t = 3 \times 10^5$. The system size is $L_X \times L_Y = 400 \times 400$. The other model parameters and the initial conditions of the simulations are described in Sec. *Characterization of the nematic phase* of the main text.

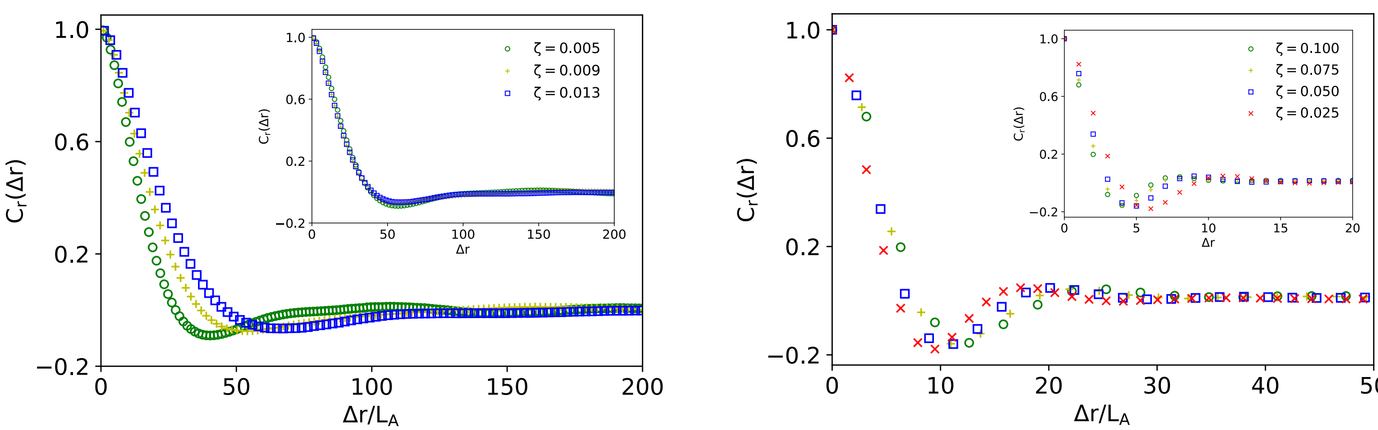

Fig. 2 Correlation functions at low friction and high activities. The main figures illustrate the correlation functions scaled by the active length L_A while the insets show the unscaled correlation functions. (Left) At very low friction, $\chi = 0.00016$, the characteristic length is comparable to the system size. Due to finite size effects, the characteristic length does not scale with the active length. (Right) High activities and substrate friction $\chi = 0.1$. In this regime, $L_A < L_N$ ($L_A = 0.32$ for $\zeta = 0.1$ and $L_A = 0.63$ for $\zeta = 0.025$) and defect formation is suppressed. The system size is $L_X \times L_Y = 400 \times 400$.

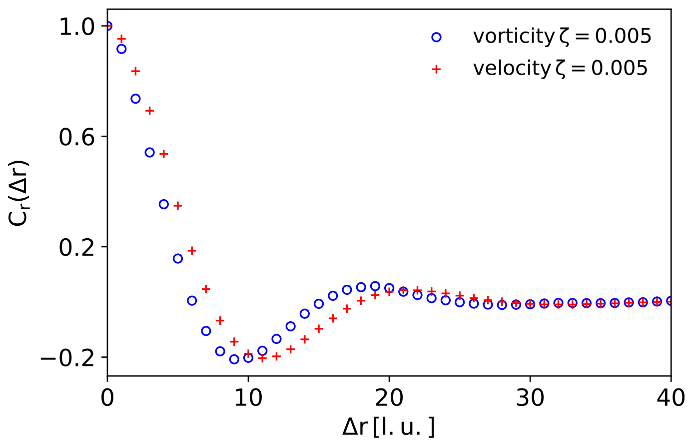

Fig. 3 Space correlation functions of the velocity and vorticity fields for an active nematic with activity $\zeta = 0.005$. The other model parameters and the initial conditions of the simulations are described in Sec. *Characterization of the nematic phase* of the main text.

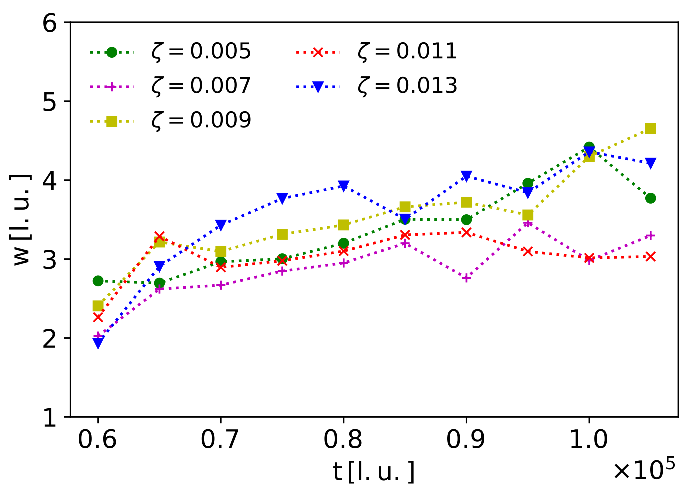

Fig. 4 Width of the interface: Standard deviation of the mean interfacial position of the flat interface of active nematics with five different activities. The mean interface position is ploted in Fig. 3 of the main text (see subsection *Flat interface* for details of the simulation).

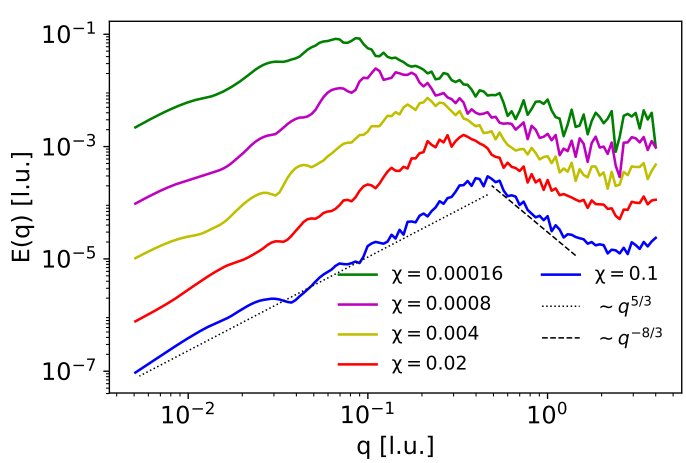

Fig. 5 Energy spectrum in lattice units for an active nematic in the turbulent phase with activity $\zeta = 0.009$ and different substrate frictions χ. The increasing branch of the spectrum apears to follow the experimental $5/3$ power law while the decreasing branch follows the experimental $-8/3$ power law only approximately. The exponent of the decreasing branch of the energy spectrum is higher for systems with low substrate friction, $\chi = 0.00016$ and $\chi = 0.0008$, but this may be due to finite size effects as the screening length $L_F = \sqrt{\nu/\chi}$ increases with decreasing friction. $L_F \approx 38$ for $\chi = 0.00016$, which is approximately 10% of L_X.