

Impact of Individual Defection on Collective Motion

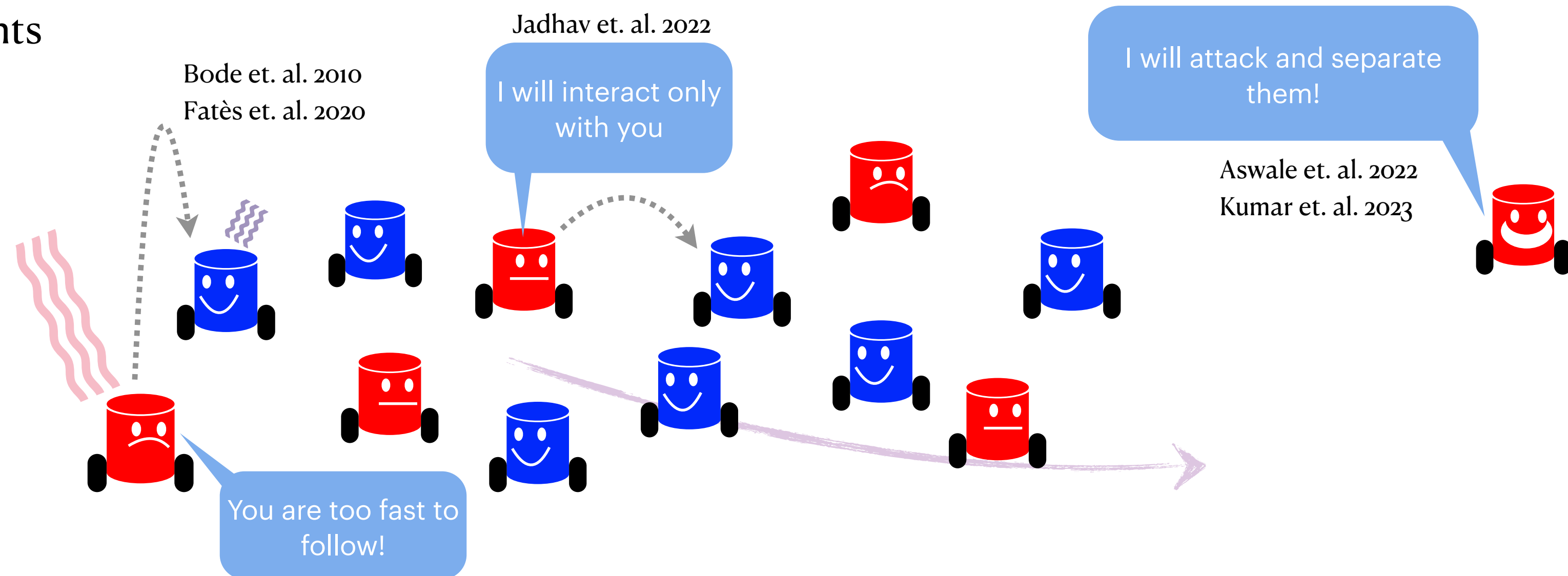
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Question to Ponder

If individuals during collective motion probabilistically defect (do not interact) with their neighbours and rather keep moving in the same direction, can the group still collectively achieve consensus on the direction of motion (polarize)? Our simulations with probabilistically defecting agents in collective motion models show that, in the Pairwise interaction model, increasing probability to defect increases the polarization time. On the other hand, in the Couzin model, defecting in specific zones can speed up the alignment process.

Related Studies

N agents



Agent Kinematics: Dubins' Car Model

Dubin et. al. 1957

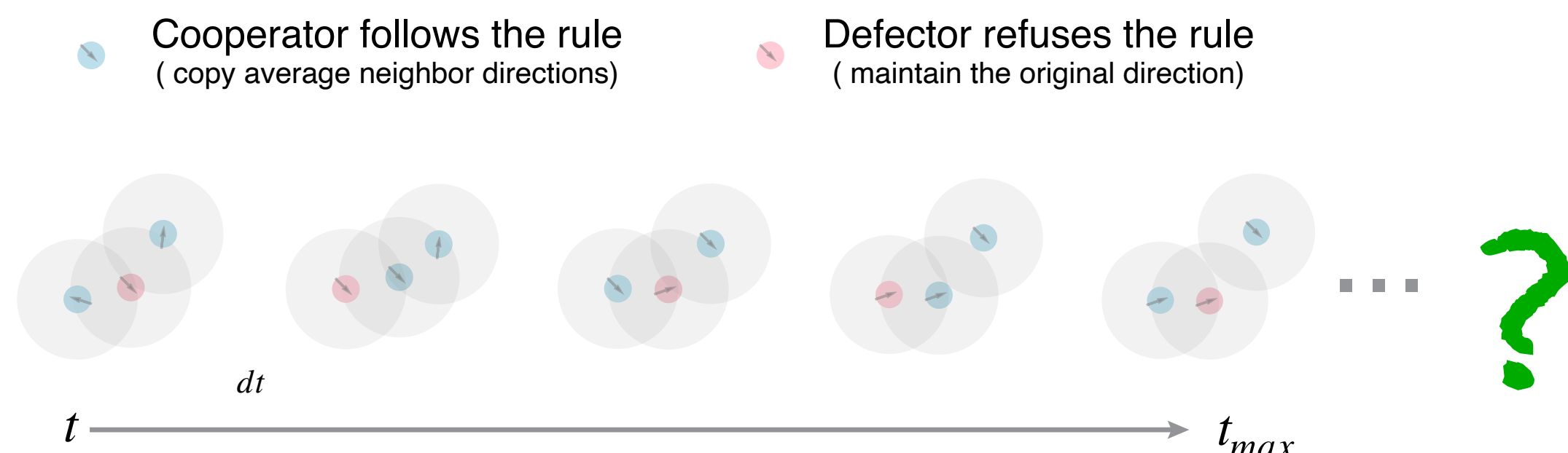
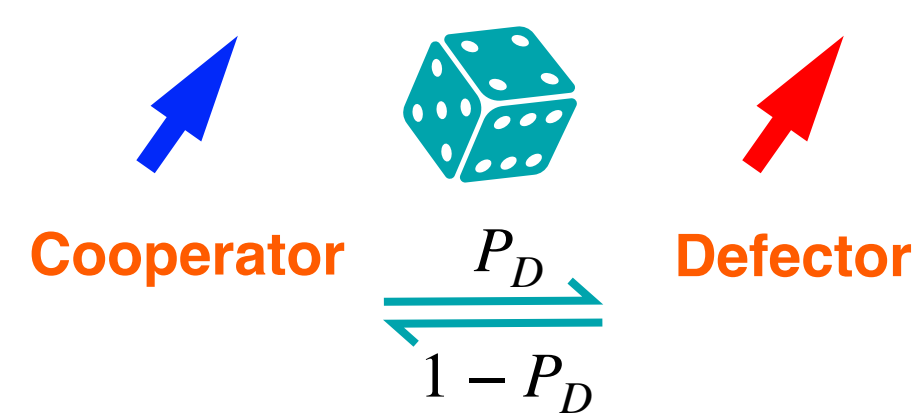
$(x, y) :=$ cartesian co-ordinates, $\psi :=$ yaw, $v :=$ speed

$\dot{x} = v \cos(\psi)$, $\dot{y} = v \sin(\psi)$, $\dot{\psi} = \omega$, $\omega < \omega_{\max}$

Defection in Collective Motion

P_D = Probability to defect

If Individuals defect probabilistically, can the group still become polarized



Topological interaction model

Metric based zonal models

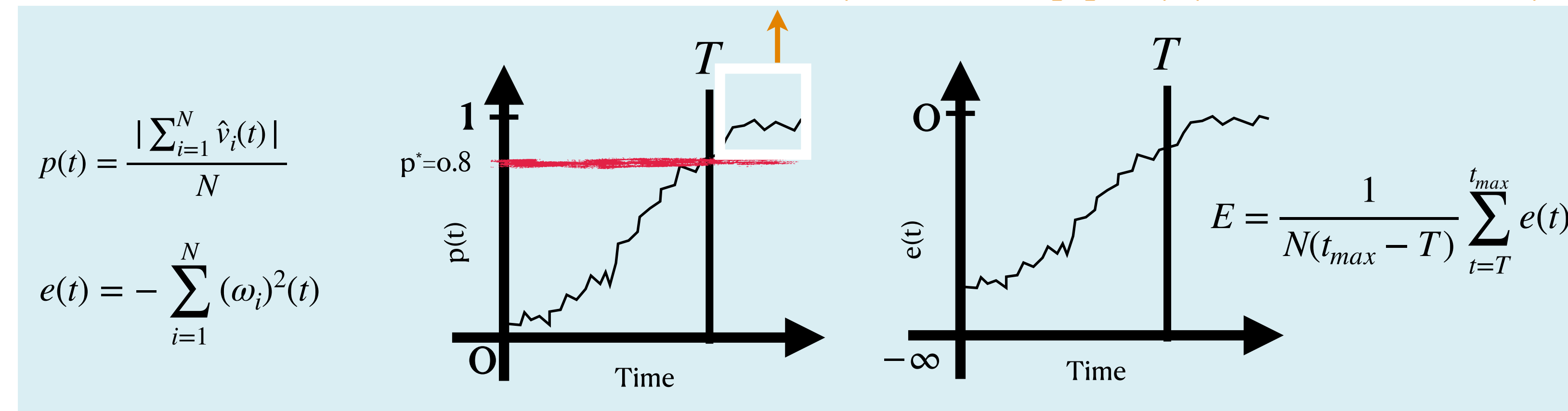
$$\psi_i(t+1) = \psi_j$$

$$\psi_i(t+1) = \sum_{j=1}^n \psi_j$$

$$\psi_i(t+1) = \begin{cases} \psi_i(t+1), & \text{if cooperating} \\ \psi_i(t), & \text{if defecting} \end{cases} \quad \omega_i = \begin{cases} \min\left(\frac{\psi_i(t+1) - \psi_i(t)}{dt}, \omega_{\max}\right), & \text{if cooperating} \\ 0, & \text{if defecting} \end{cases}$$

What do we Measure?

Probability of reaching group polarization above p^*



References

S. Agrawal, J. Jhawar, A. Reina, S.P. Baliyarasimhuni, H. Hamann, L. Li. Impact of Individual Defection on Collective Motion. In Proceedings of 14th International Conference on Swarm Intelligence (ANTS), LNCS 14987: in press. Springer, Cham, 2024.

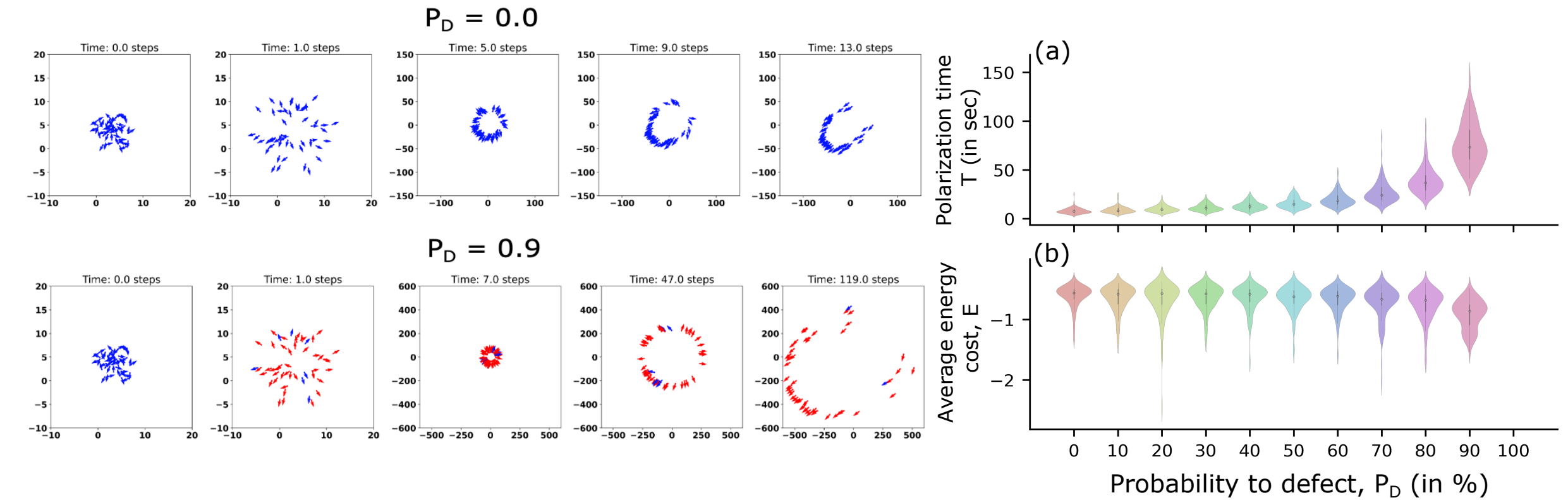
Acknowledgements

This work has been financially supported by the Indian Institute of Science Education and Research, Bhopal, India (S.A.,S.P.B.), the Max-Planck Society (L.L.), DFG under Germany's Excellence Strategy - EXC 2117 - 422037984 (S.A.,A.R.,H.H.,L.L.), the Sino-German Centre in Beijing for generous funding of the Sino-German mobility grant M-0541 (L.L.), and Messmer Foundation Research Award (L.L.) and ZuKonnnect Fellowship 2024.



Pairwise Interaction Model

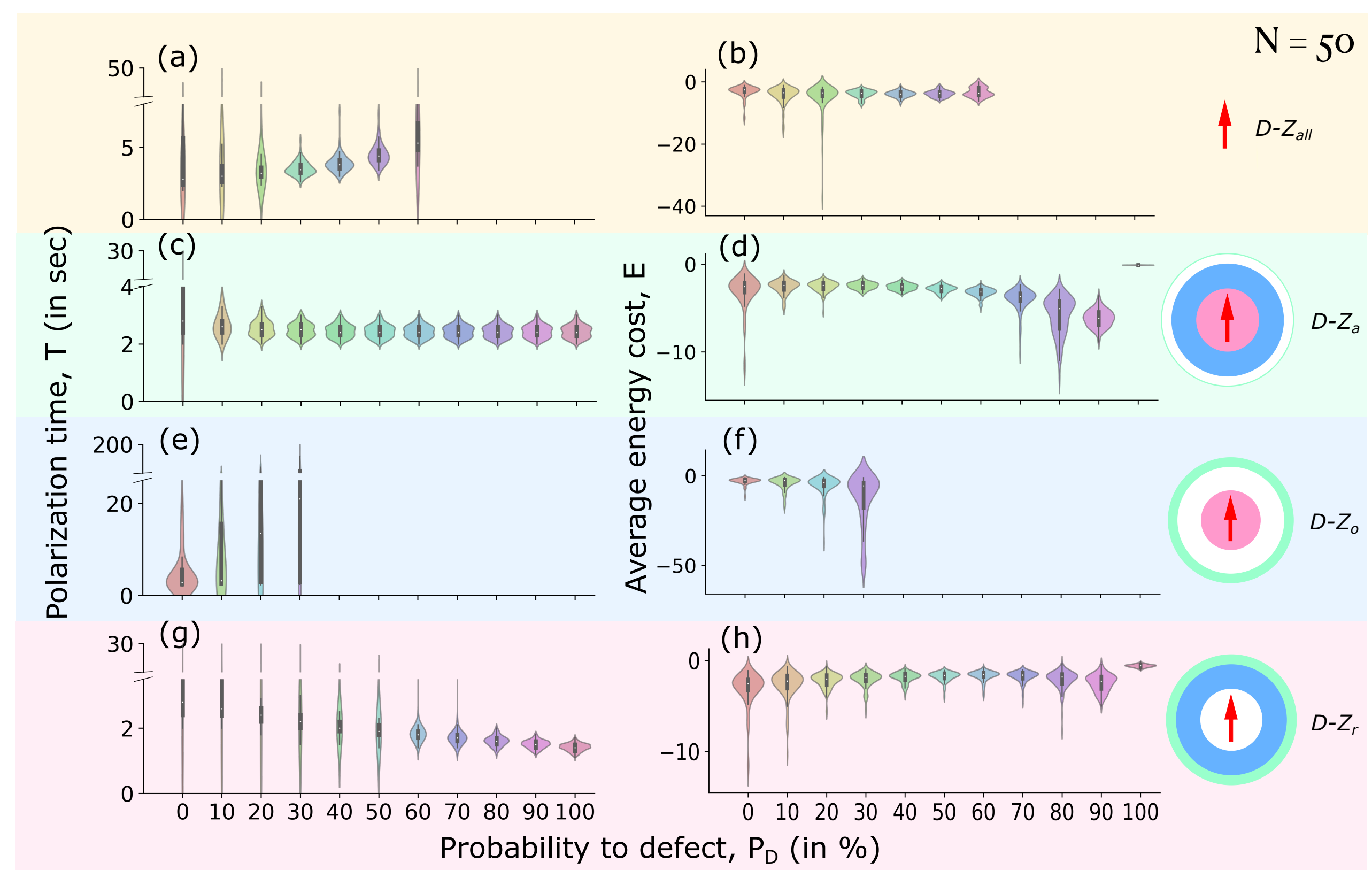
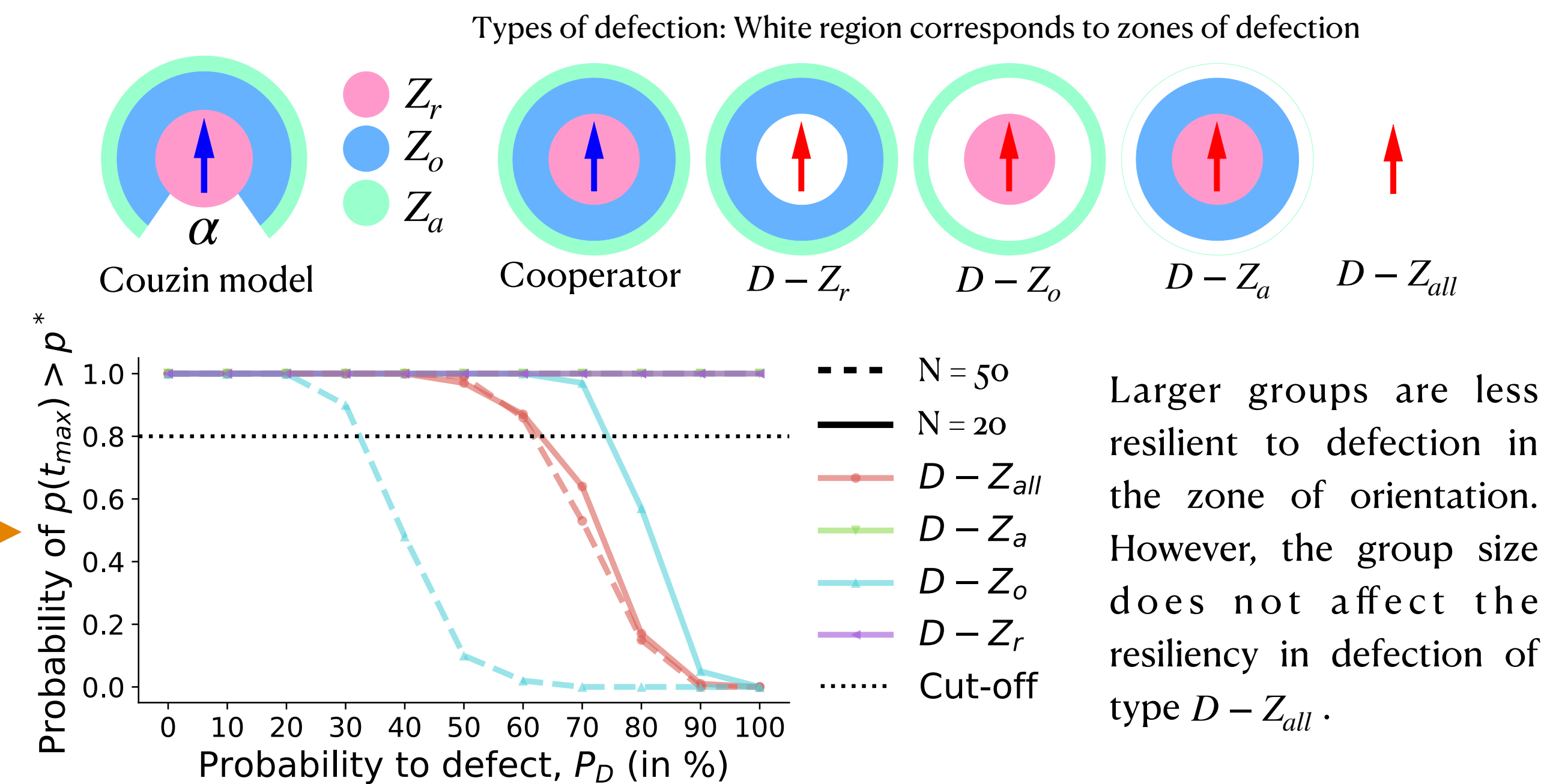
Jhawar et. al. 2020



Zonal Model

Highly parallel formation

Couzin et. al. 2002



Defection with certain probability in specific zones reduces the polarisation time, T, and also the average energy cost, E.

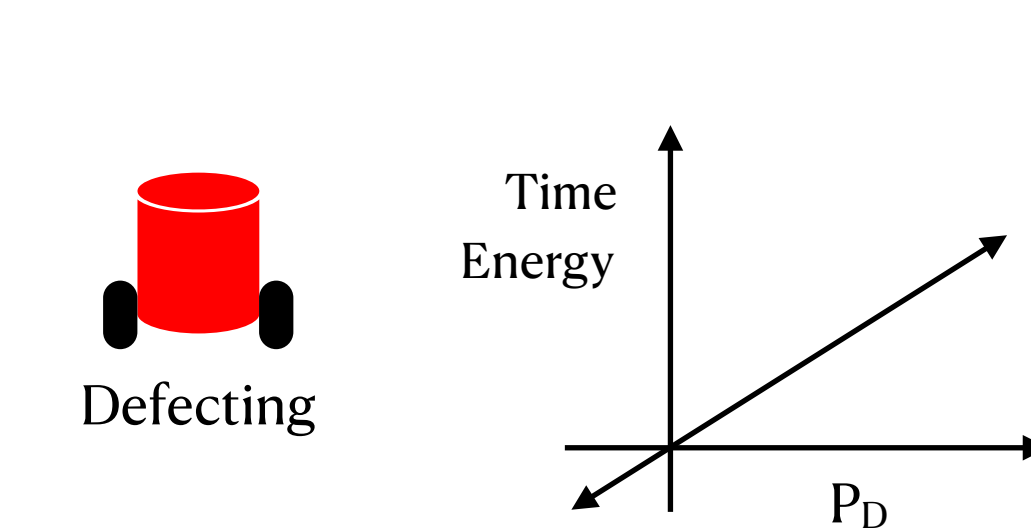
Take Home Message

अधर्मोऽपि धर्मो भवति यदा धर्मोऽधर्मो भवति।

(Adharmo'pi dharmo bhavati yadā dharmo'dharmo bhavati)

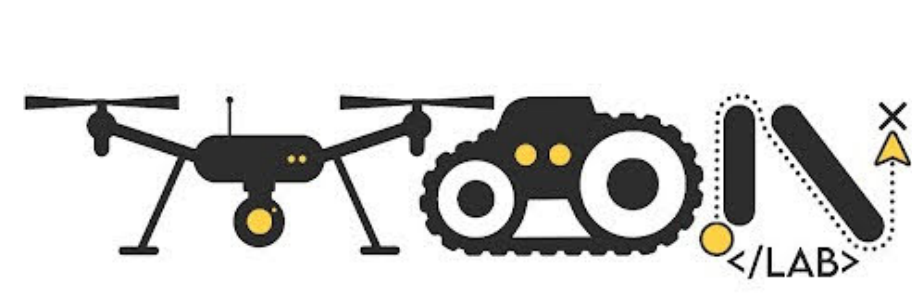
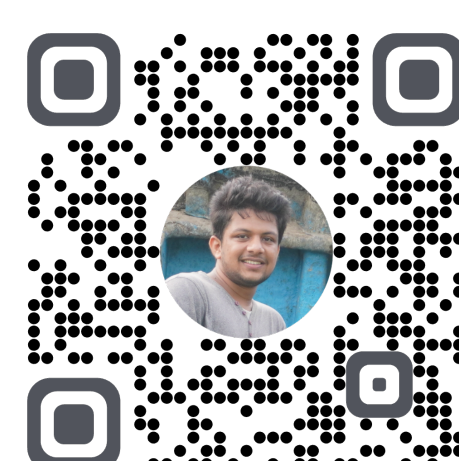
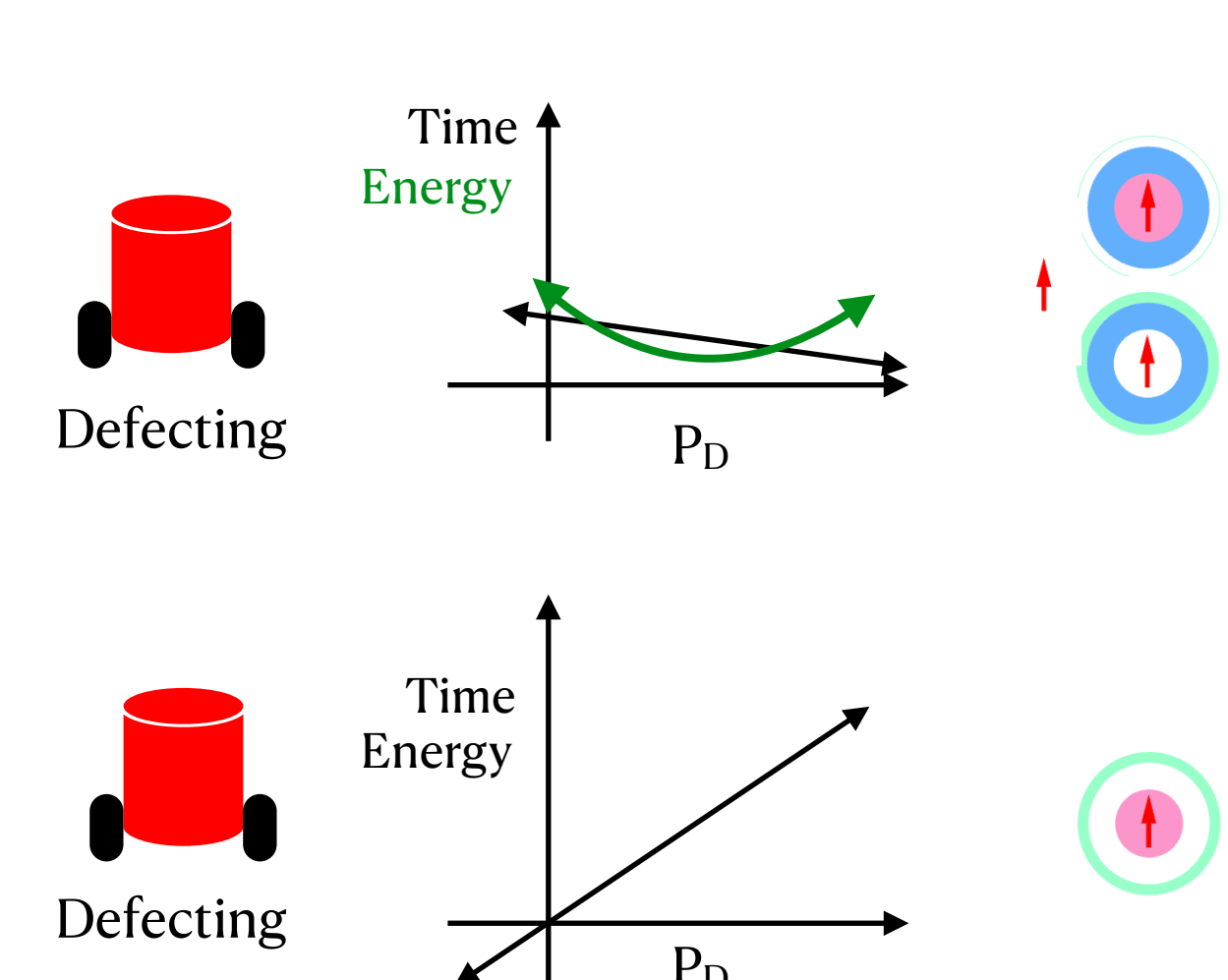
"Even undesirable actions becomes good when good actions becomes undesirable."

Pairwise interaction model

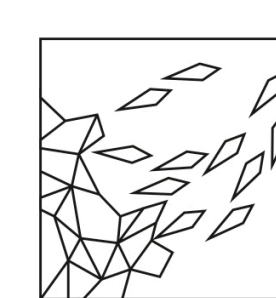


Defection in pairwise model is not beneficial to the group.

Couzin model



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