



Vicsek Model

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- 1) Motivation and Theory.**
- 2) Periodic Boundaries.**
- 3) Reflecting Boundaries.**
- 4) Periodic Boundaries with Vision.**
- 5) Reflecting Boundaries with Vision.**
- 6) Conclusion. + discussion.**

1) Motivation and Theory

Q: Why are semiconductors interesting?

Applications.¹²

- Energy conversion: e. g. photovoltaic
- Computer industry: e. g. 'Silicon Valley'



ales.airliquide. <https://ales.airliquide.com/our-markets/photovoltaic>. Accessed on the 15.11.2021.

¹ W. Demtröder. *Experimentalphysik 3: Atome, Moleküle und Festkörper*. 5. Auflage. Springer, Berlin, 2016.

² Semiconductors.org. <https://www.semiconductors.org/>. Accessed on the 15.11.2021.

2) Periodic Boundaries

Theory.³

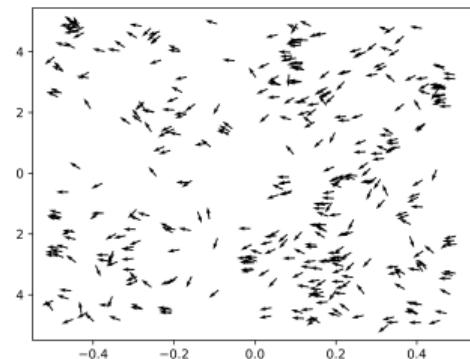
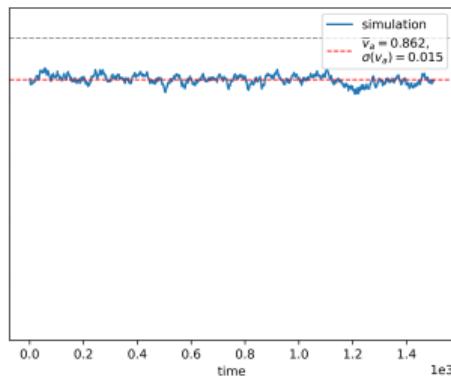
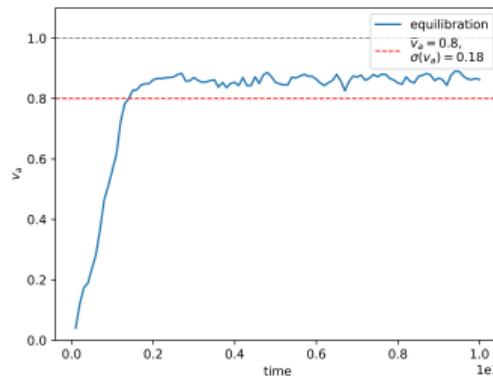
- highly doped n- and p-layer
- thinner barrier layer:
 - ① High field strengths due to $E = \frac{U}{d}$
 - ② At $U = U_Z \Rightarrow$ field kicks out electrons from crystal bonds
 - ③ Avalanche-like charge multiplication
 - ④ Current even in blocking direction

³ elektronik-kompendium. <https://www.elektronik-kompendium.de/sites/bau/0201211.htm>. Accessed on the 15.11.2021.

2) Periodic Boundaries

Trajectory. Example.

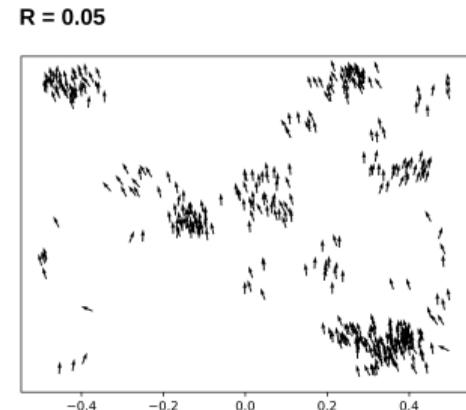
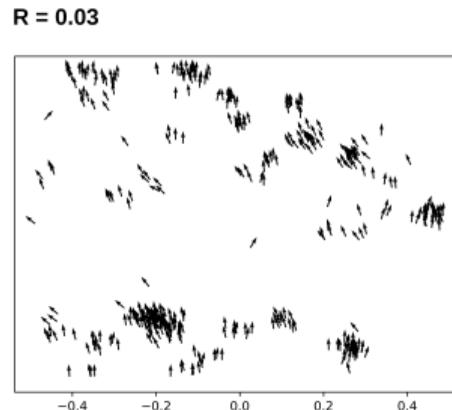
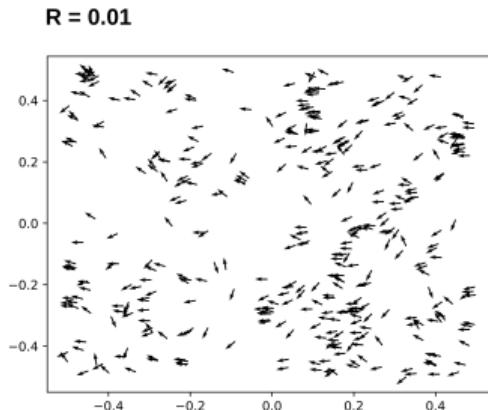
- $\rho = 400, v = 0.03, R = 0.01, D_{\text{rot}} = 0.01, \Delta t = 1.0$
- Representative trajectory is shown
- Equilibration in ≈ 200 steps



2) Periodic Boundaries

Configurations. R -dependence.

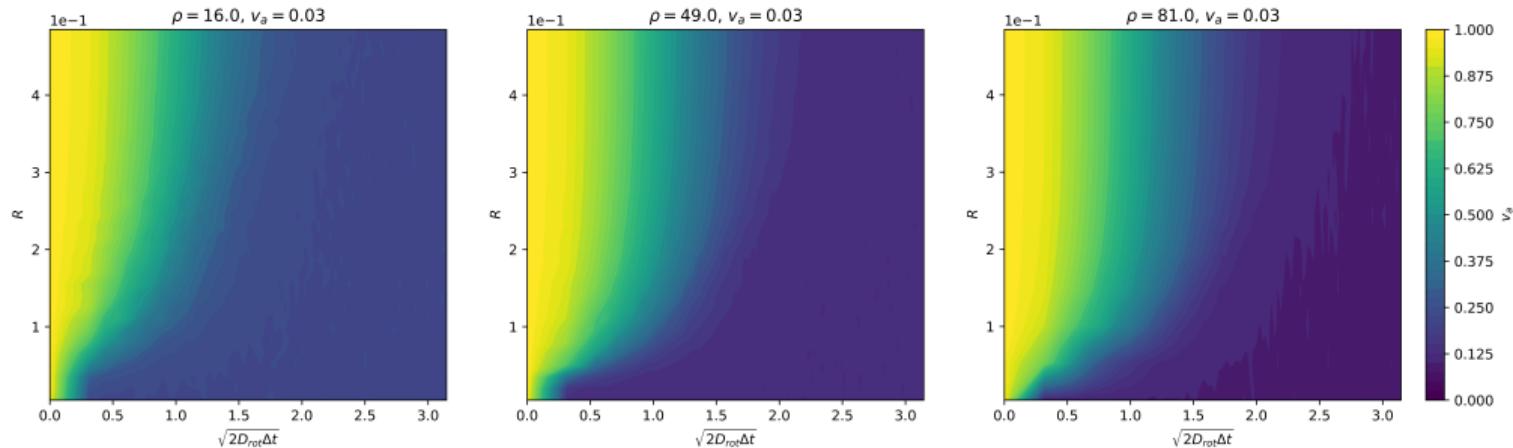
- $\rho = 400, v = 0.03, D_{\text{rot}} = 0.01, \Delta t = 1.0$
- Bigger $R \Rightarrow$ bigger flocks



2) Periodic Boundaries

Phase transitions. 2D Levels in parameter space.

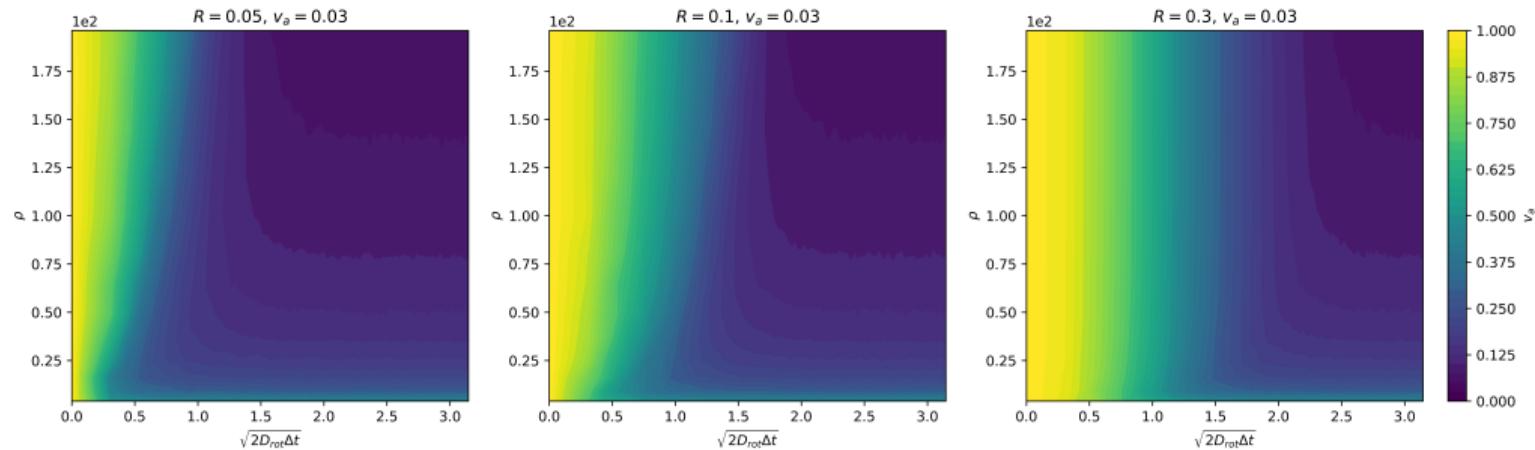
- R against $\sqrt{2D_{\text{rot}}\Delta t}$



2) Periodic Boundaries

Phase transitions. 2D Levels in parameter space.

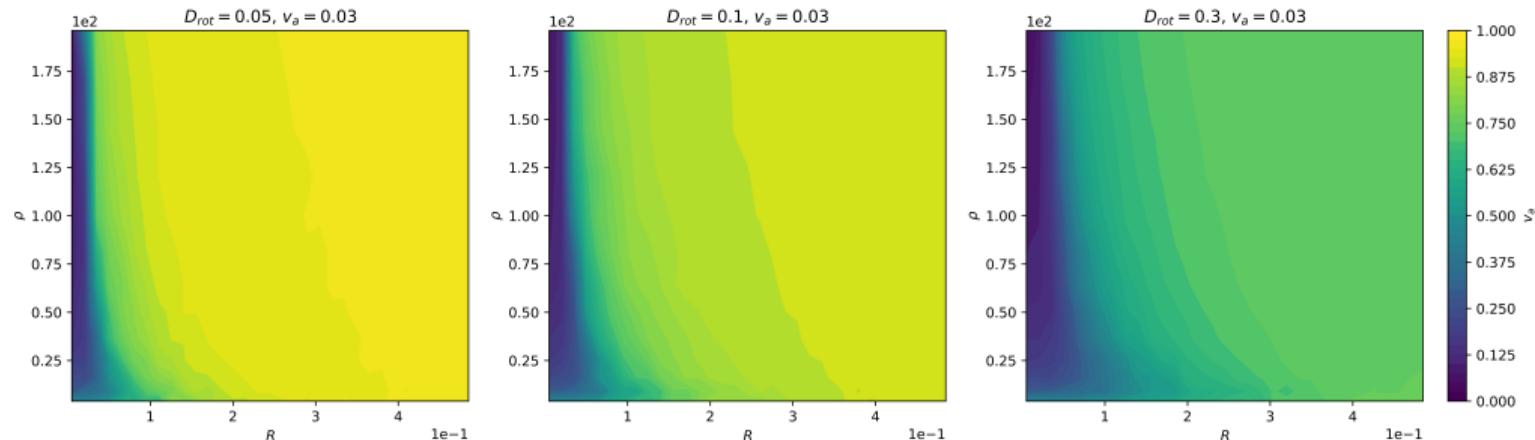
- ρ against $\sqrt{2D_{\text{rot}}\Delta t}$



2) Periodic Boundaries

Phase transitions. 2D Levels in parameter space.

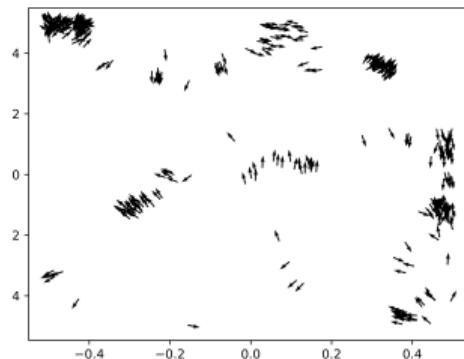
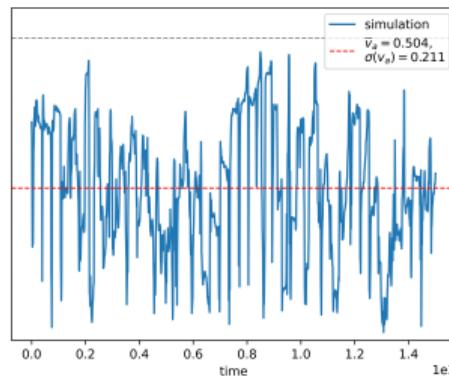
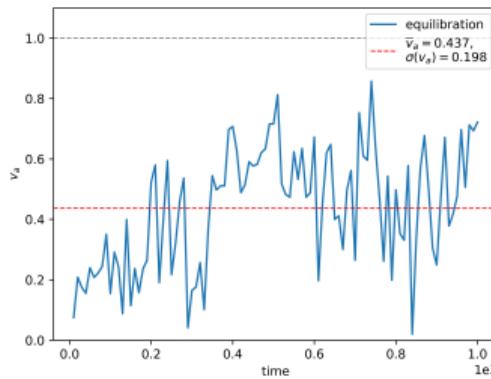
- ρ against R



3) Reflecting Boundaries

Trajectory. Example.

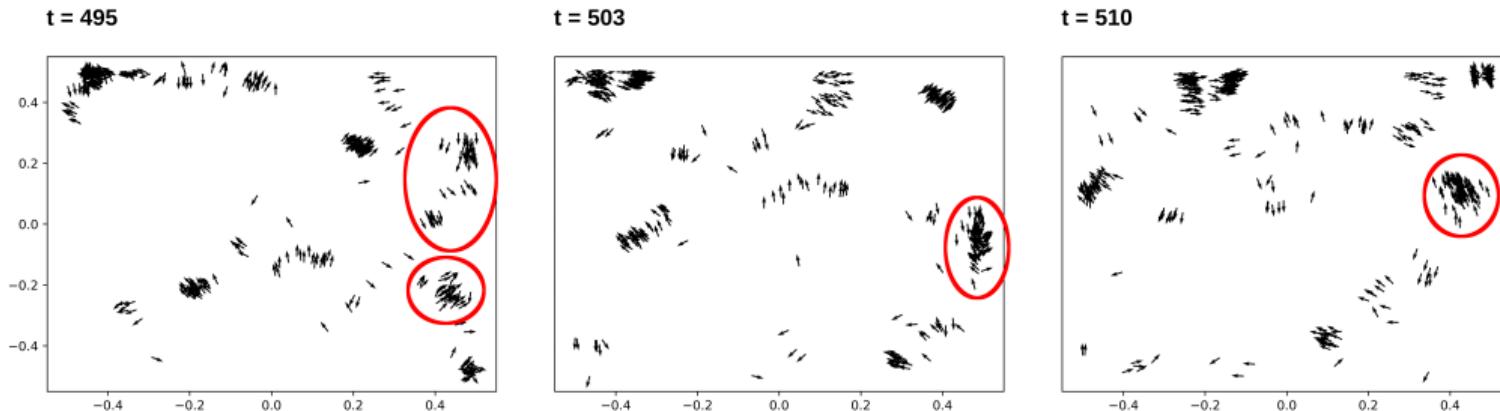
- $\rho = 400, v = 0.03, R = 0.03, D_{\text{rot}} = 0.01, \Delta t = 1.0$
- Representative trajectory is shown
- Large fluctuations



3) Reflecting Boundaries

Trajectory. Interesting Collisions.

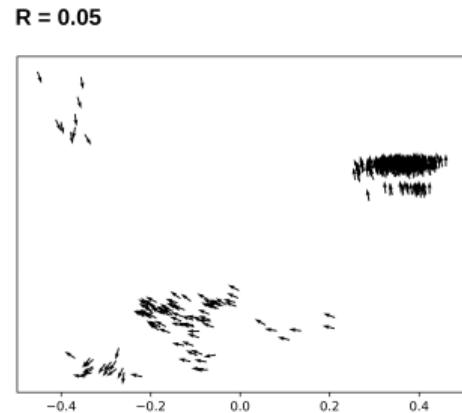
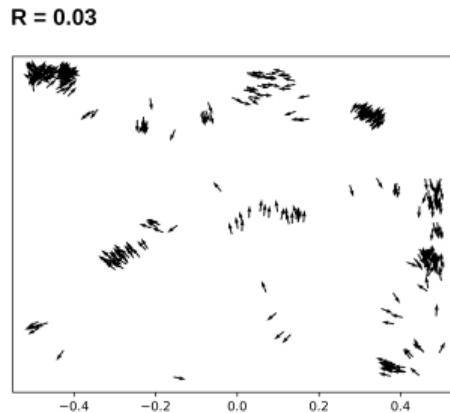
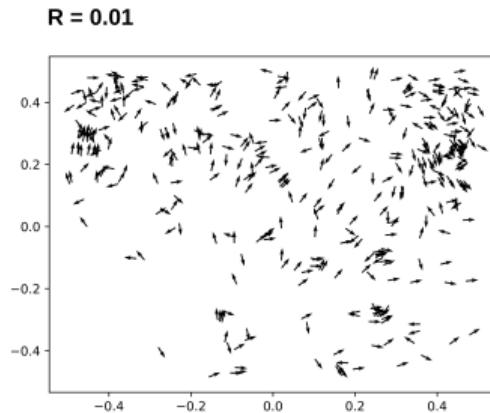
- $\rho = 400, v = 0.03, R = 0.03, D_{\text{rot}} = 0.01, \Delta t = 1.0$
- Two incoming flocks \rightarrow one outgoing flock
-



3) Reflecting Boundaries

Configurations. R -dependence.

- $\rho = 400, v = 0.03, D_{\text{rot}} = 0.01, \Delta t = 1.0$
- Bigger $R \Rightarrow$ bigger flocks
- Flocking stronger compared to periodic boundaries

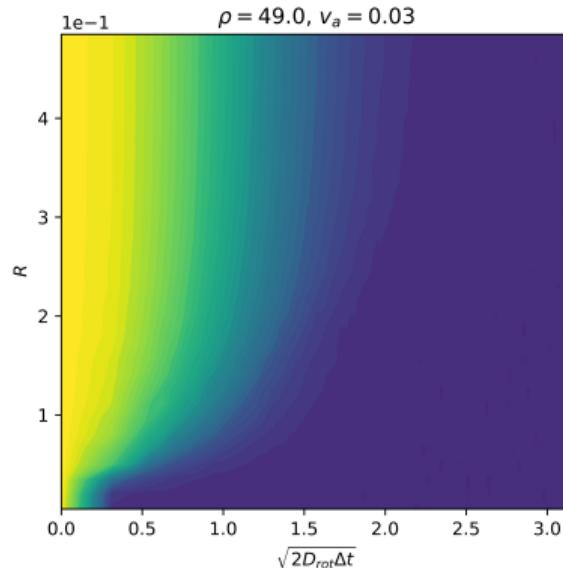


3) Reflecting Boundaries

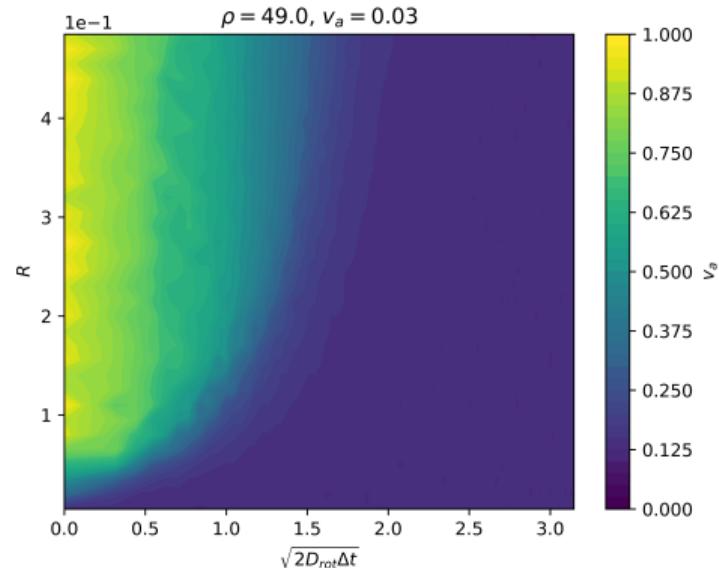
Phase transitions. 2D Levels in parameter space.

- R against $\sqrt{2D_{\text{rot}}\Delta t}$

Periodic Boundaries:



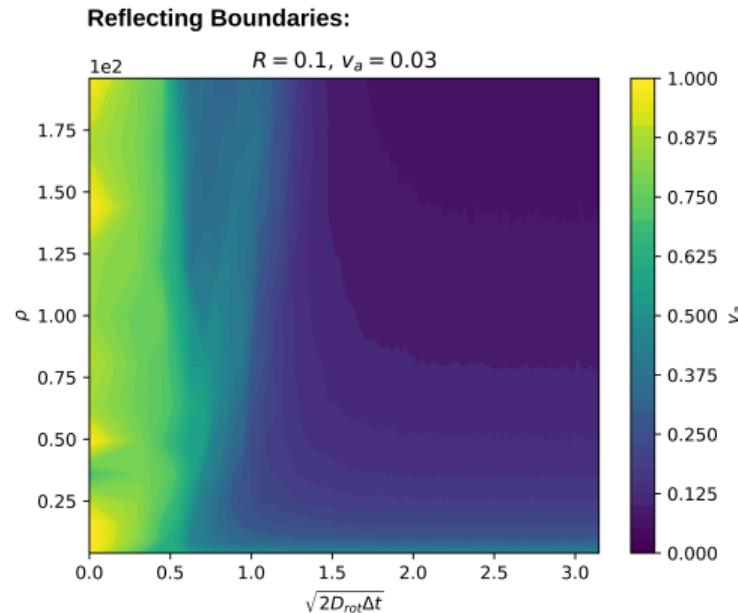
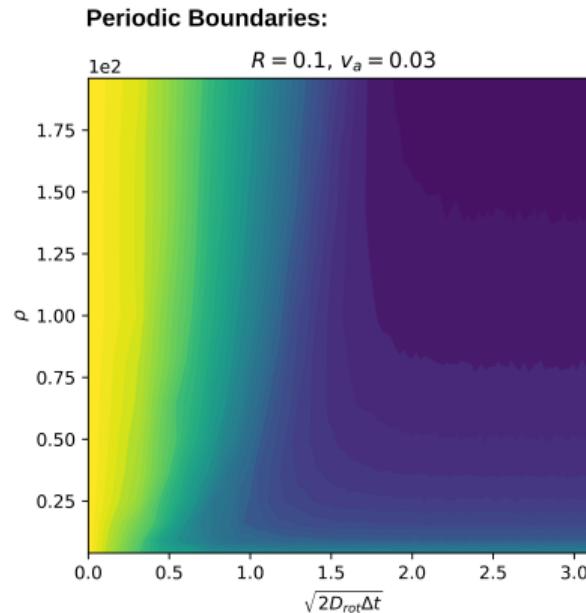
Reflecting Boundaries:



3) Reflecting Boundaries

Phase transitions. 2D Levels in parameter space.

- ρ against $\sqrt{2D_{\text{rot}}\Delta t}$

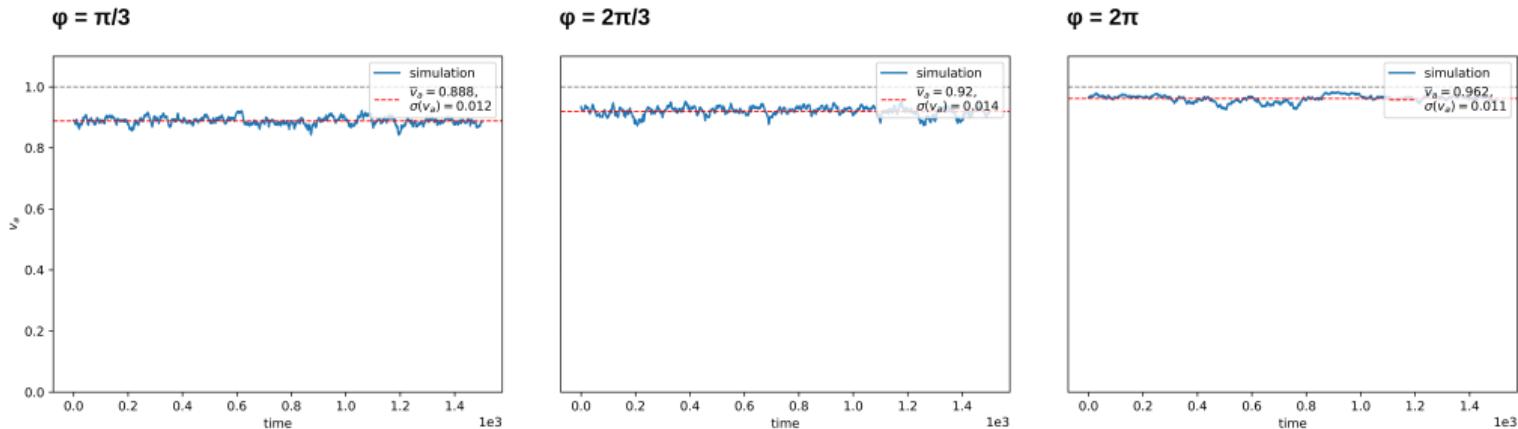




4) Periodic Boundaries with Vision

Trajectory. Comparison.

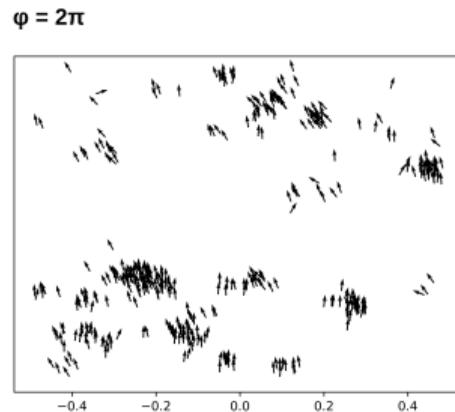
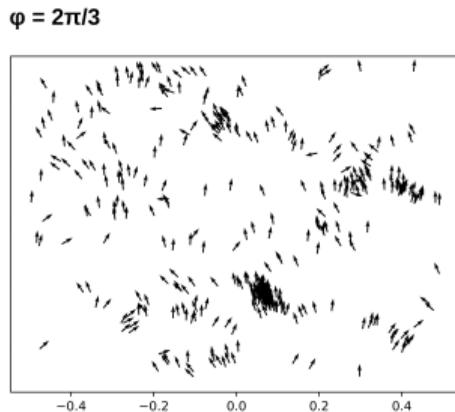
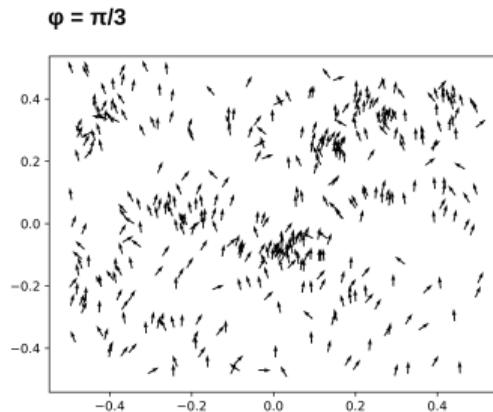
- $\rho = 400, v = 0.03, R = 0.03, D_{\text{rot}} = 0.01, \Delta t = 1.0$
- v_a grows with vision angle



4) Periodic Boundaries with Vision

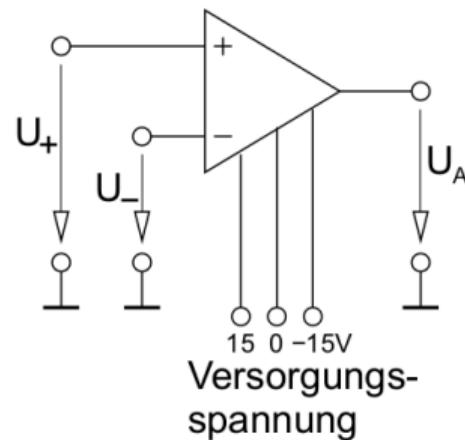
Configurations. Comparison.

- $\rho = 400, v = 0.03, R = 0.03, D_{\text{rot}} = 0.01, \Delta t = 1.0$
- Flock size grows with vision angle



5) Reflecting Boundaries with Vision.

Theory. Symbol.



Cantillano C., Grundpraktikum 2: Halbleiterbauelemente. Internal Proceedings. University of Innsbruck , 2021.



Thank you for your attention!

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