Flocks With Trap, Vision-Cone And Communication-delay

Arnab Saha
(SPPU/UniPune)

Statistical Physics Meet.2017

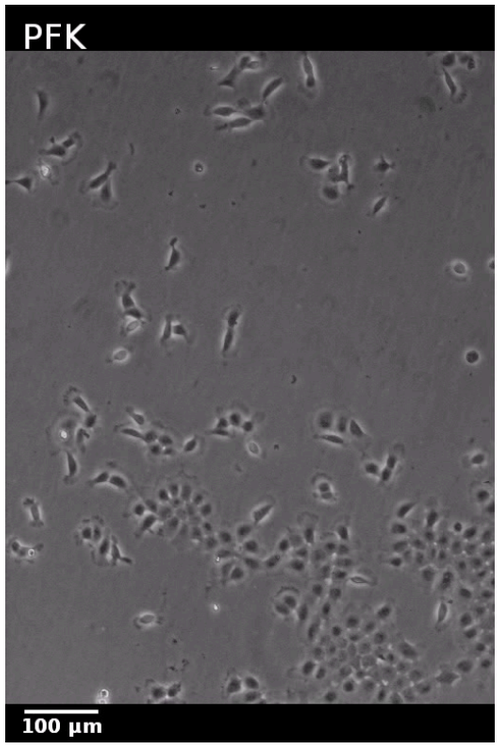
Hartmut Löwen (H.H.U)

Ronojoy Adhikari (IMSC)
Rajesh Singh

Sayeed Ahmad (UniPune)
Mihir Dhurve (Unipune / ICTP)

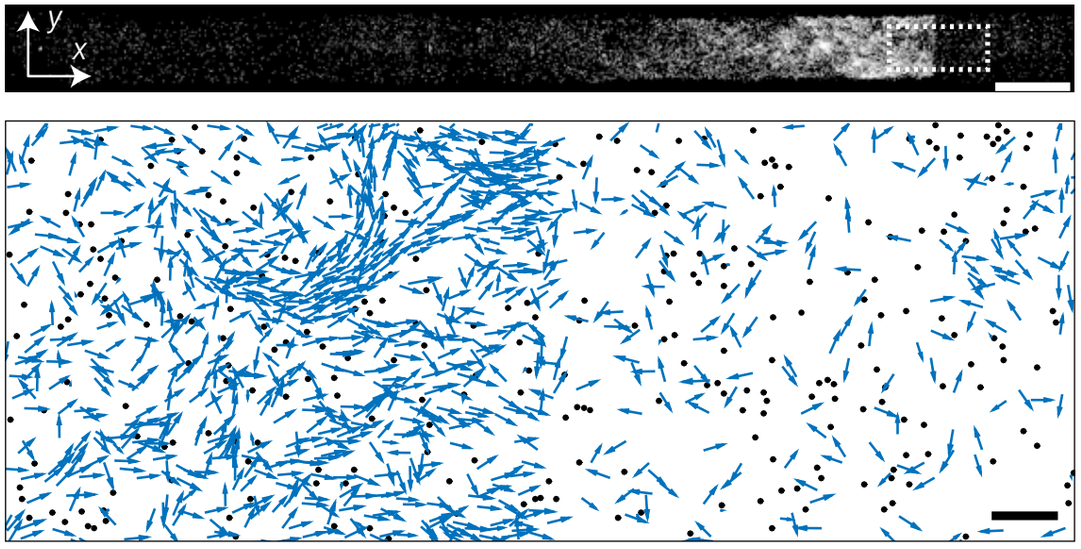
Flocks And Active Systems

Flock : Interacting agents process local energy to move together

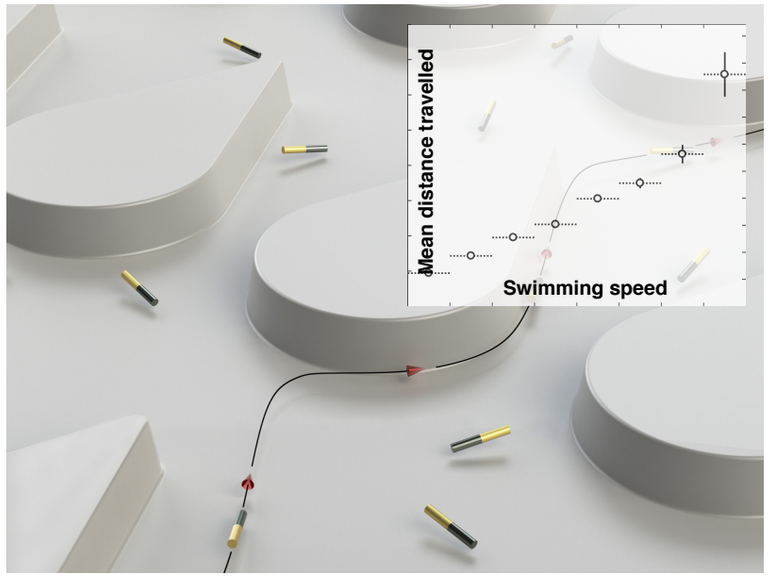


External Perturbation

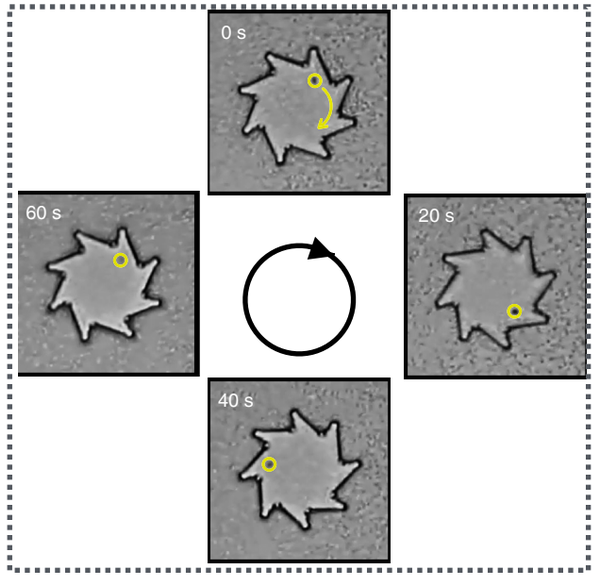
Different Perturbations : disordered, tear-drops and sawtooth obstacles



Nullifying directed transport



Directed transport

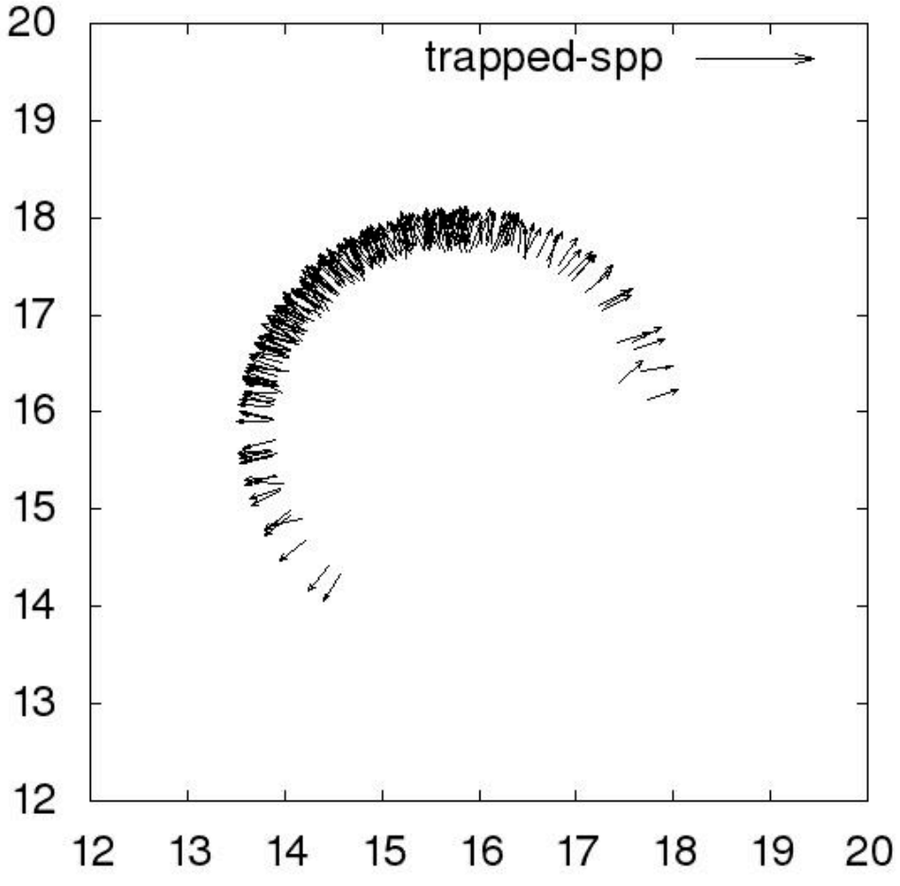


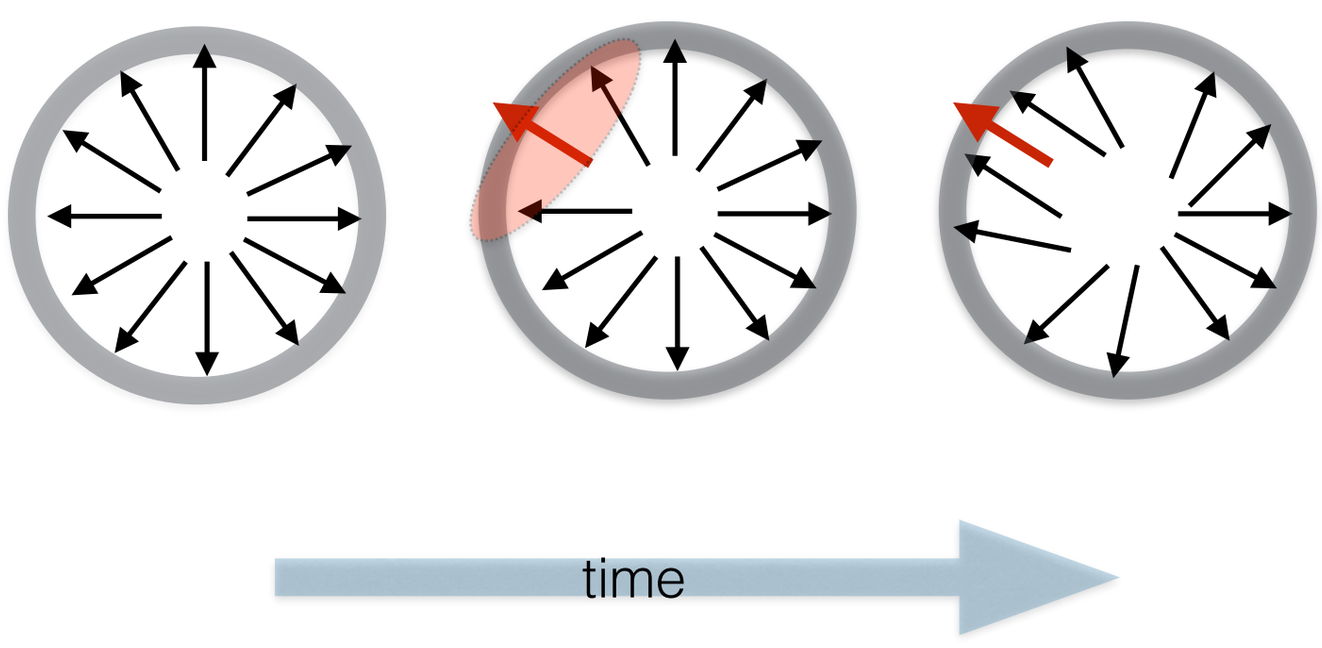
Work extraction

What happens close to the boundaries of the ‘obstacles’?

External Perturbation : Trap

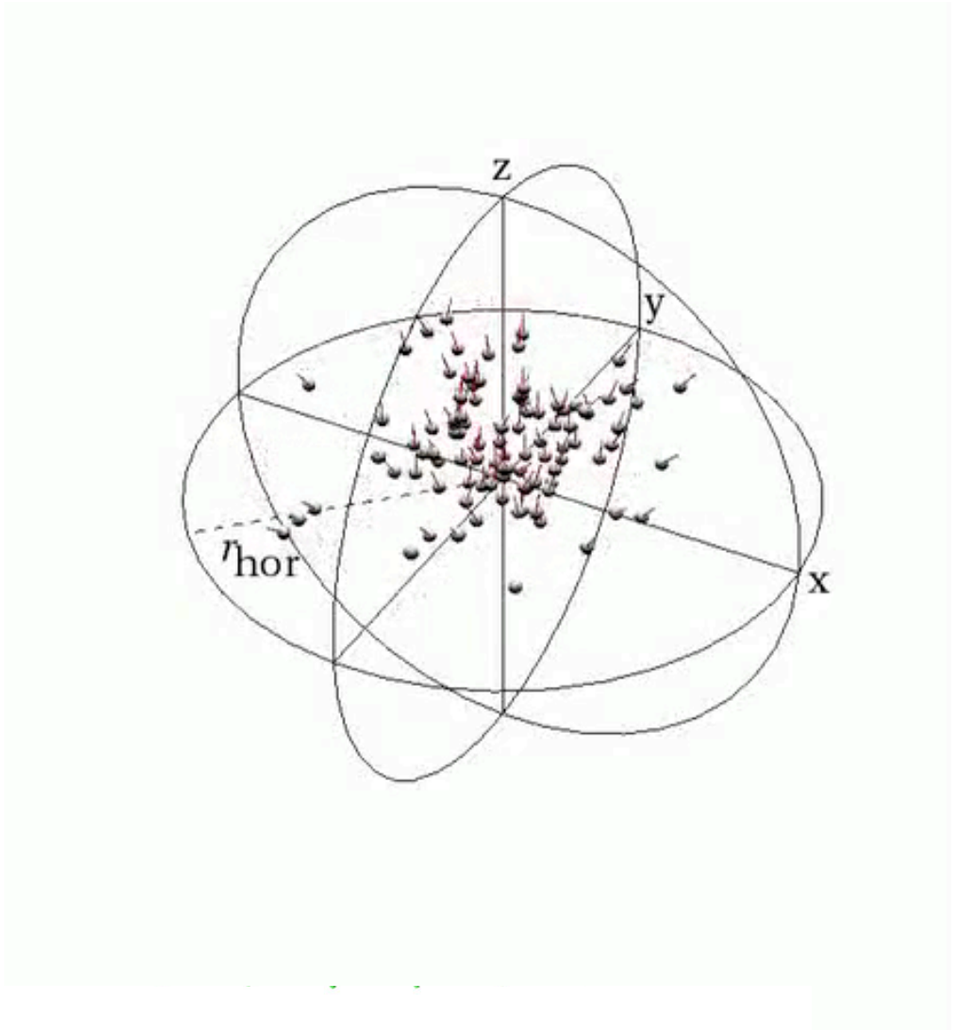
Self-propellers with Vicsek alignment + Harmonic trap

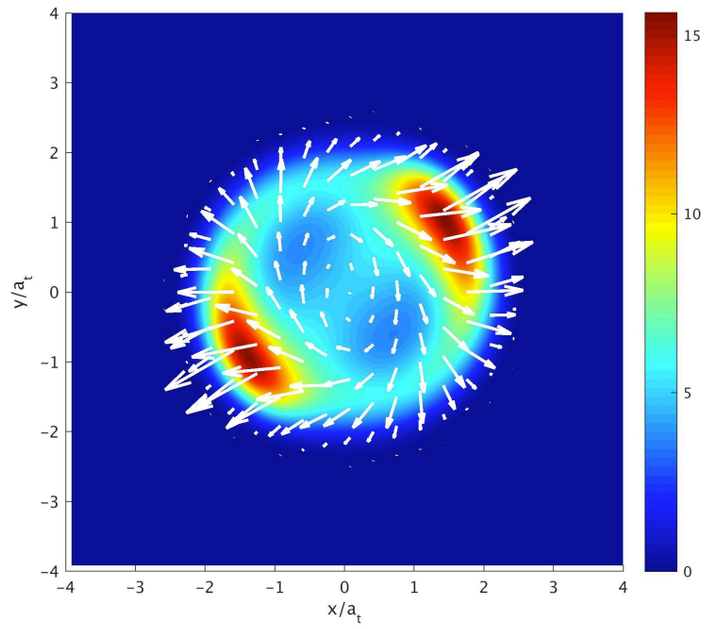


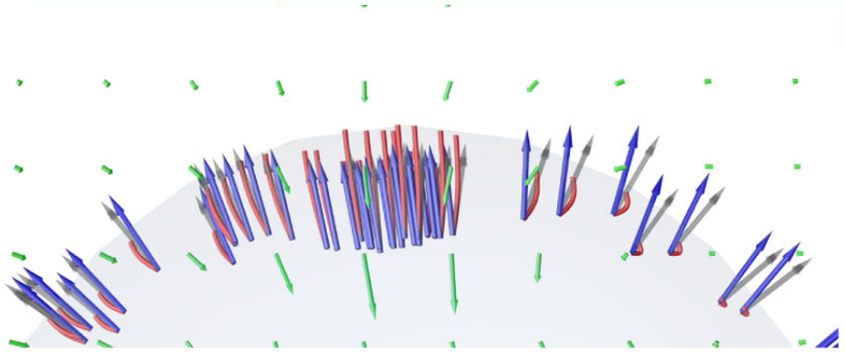


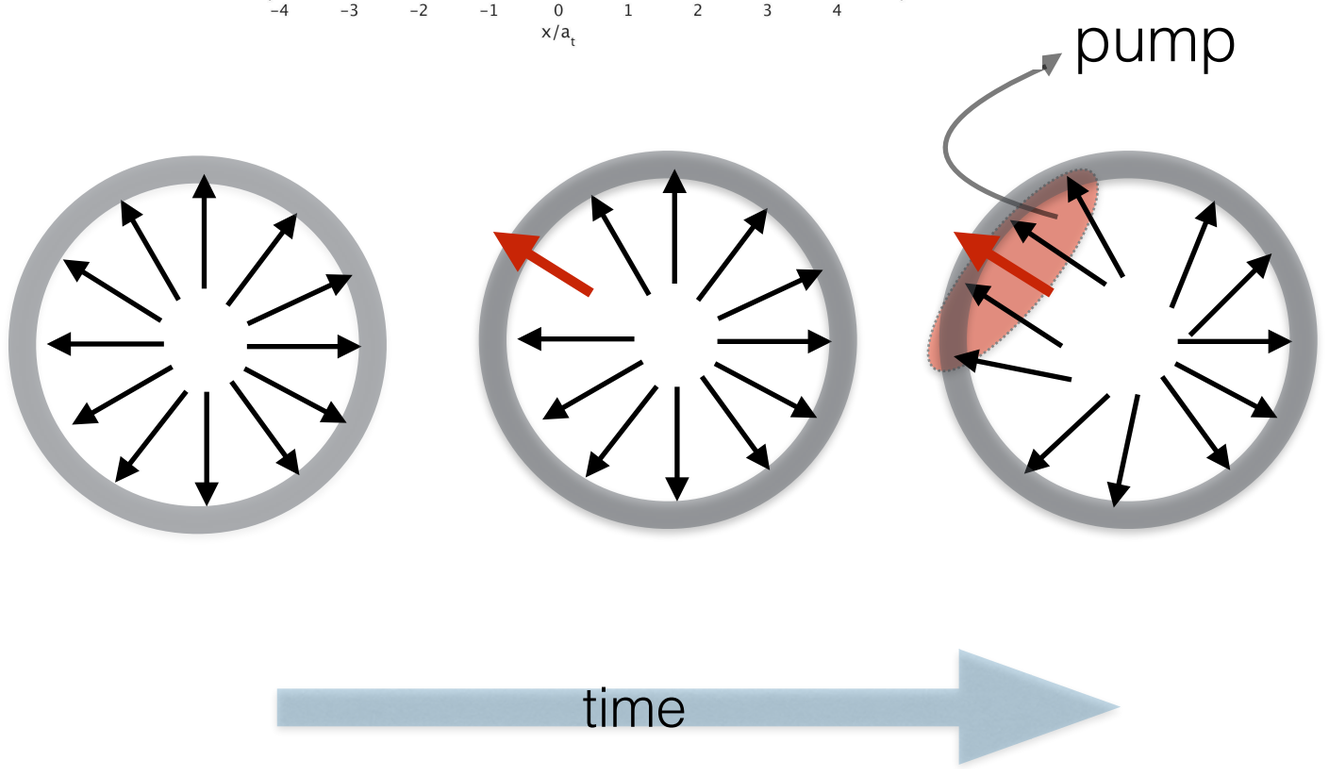
Breaking of spherical symmetry

Self-Propeller Pump

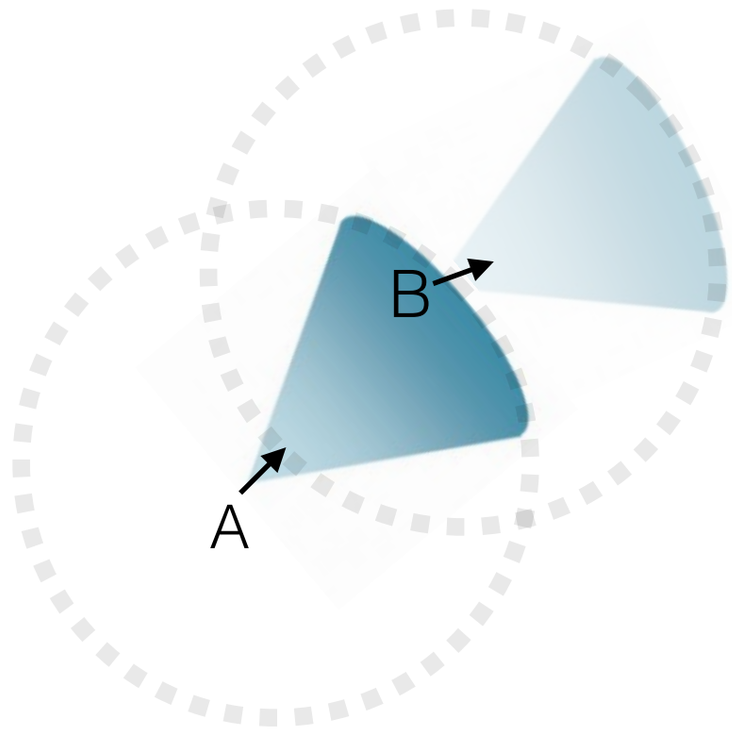


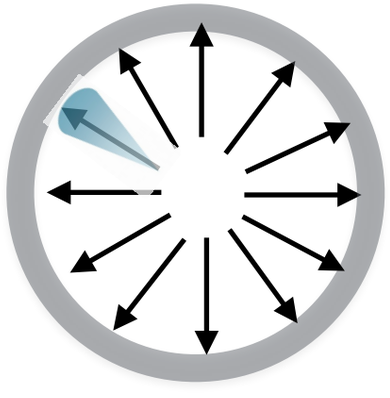






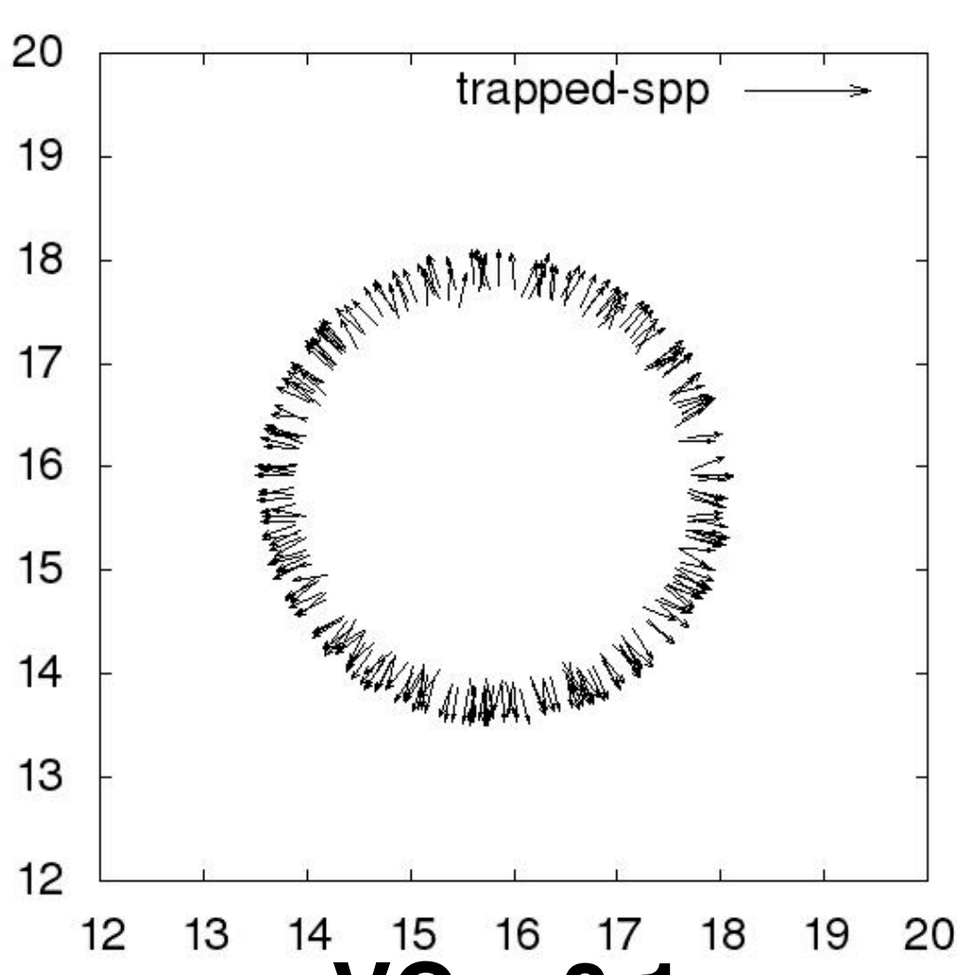
Restoring Spherical Symmetry Within The Trap : Vision-Cone





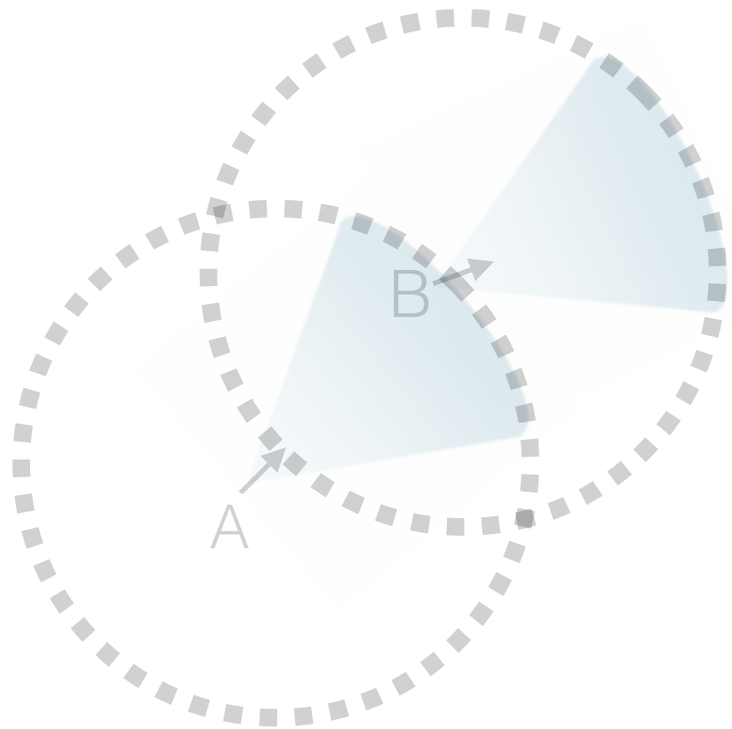
$$U_{AB} \neq 0$$

$$U_{BA} = 0$$



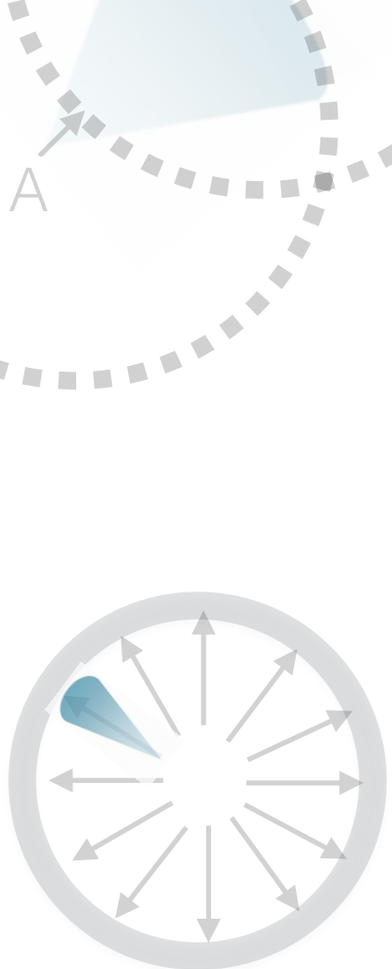
VC = 0.1π

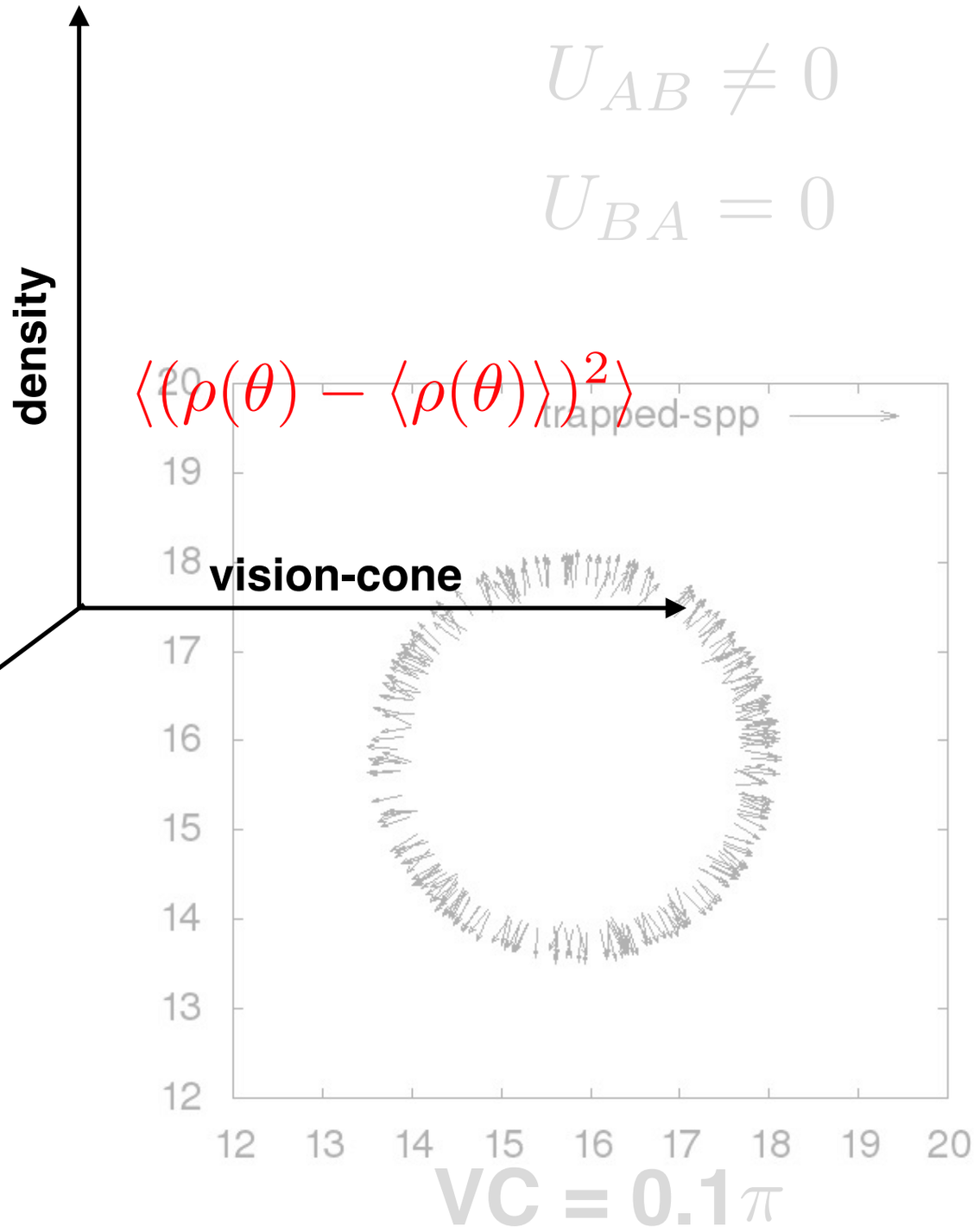
Restoring Spherical Symmetry Within The Trap : Vision-Cone



$U_{AB} \neq 0$

$U_{BA} = 0$

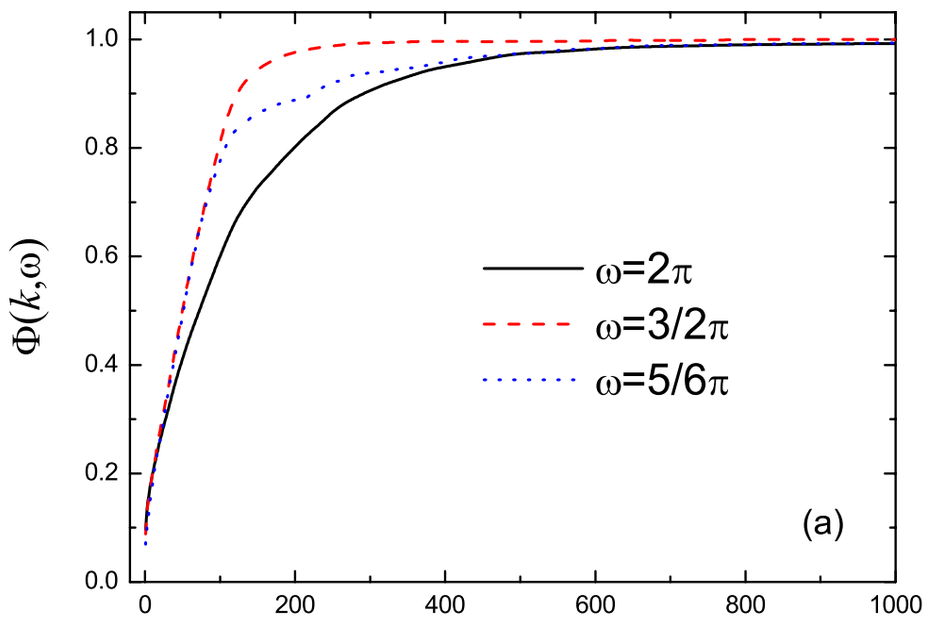




VC = 0.1π

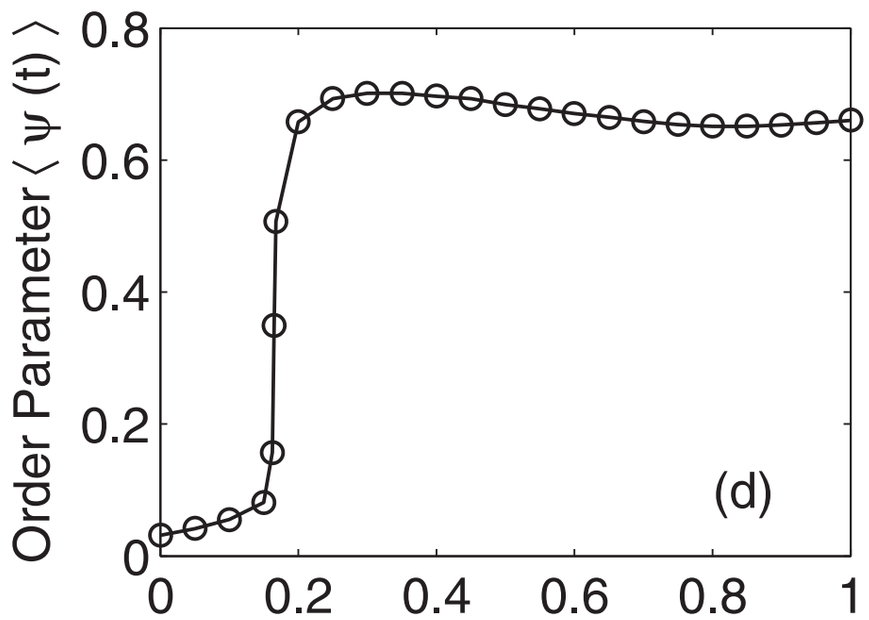
Vision-Cone : Effects In Bulk

Vicsek model



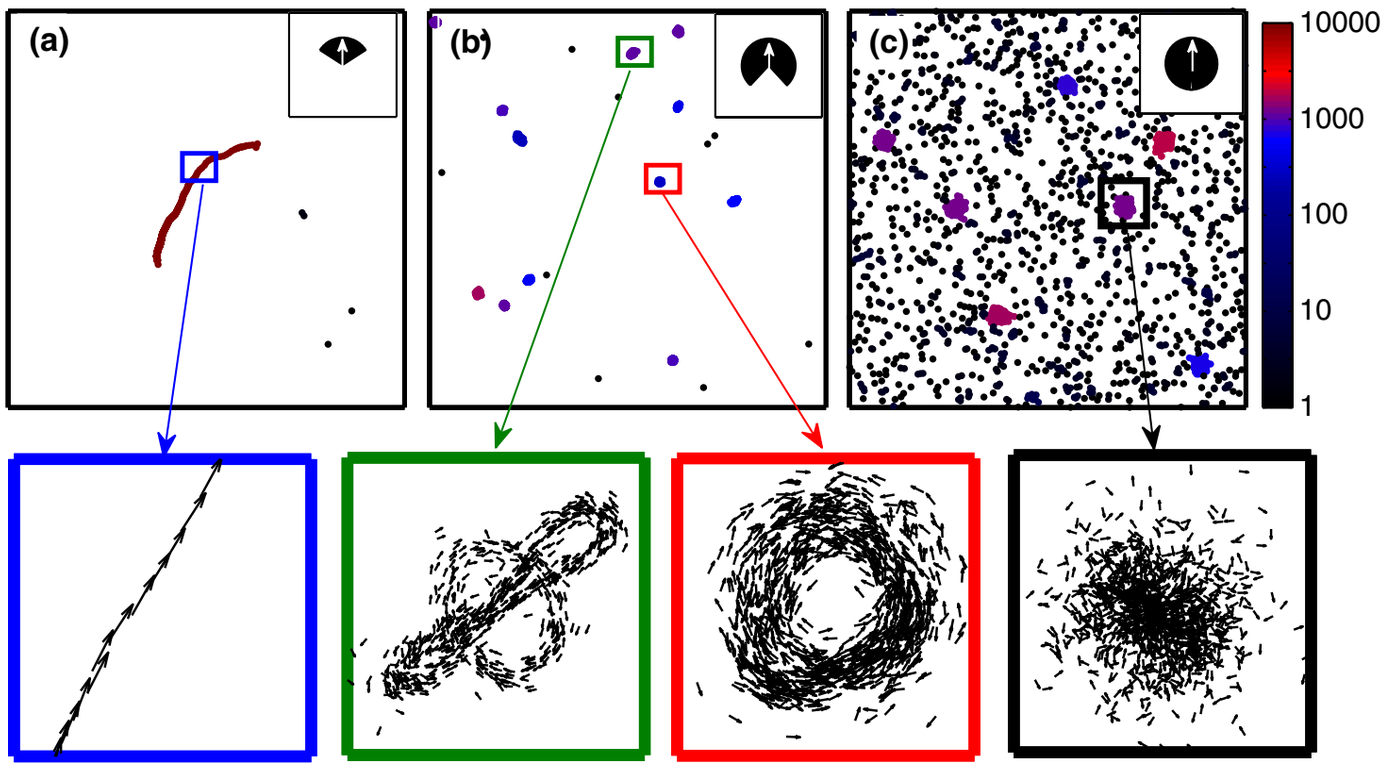
k

Vicsek model

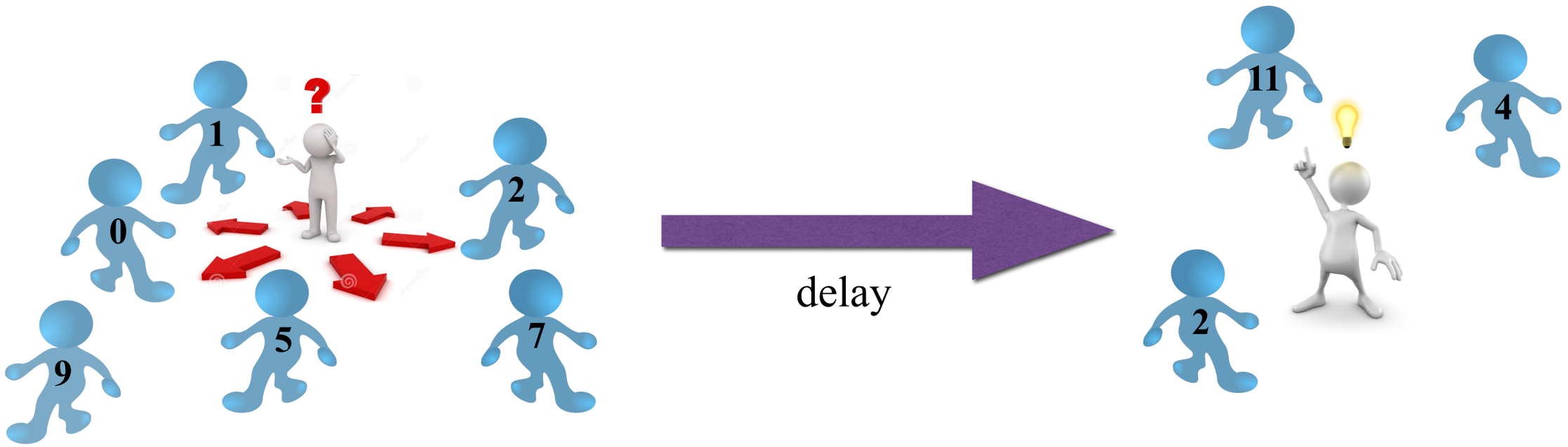


View Angle ϕ

Self-propellers
with position-based
attractive interaction
(no velocity alignment)

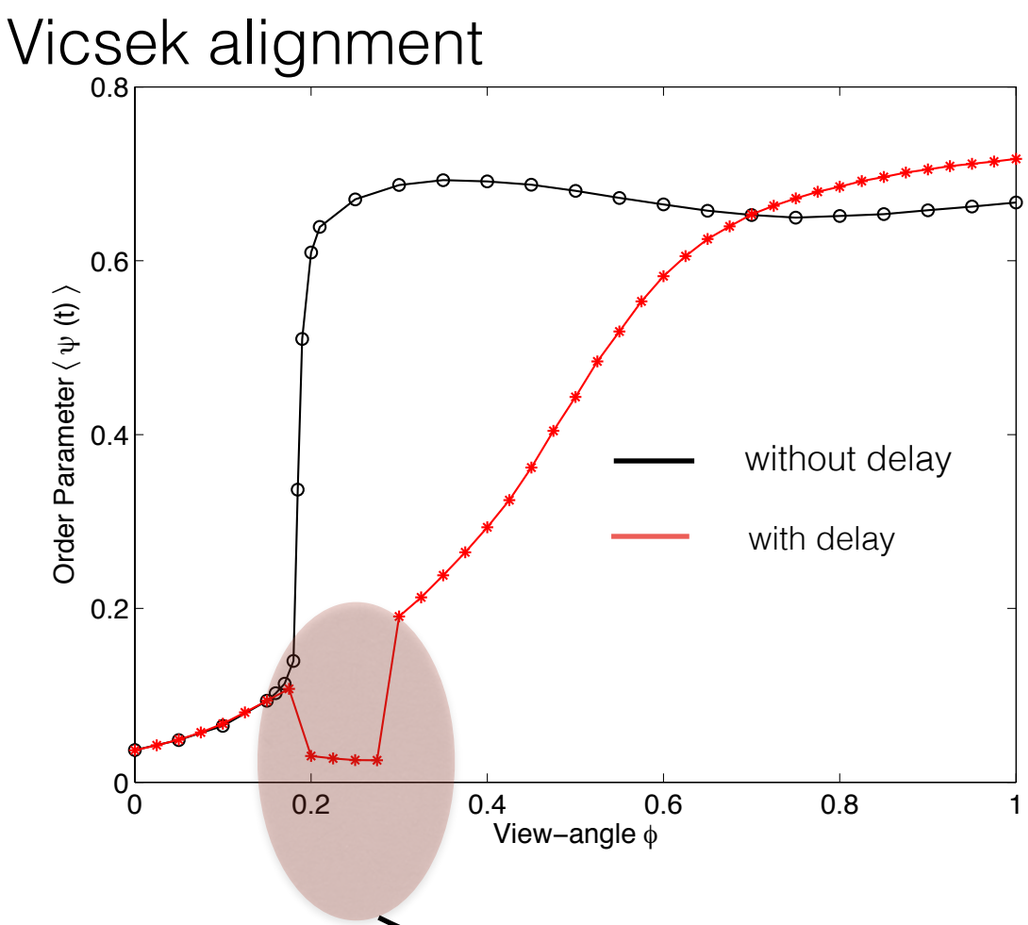


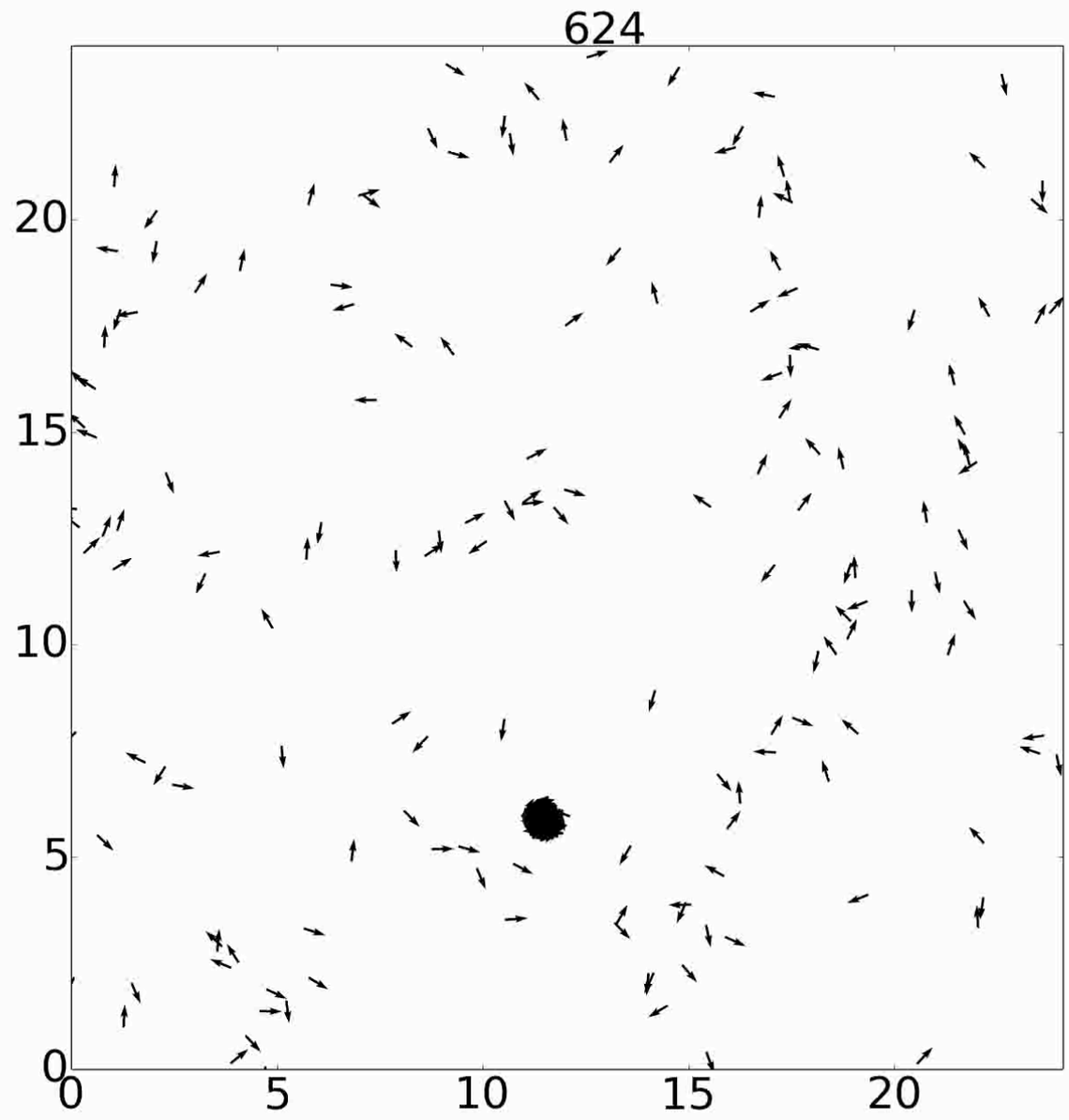
Communication Delay



Communication Delay + Vision Cone

(Effects in bulk)



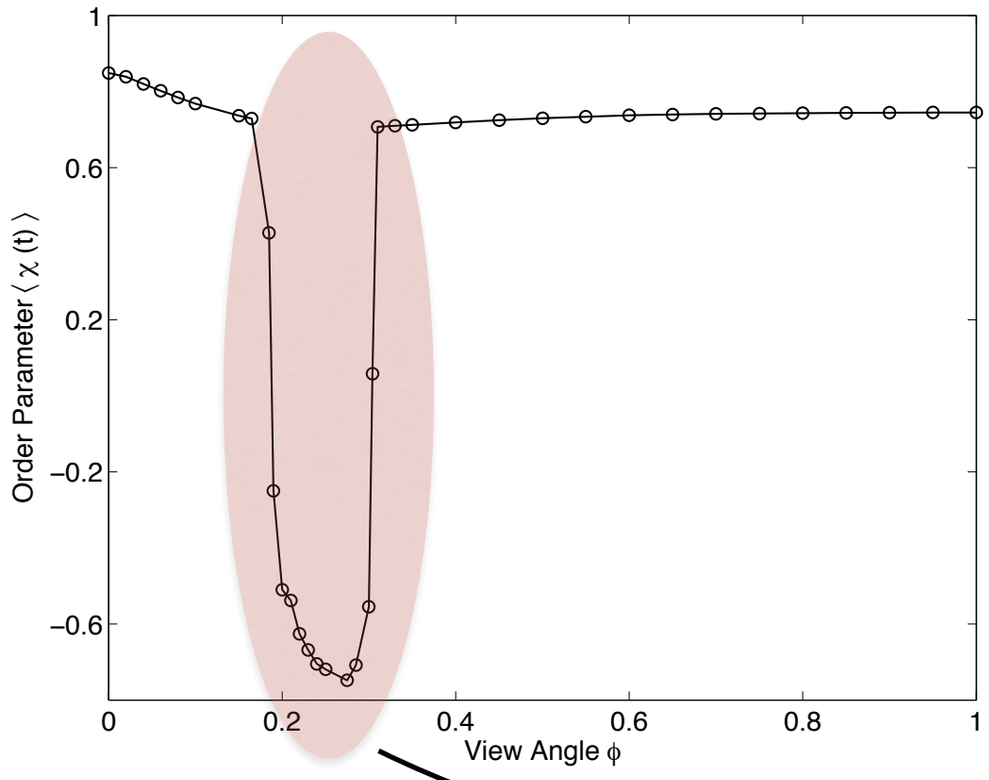


‘Frozen’ / absorbing Steady States !

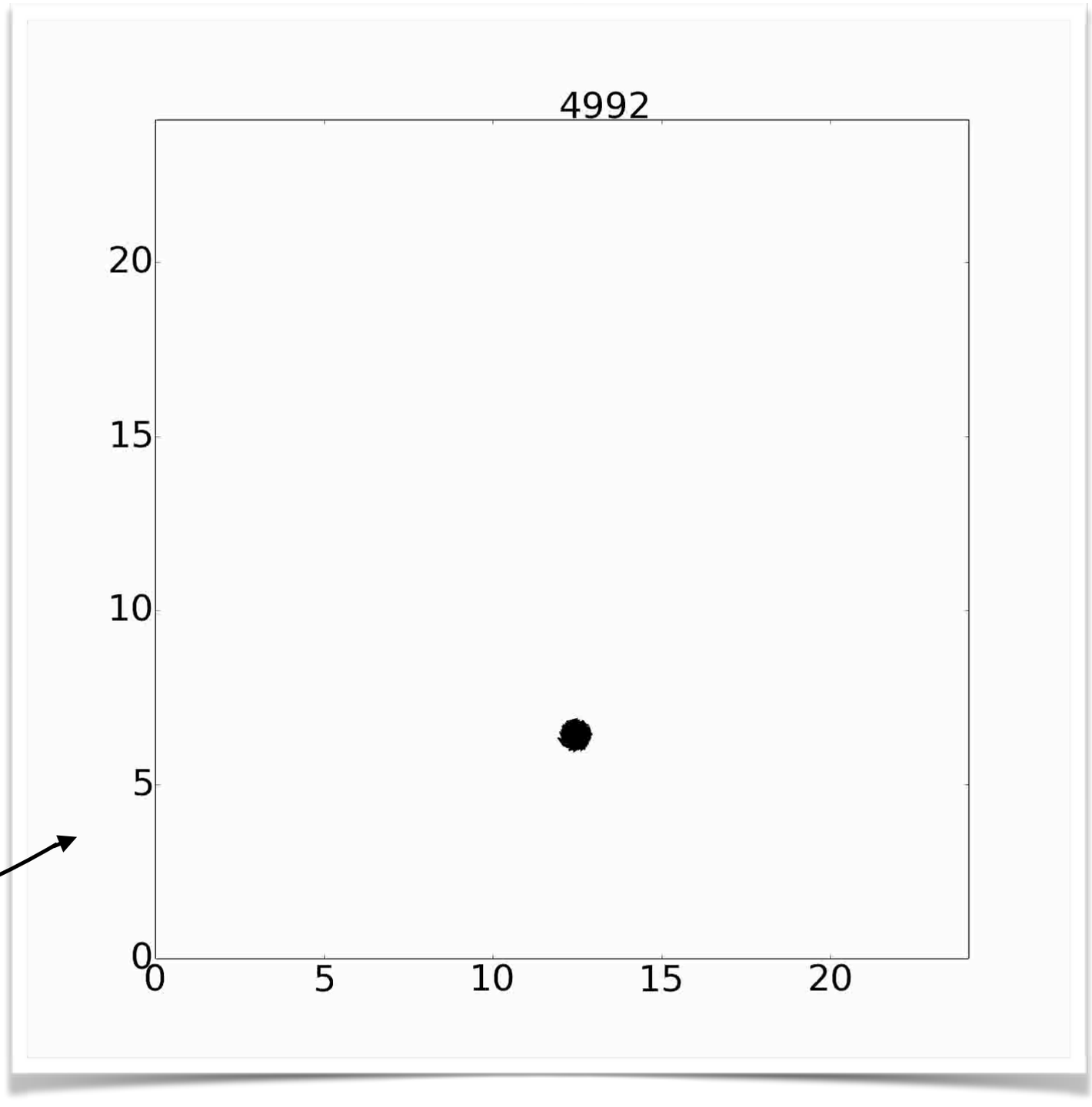
Communication Delay + Vision Cone

(Effects in bulk)

Vicsek alignment



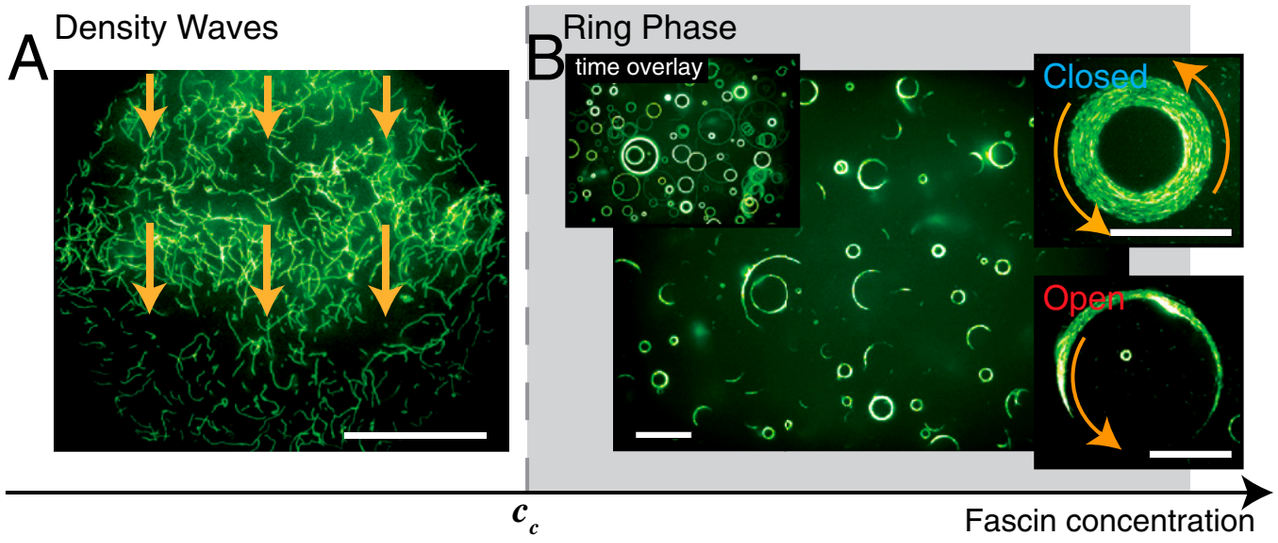
$$\chi = \langle \vec{v}_t . \vec{v}_{(t+dt)} \rangle / ||.||$$



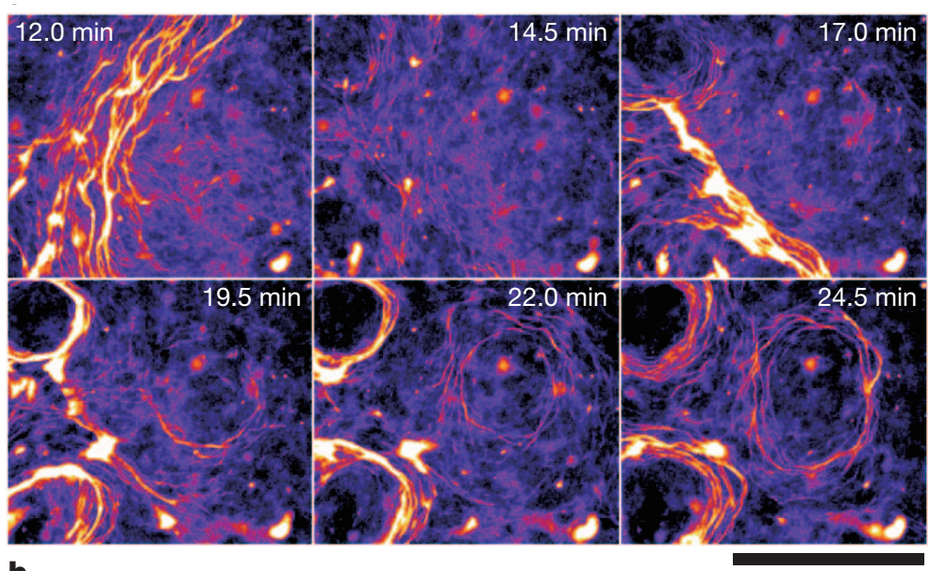
‘Frozen’ / absorbing Steady States !

‘Frozen’ Steady States

(In vitro)

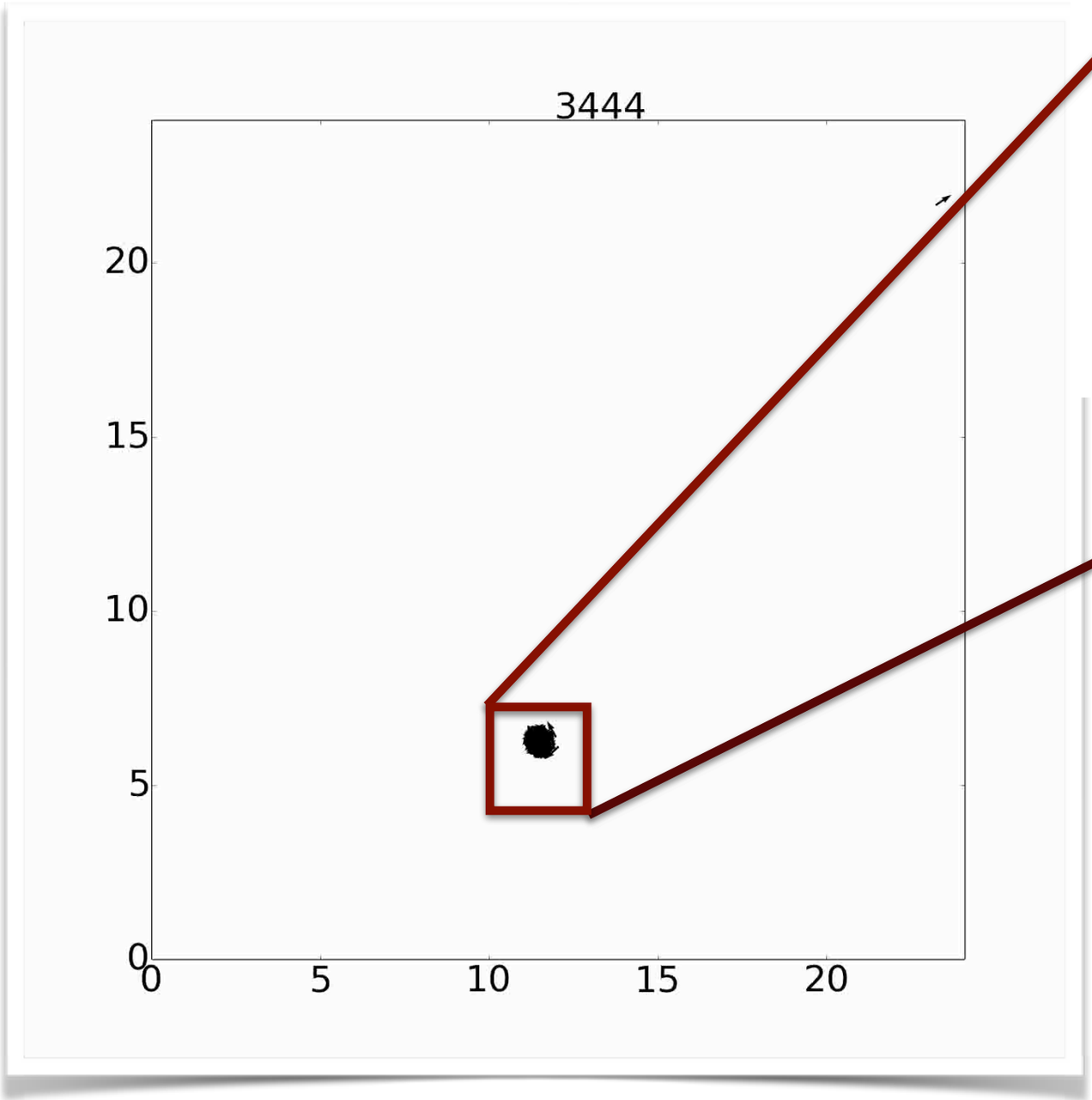


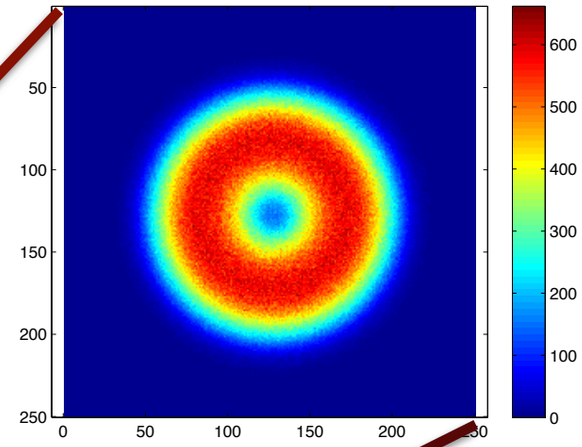
Motility Assay : Actin + motor-proteins+Fascin (passive crosslinker)



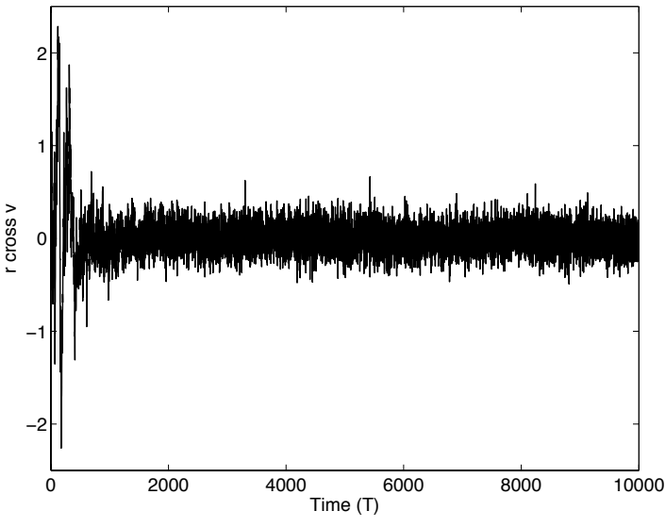
Microtubules + dynein

‘Frozen’ Steady States



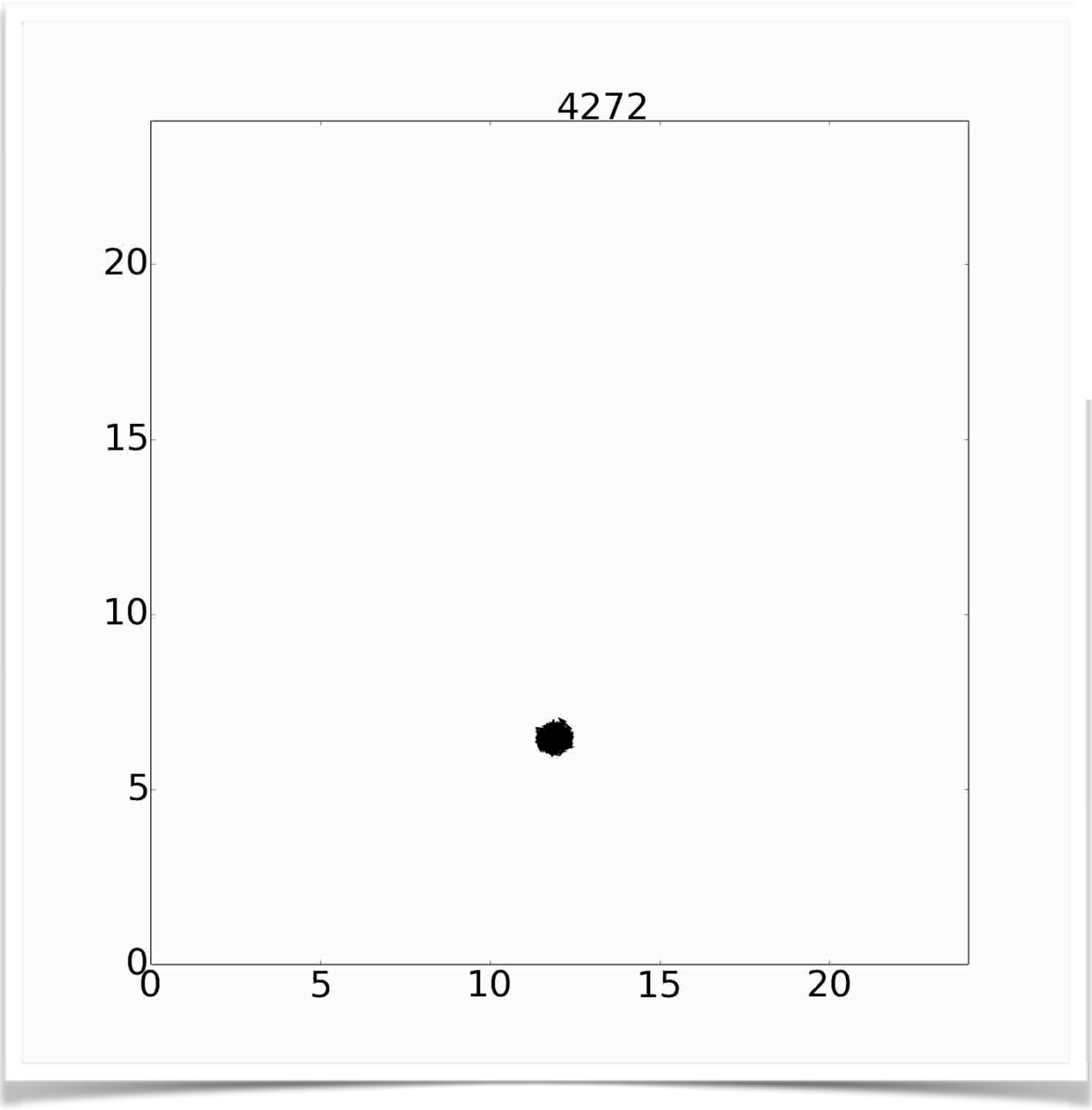


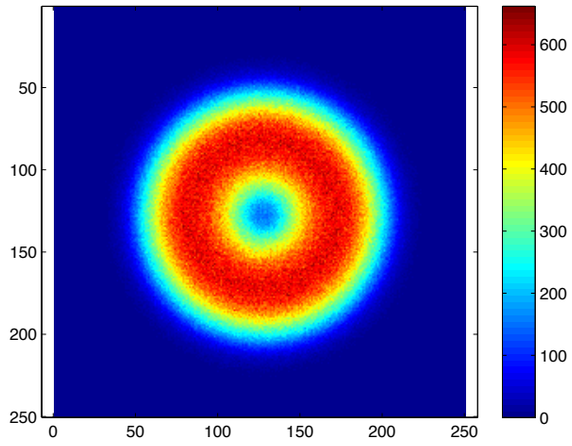
Time averaged distribution of agents within the drop



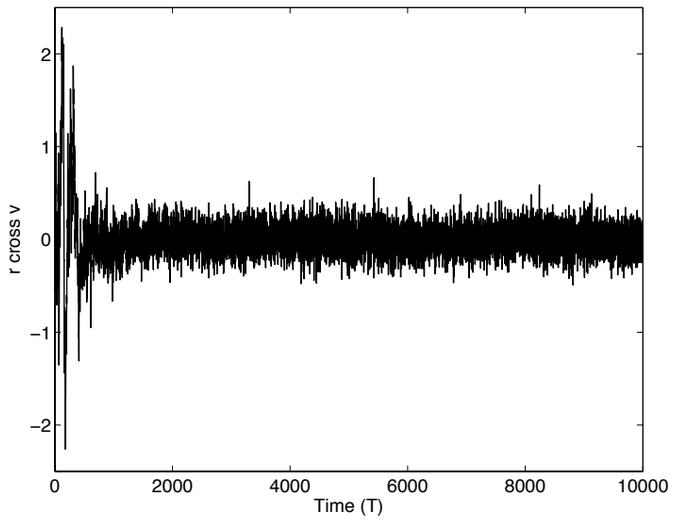
r x v within the drop vs. time

Stability Of Frozen Steady States With Noise

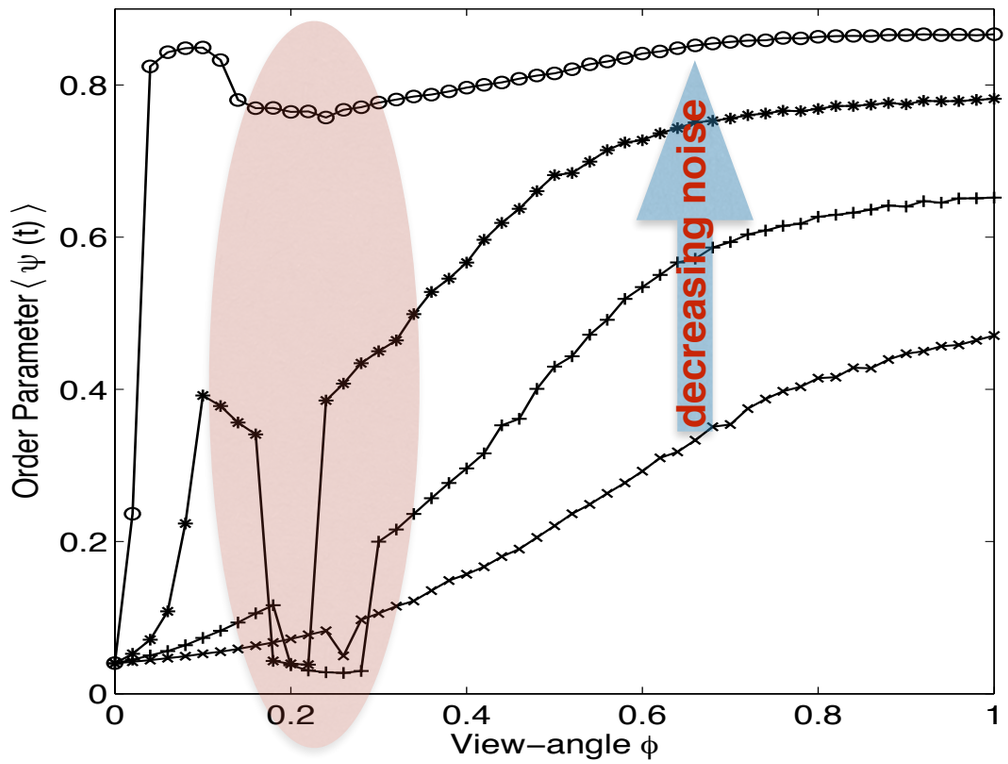




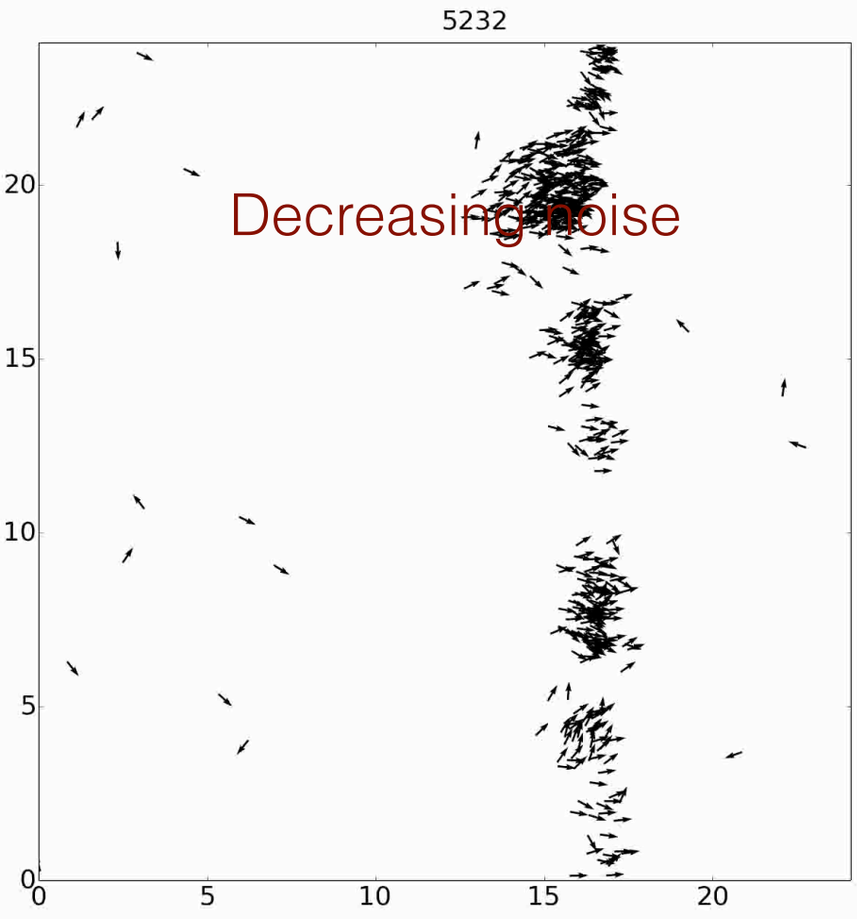
Time averaged distribution of agents within the drop

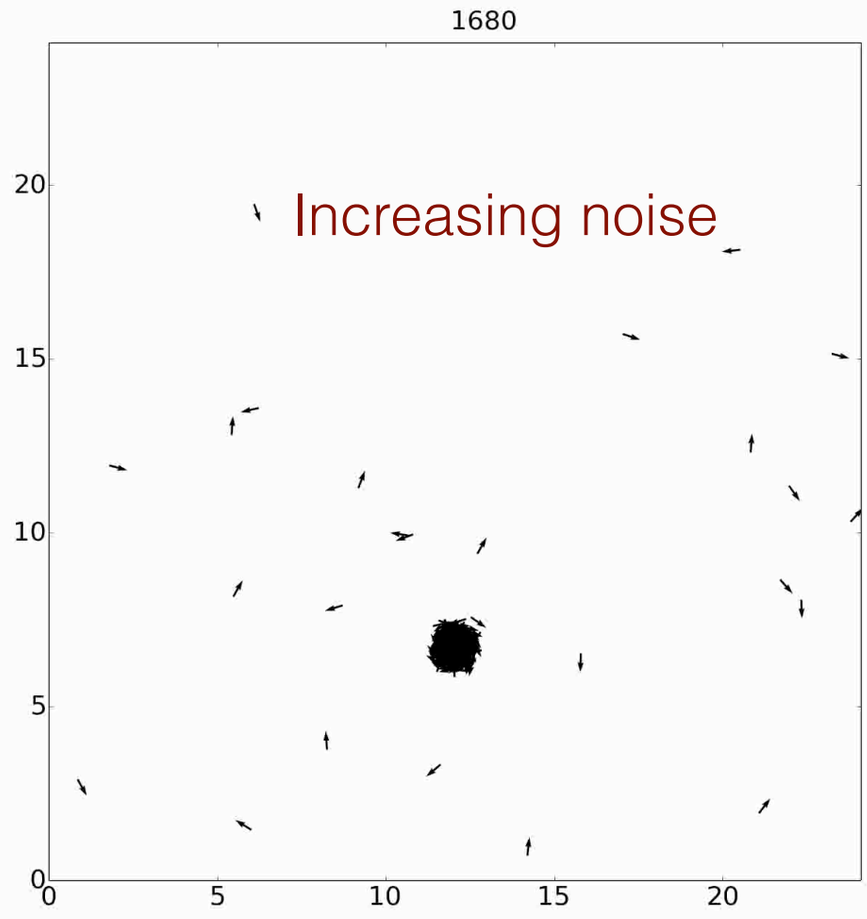


r x v within the drop vs. time

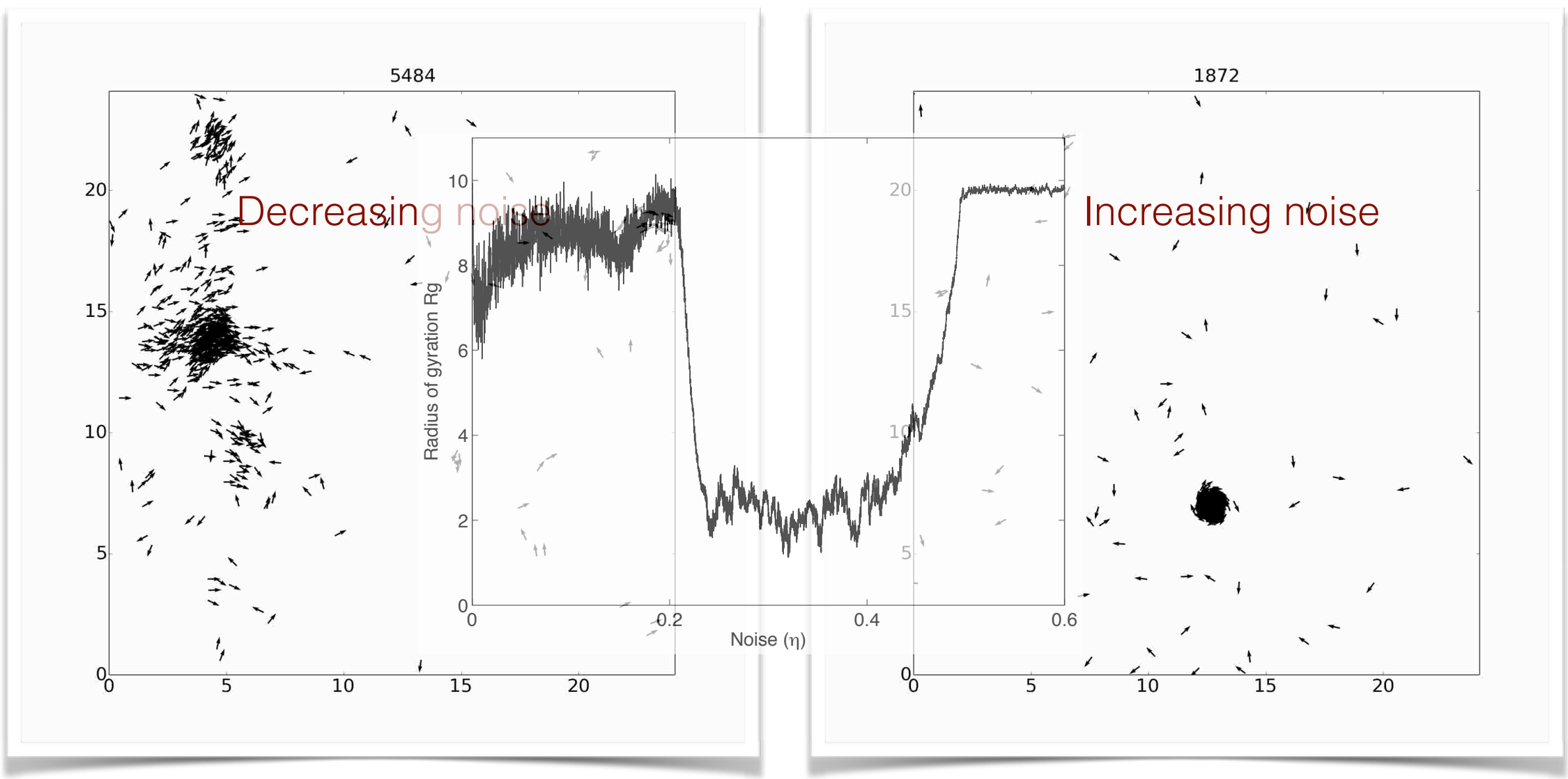


Stability Of Frozen Steady States With Noise





Stability Of Frozen Steady States With Noise



Summary

*** Vision-cone can control large-scale flocking pattern of trapped agents.**

*** Vision-cone together with communication delay can produce absorbing steady state in bulk of active model systems.**

Questions

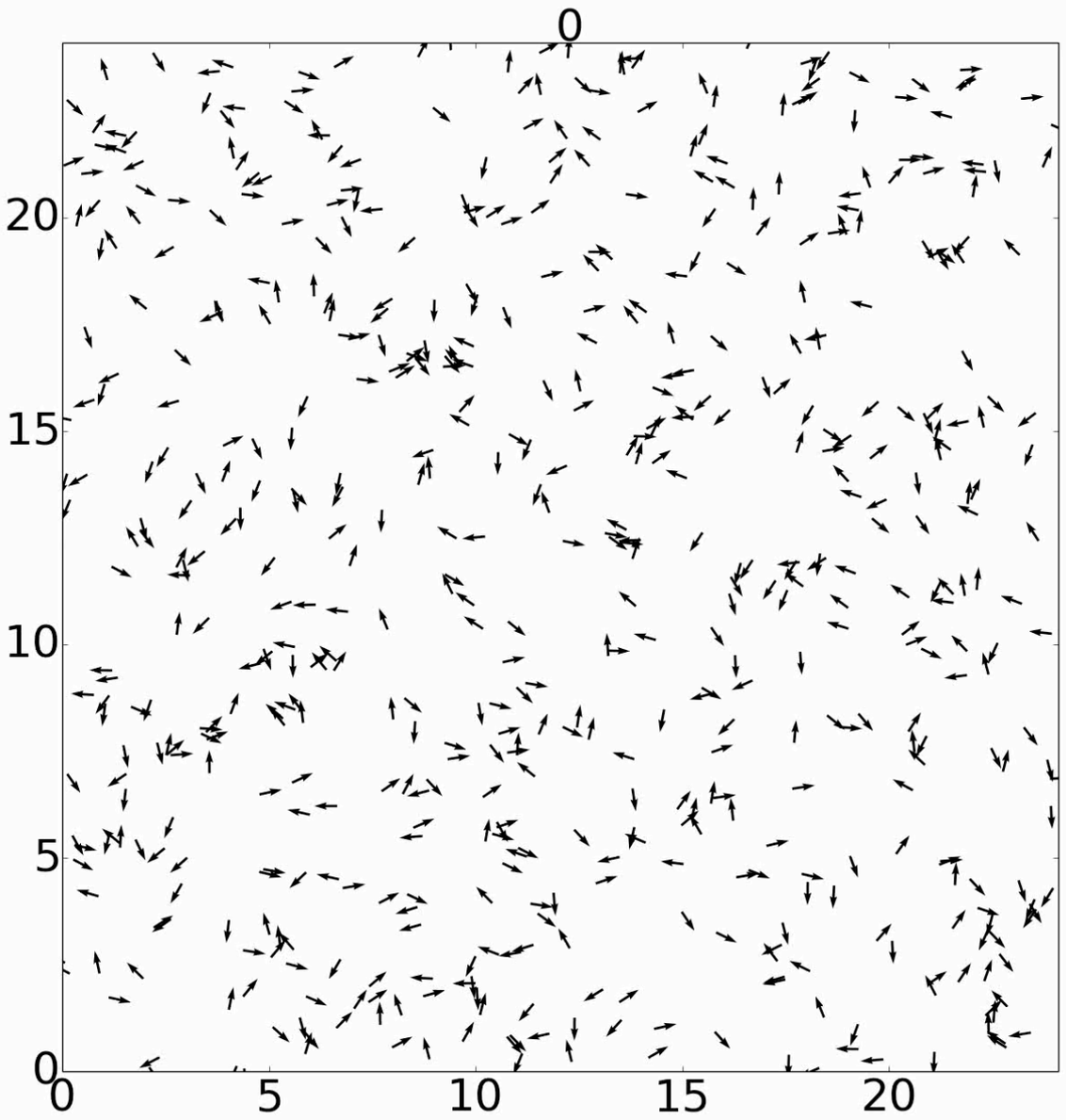
*** Curvature of the boundary & vision cone : effect on large scale pattern of flock ?**

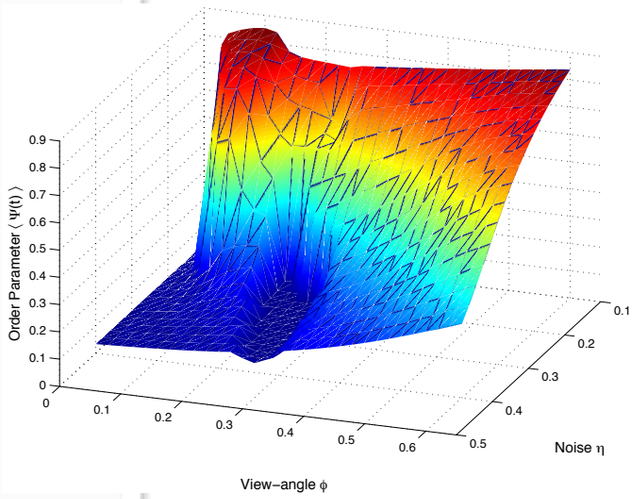
*** Onset of absorbing state in active model system : Role of vision cone & delay ?**

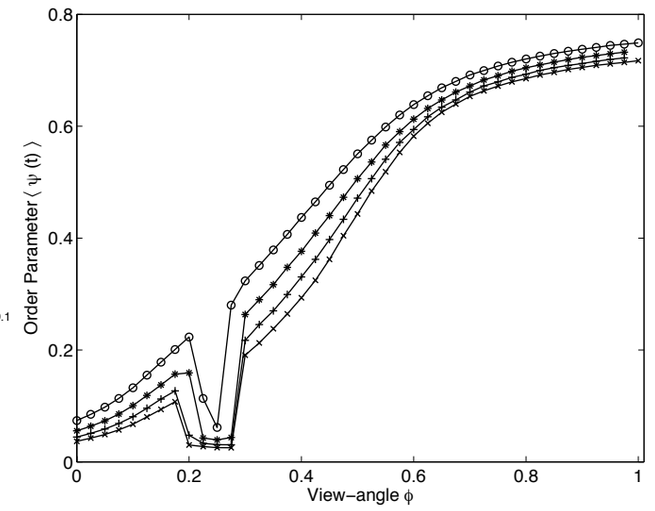
- **Vision-cone - Reduction of spatial correlation**
- **Delay - Introduction of temporal correlation / memory**

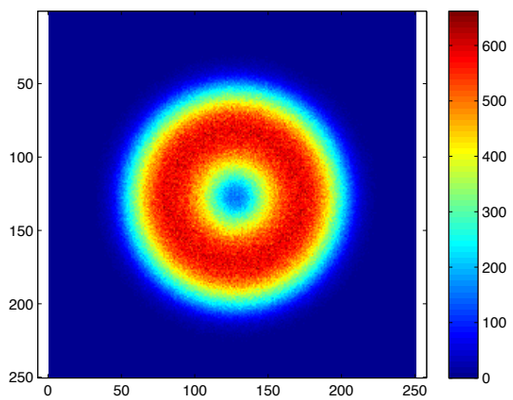
} Necessary & sufficient to form absorbing states in active systems ?

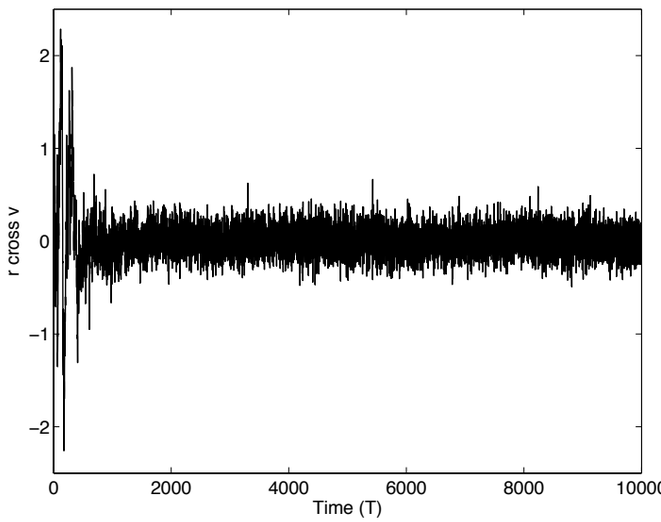
‘Frozen’ Steady States
(in bulk)



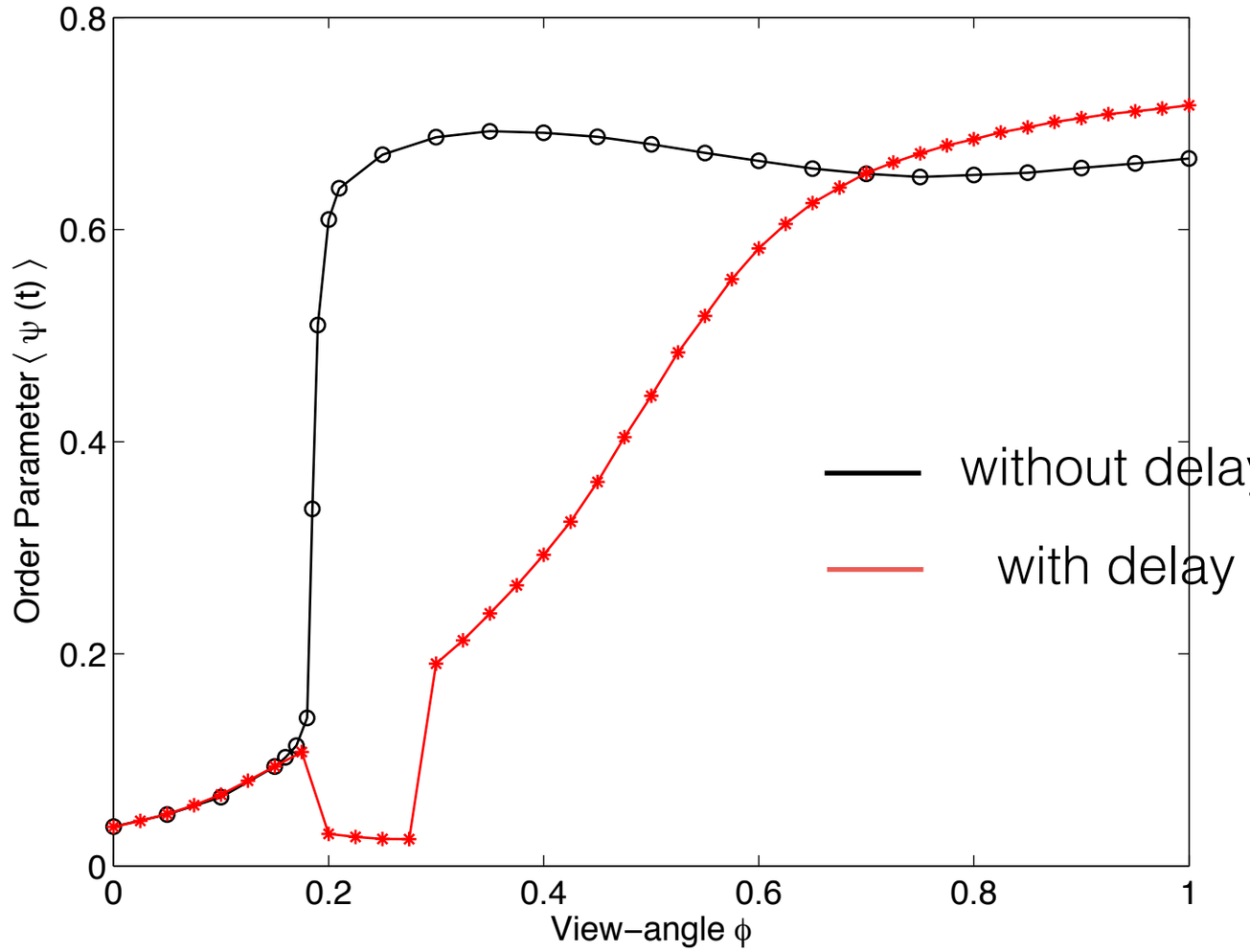




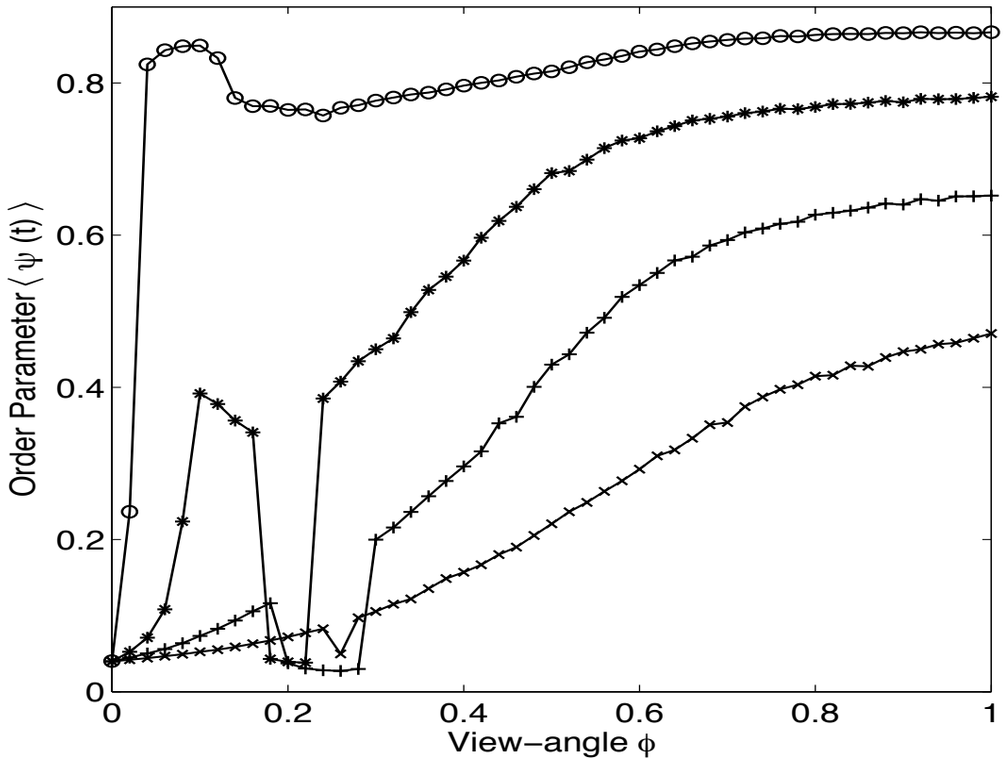


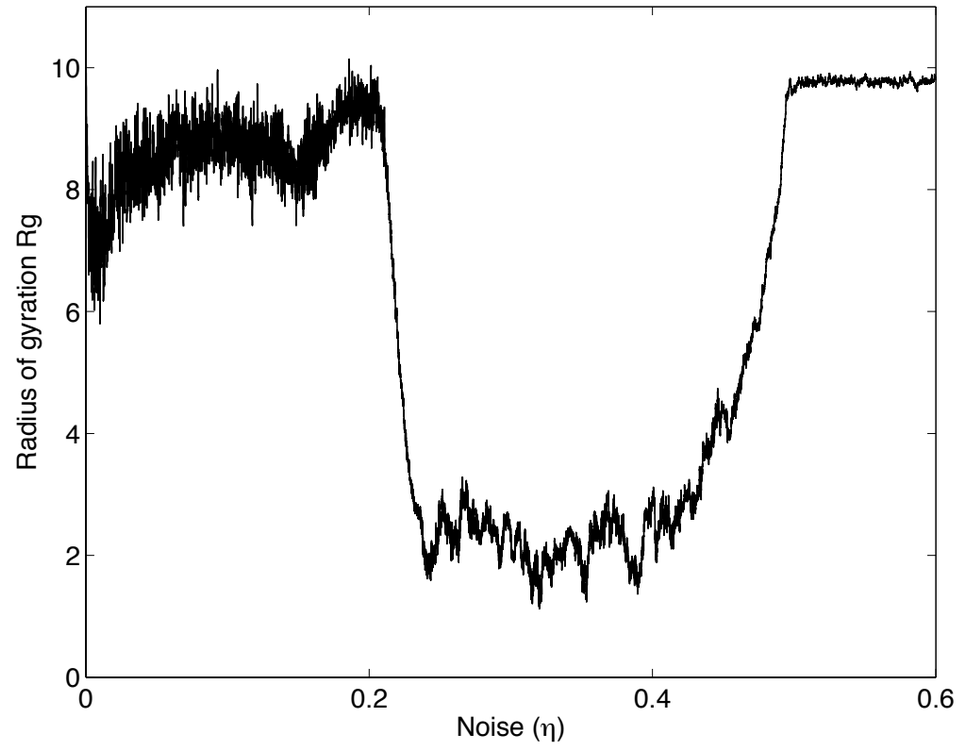


‘Frozen’ Steady States (in bulk)



Stability Of Frozen Steady States With Noise





Dynamics Within The Drop

<v(t).v(t)>/|| . || Vs. view angle

New figures : 1. new order parameter With view angle
2. 3D without grid
3. Corrected Rg Vs. noise

Discussion in the paper :

1. Dynamics within the drop : how it sustains (emergence ?)