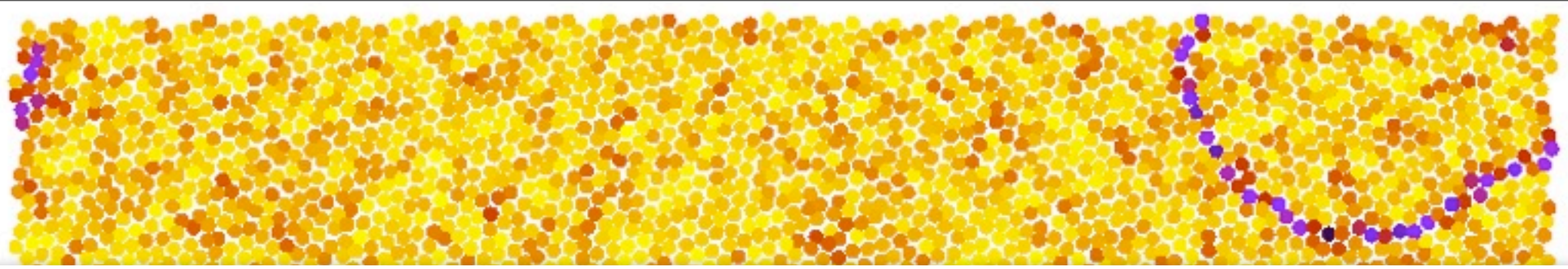

Defect-Mediated Phase Transitions in Active Soft Matter

PRL, 112, 168301 (2014)

Active Processes in Living and Nonliving Matter, KITP, UCSB

Christoph A. Weber*,
Christopher Bock** and Erwin Frey**

* MPIPKS Dresden, Germany
** LMU Munich, Germany

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spherical polar particles with ferromagnetic interactions; in 2d

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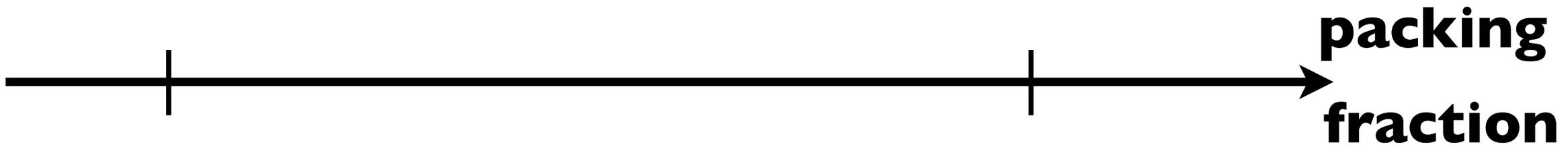

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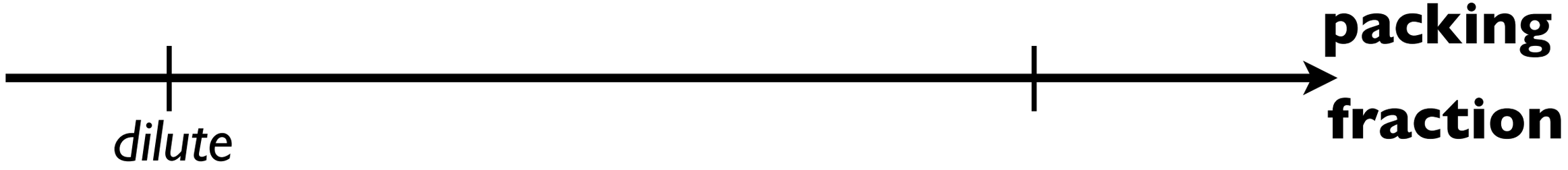

Gregoire et al.; Physica D, 157 (2003)
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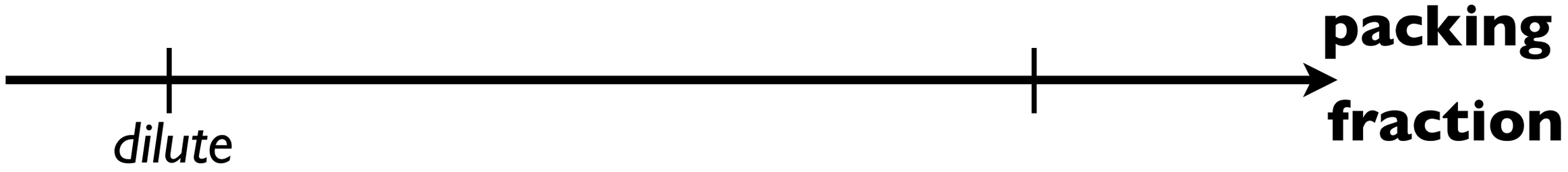

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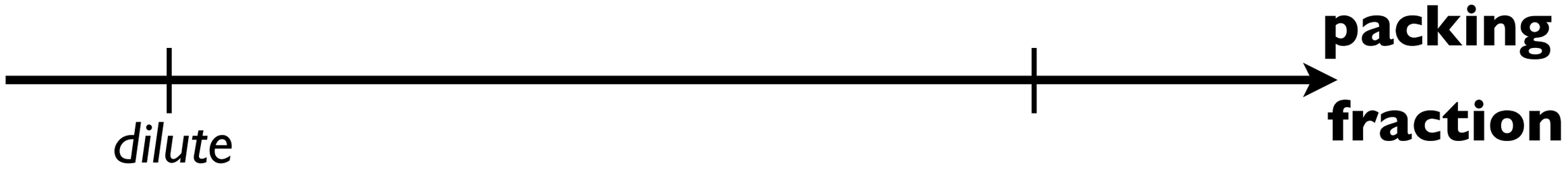
(density phase segregated pattern)



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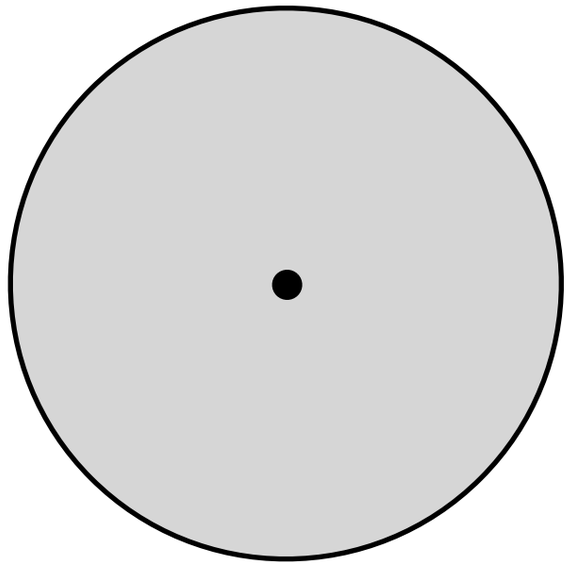

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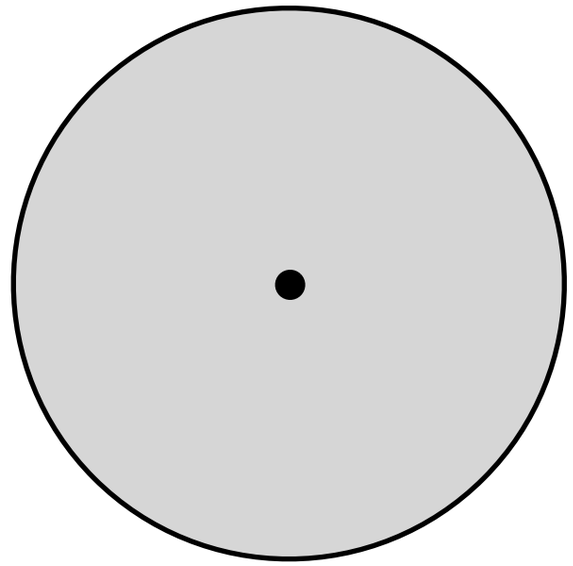

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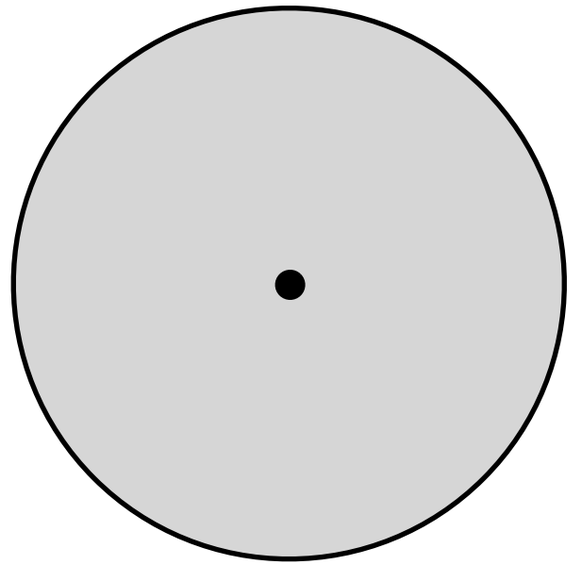

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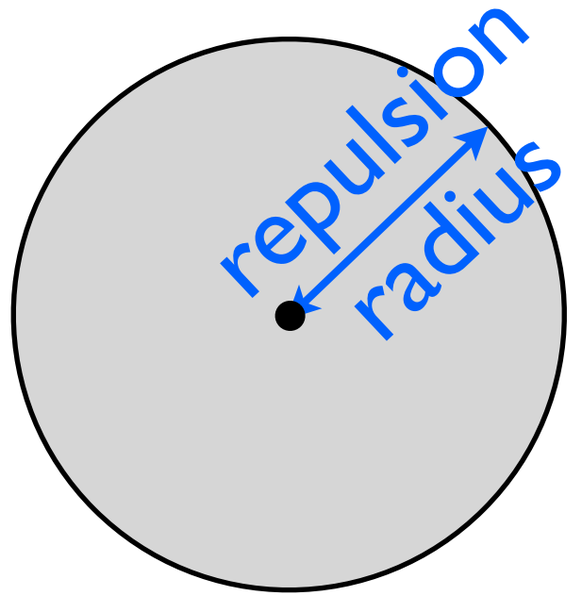

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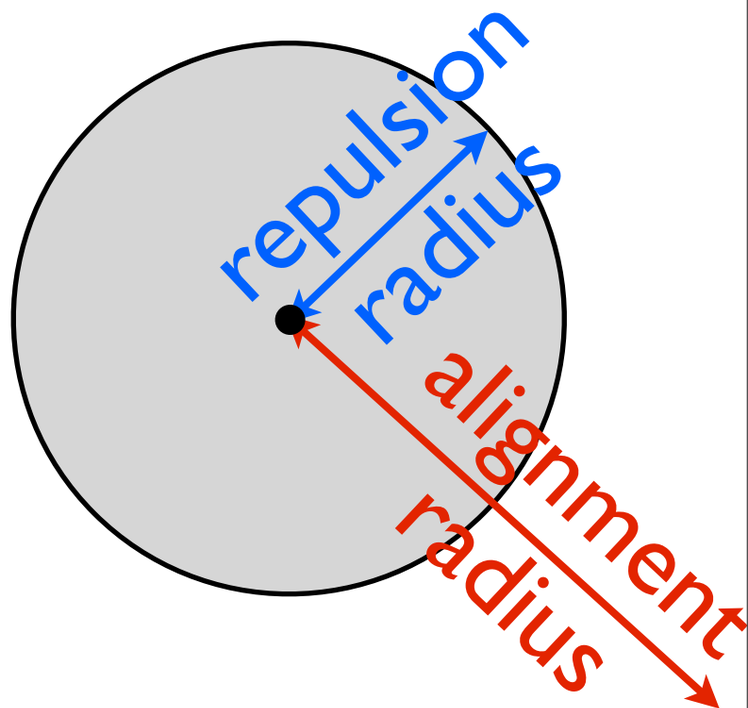

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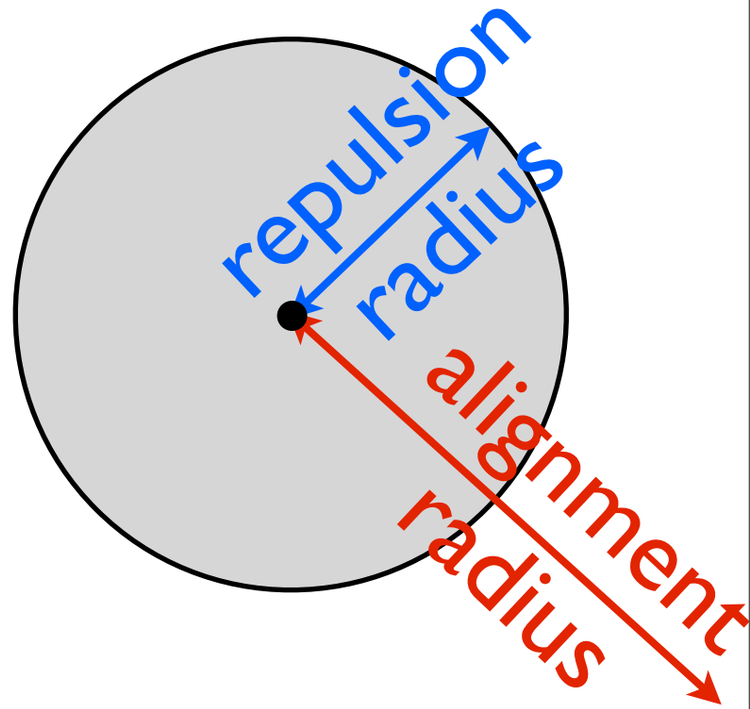

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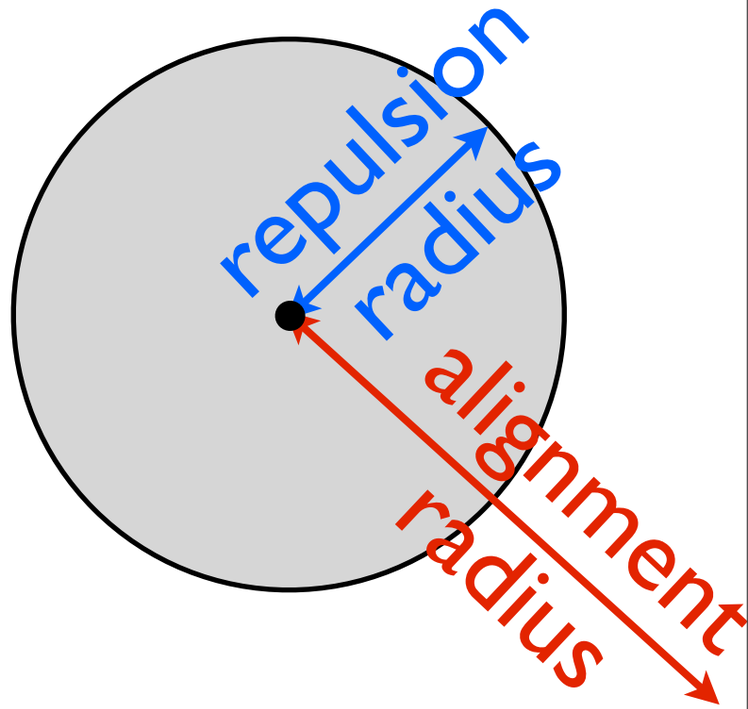

"Vicsek alignment"

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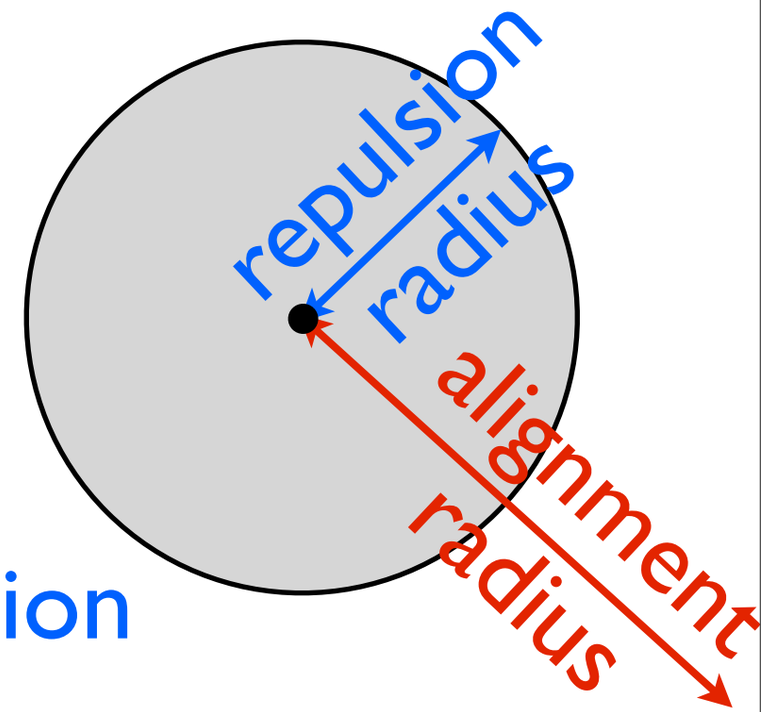

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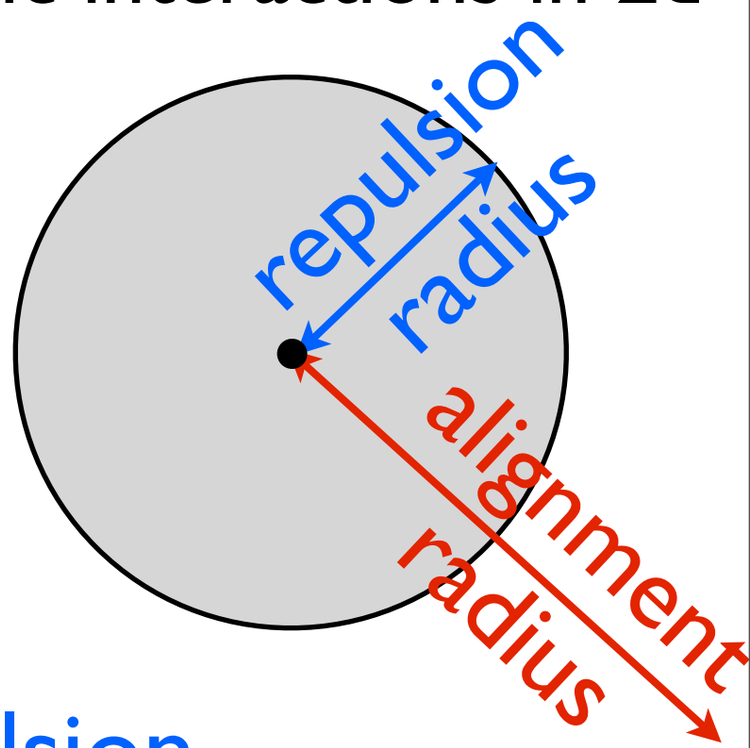
-> competition between alignment and repulsion



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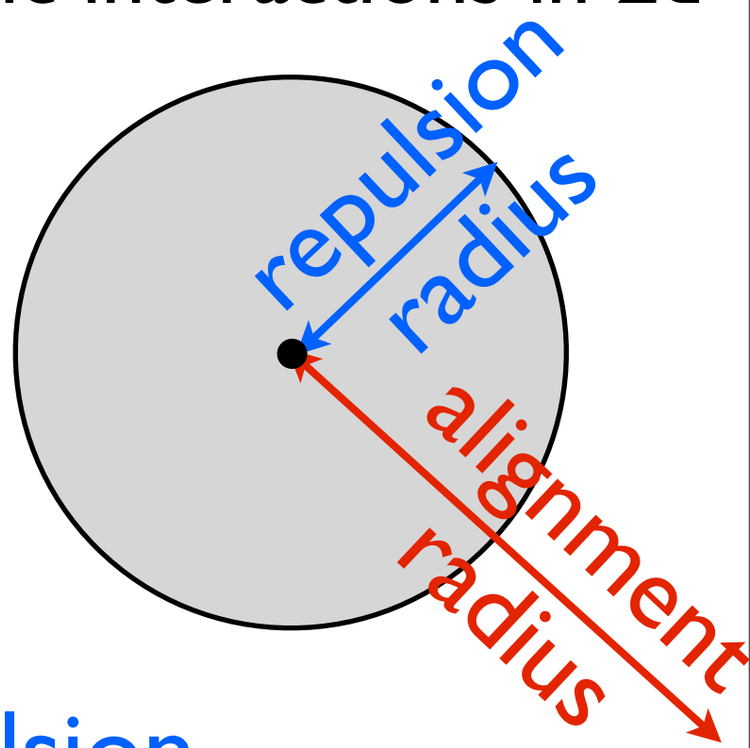

- small particle overlaps, quasi "soft core"

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P mean polarity

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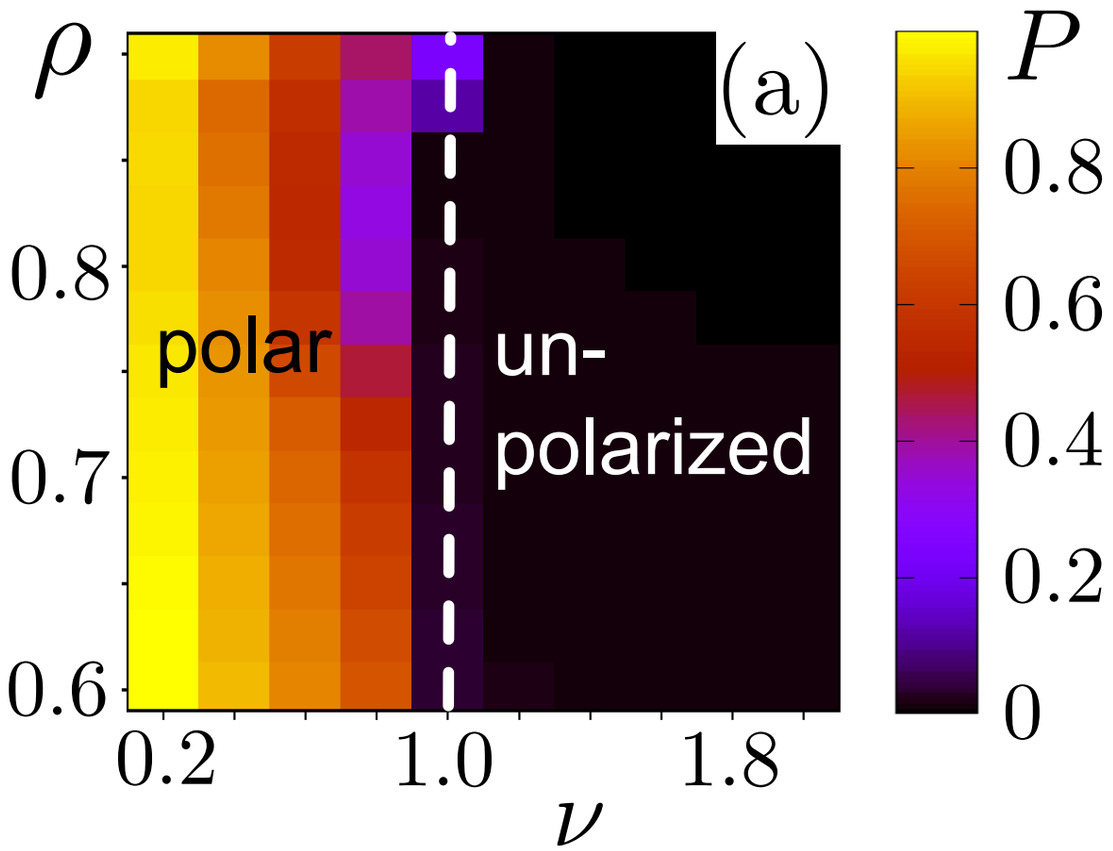

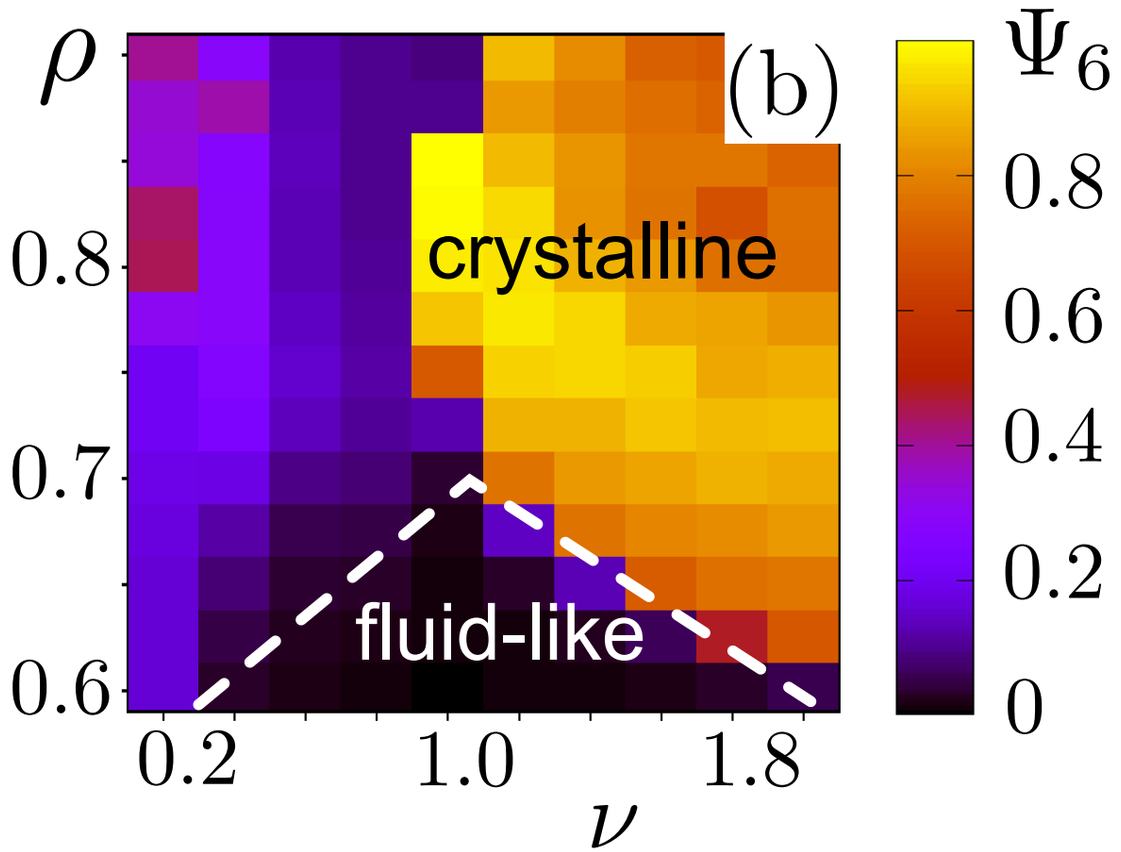

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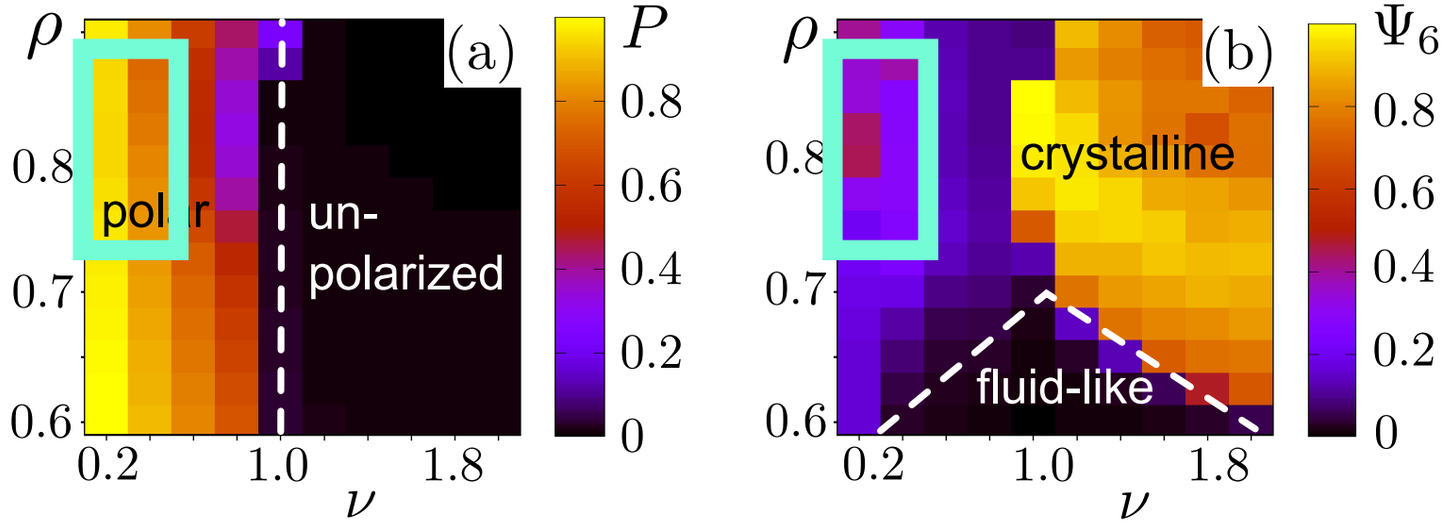
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(a)
P
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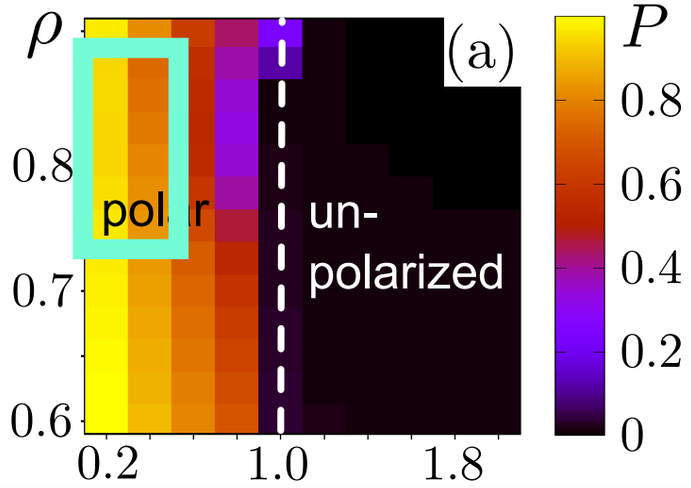
0.6
0.4
0.2
0
polar
un-
polarized
0.8
0.7
0.6
0.2
1.0
1.8
ν
ρ
(b)
Ψ6
crystalline
fluid-like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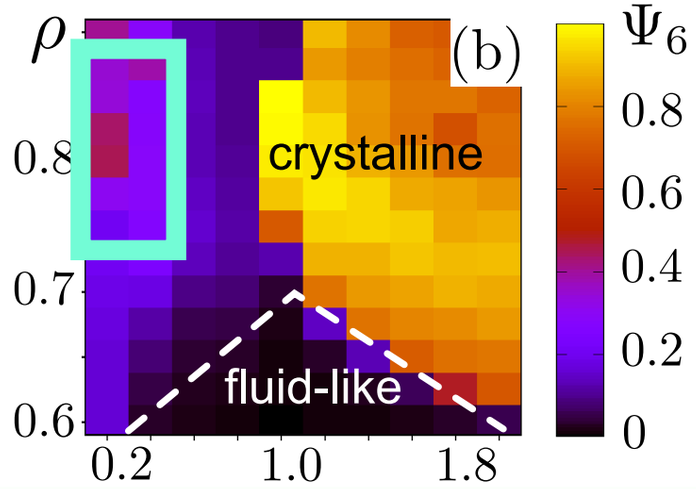
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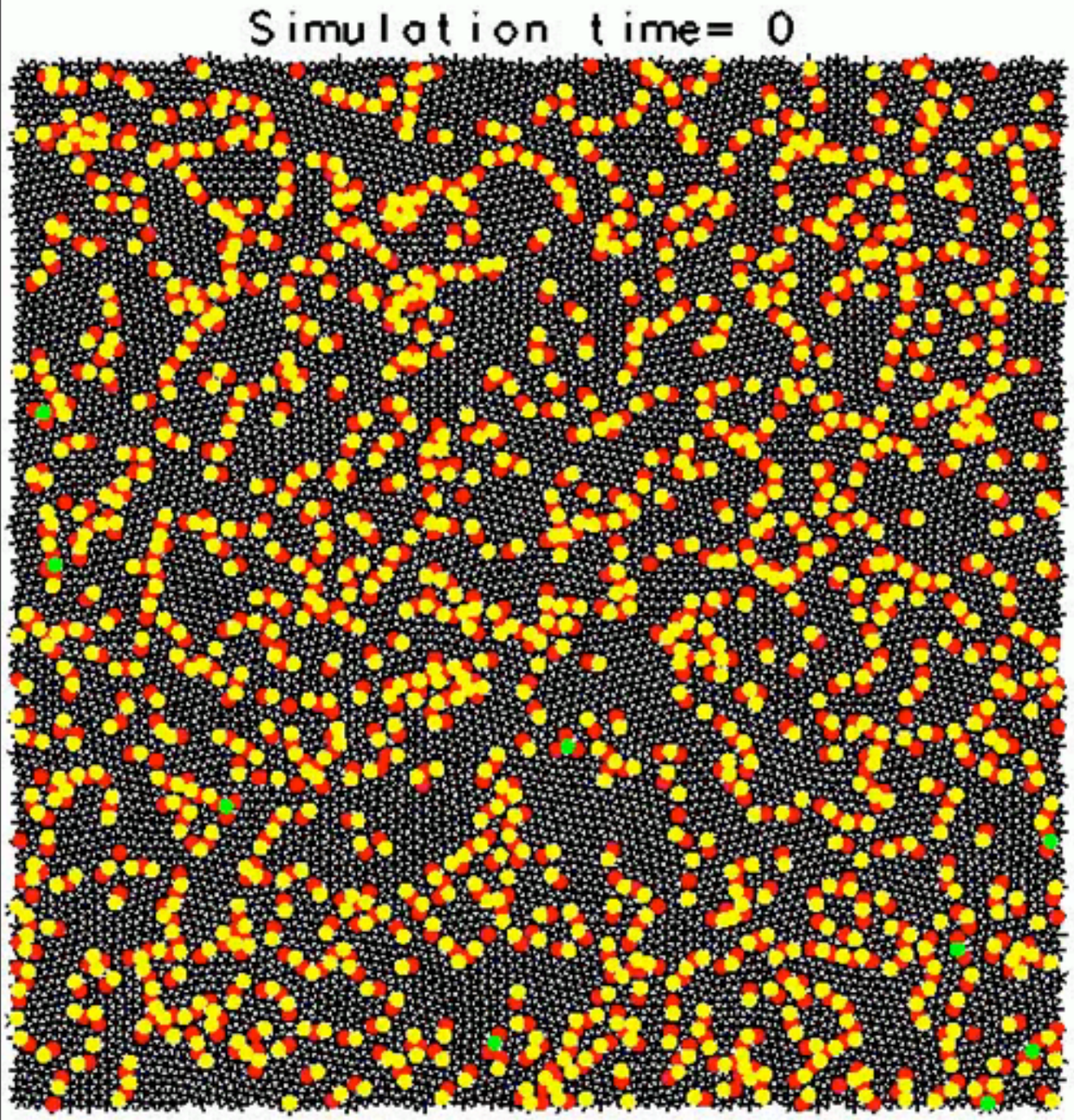
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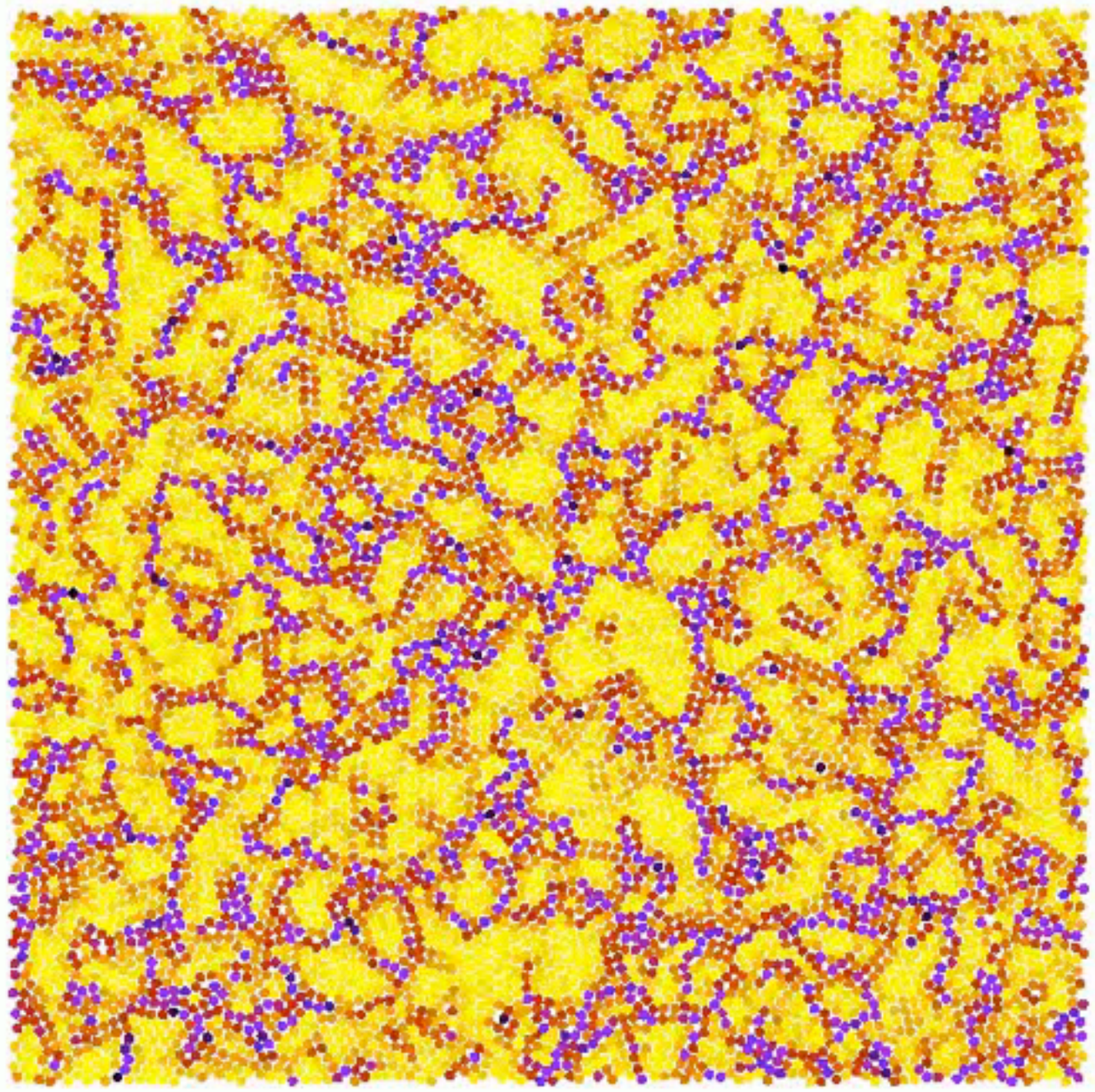
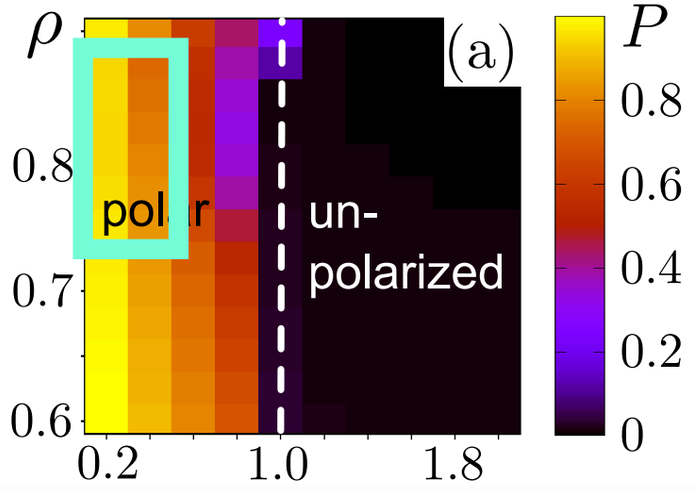
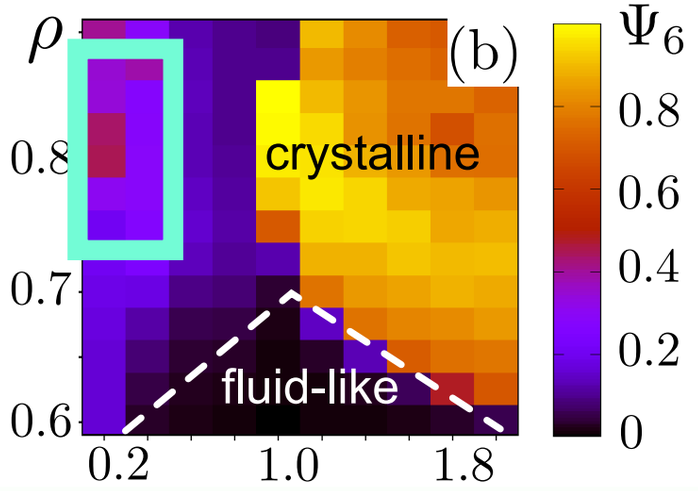
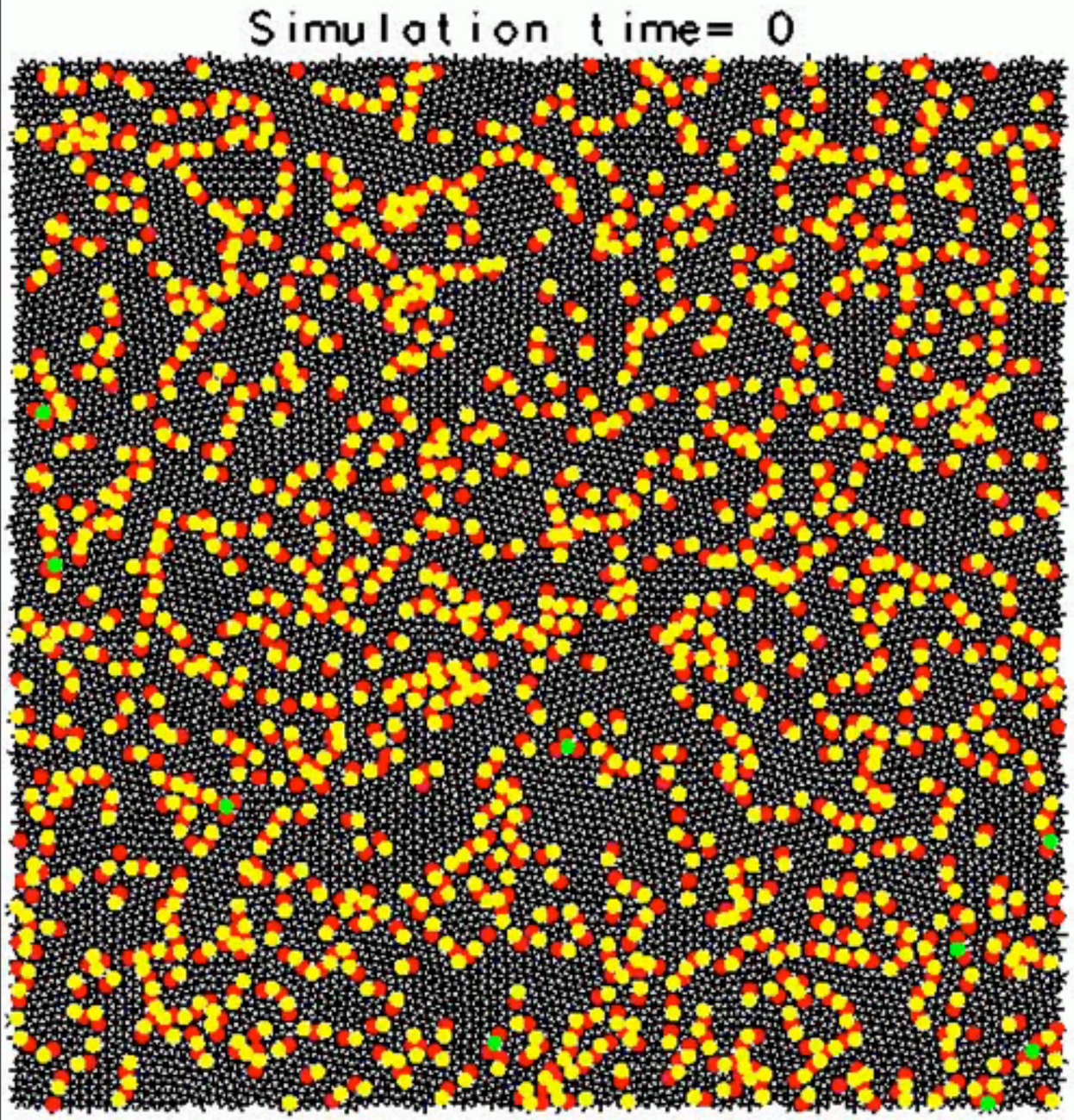
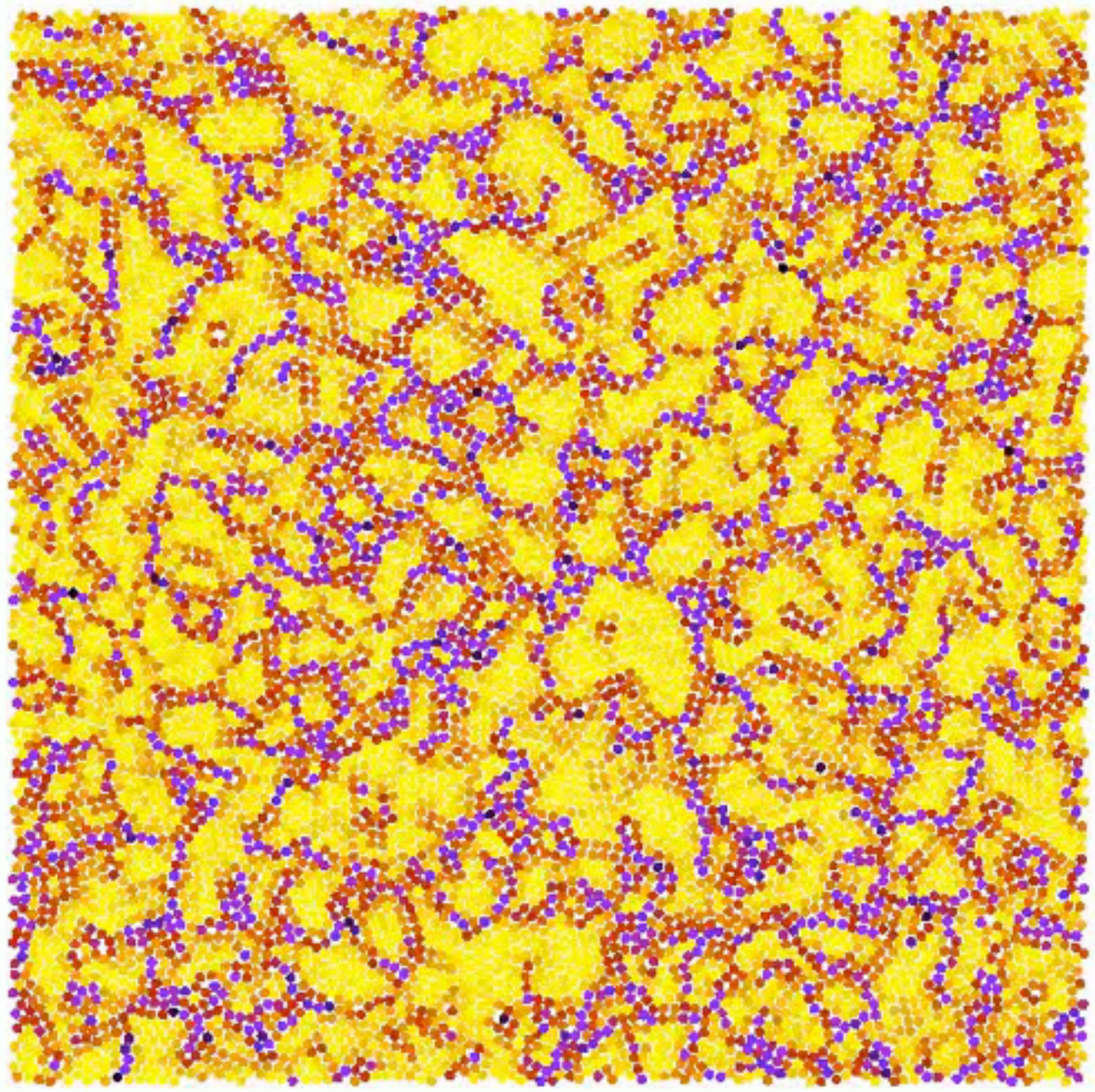


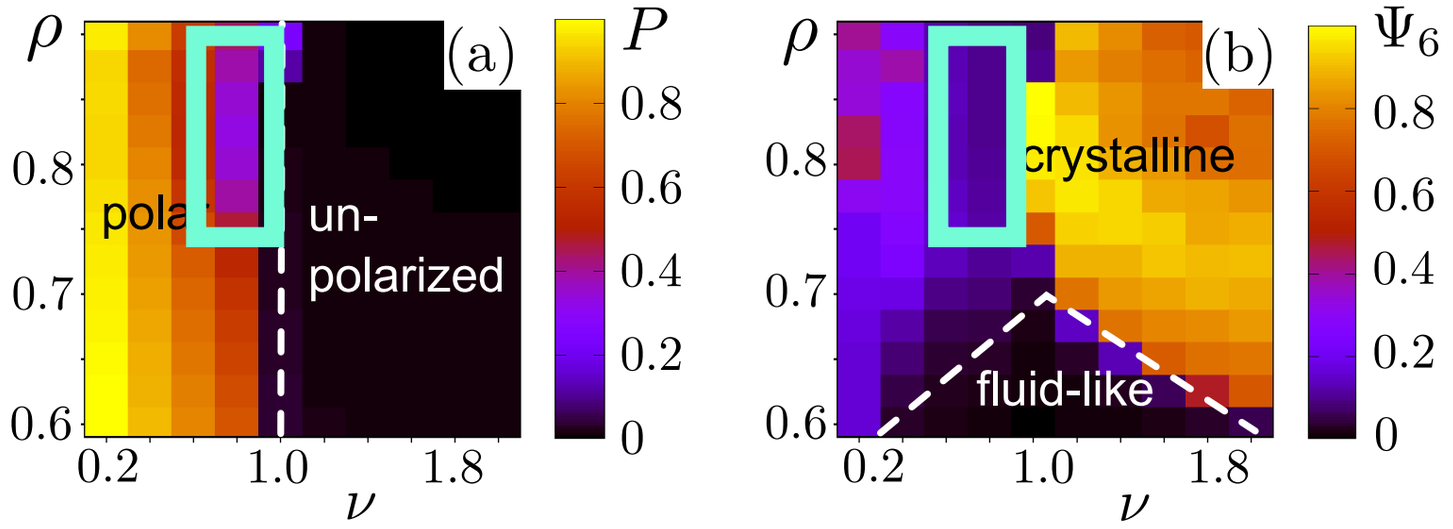








(weakly intermittent) polycrystal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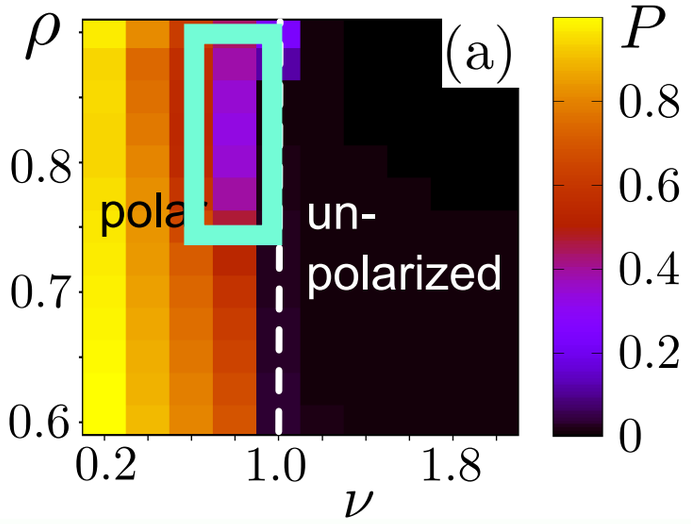
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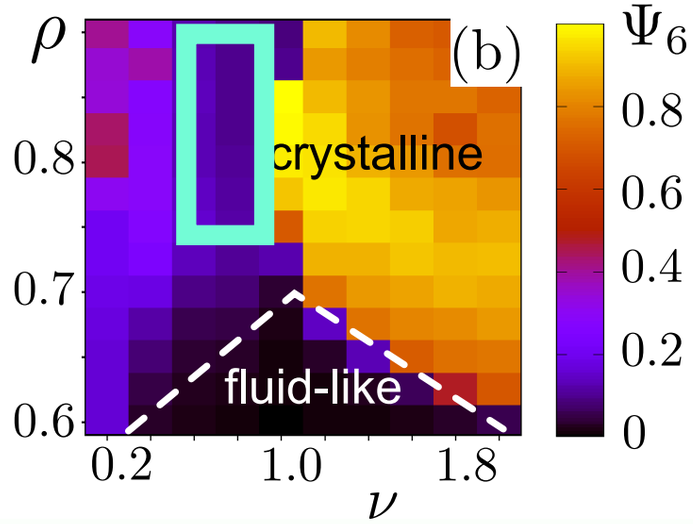
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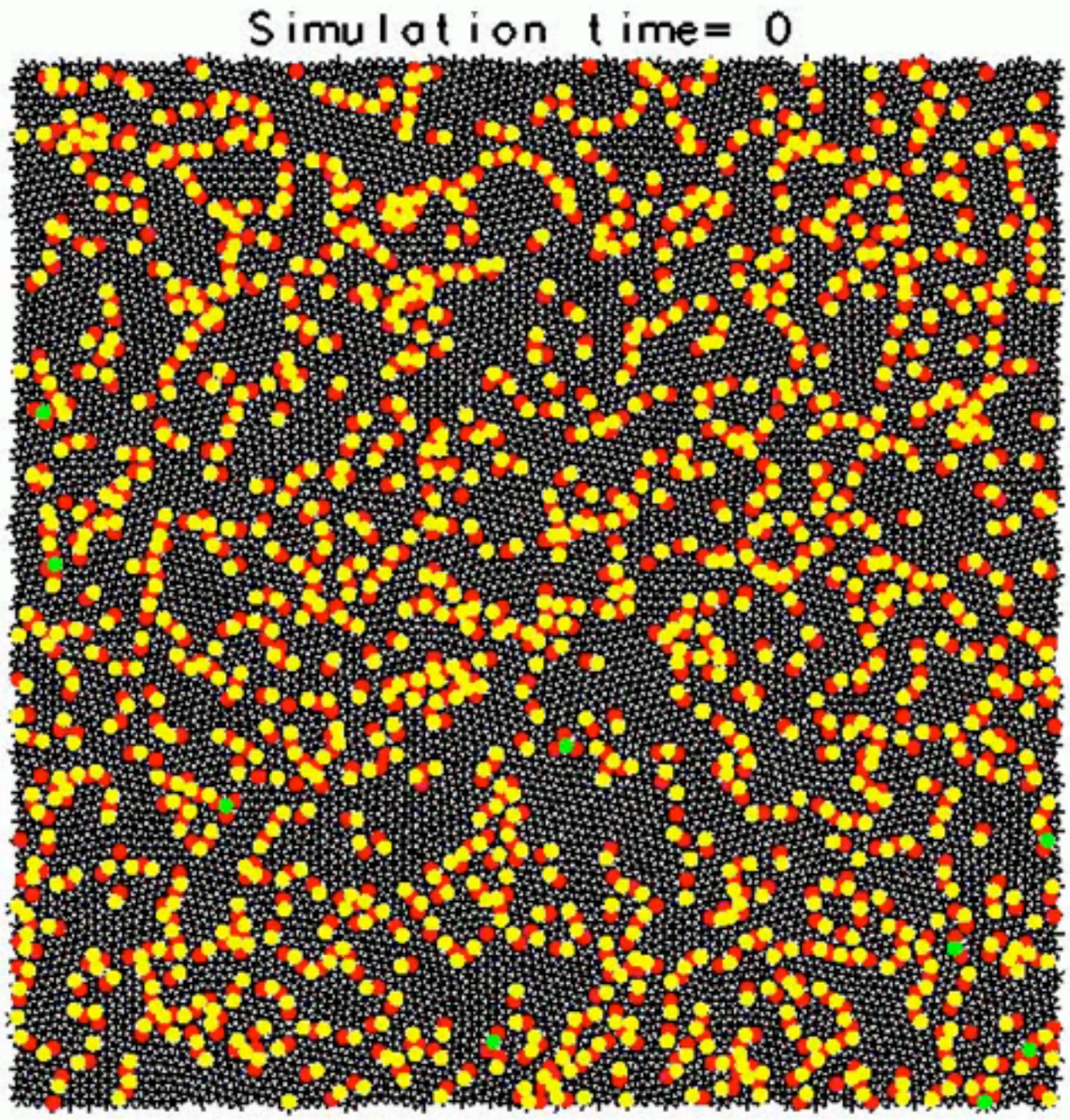
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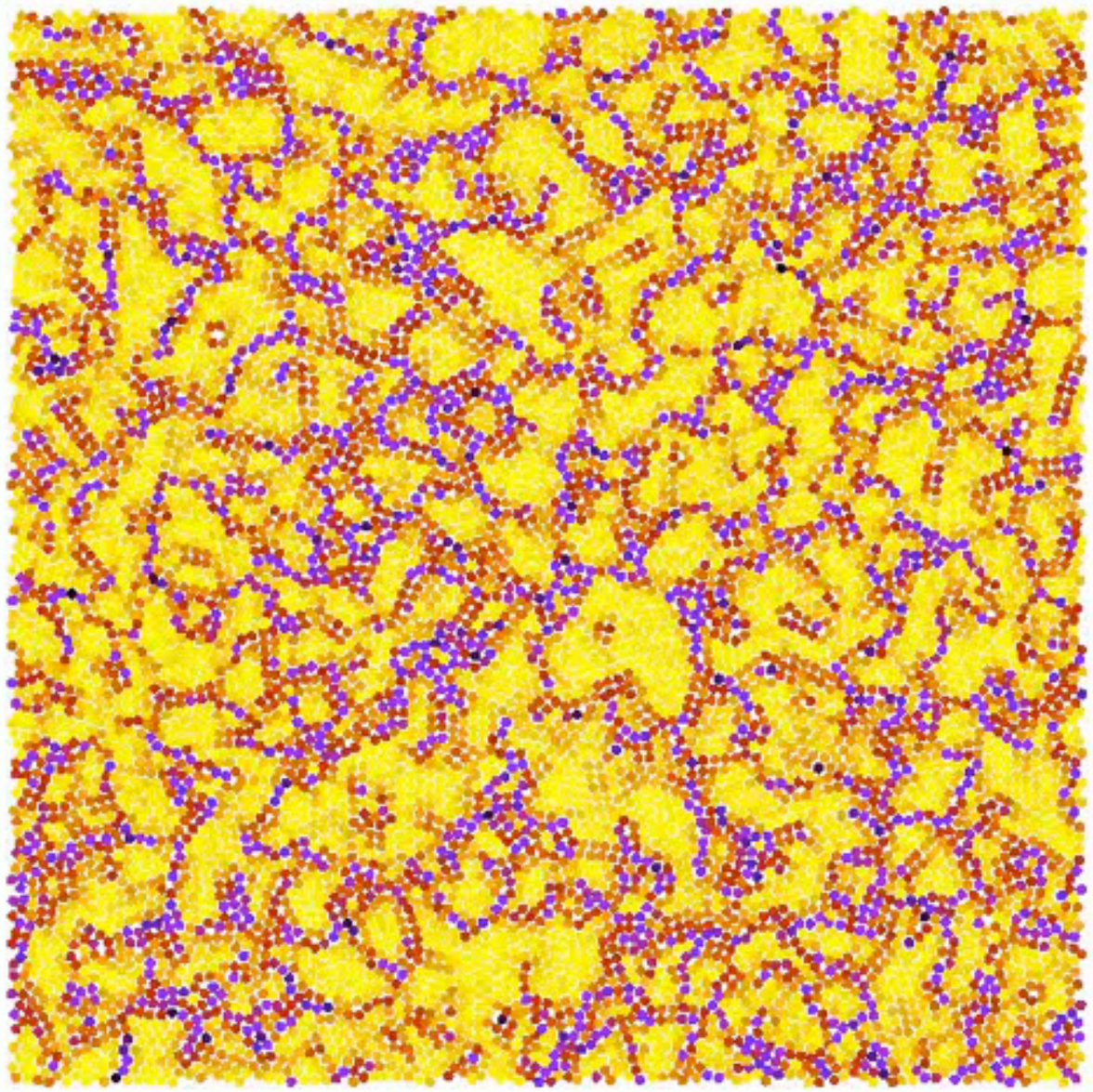
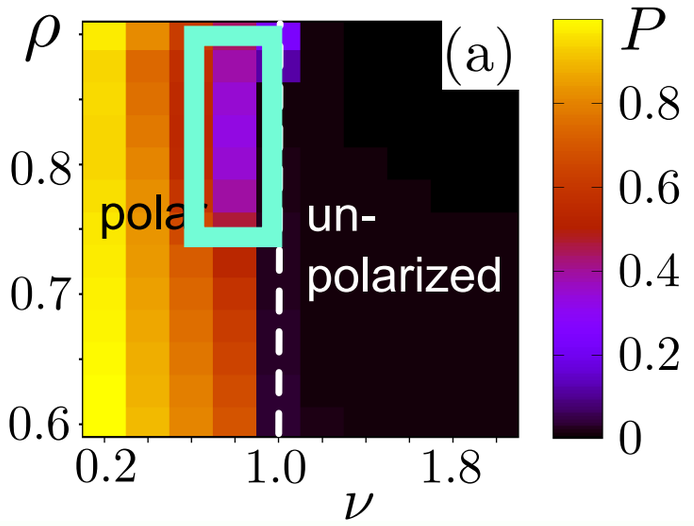
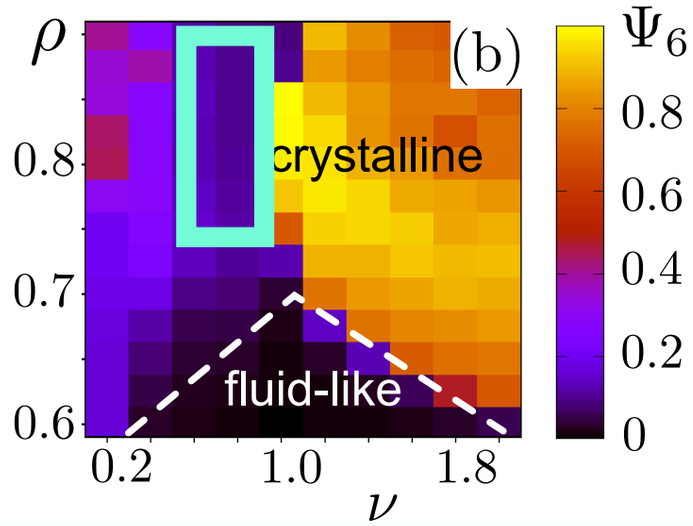
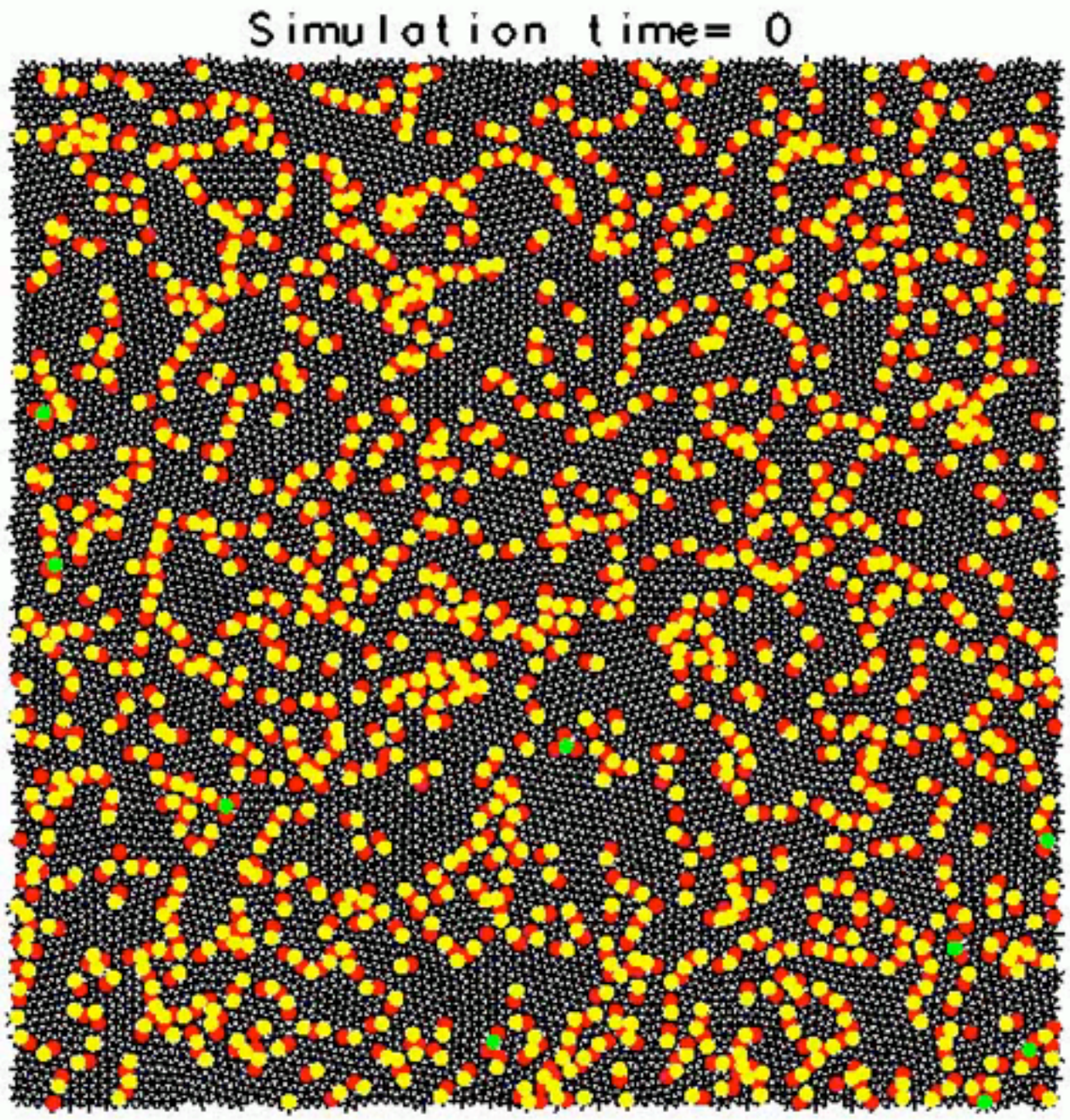
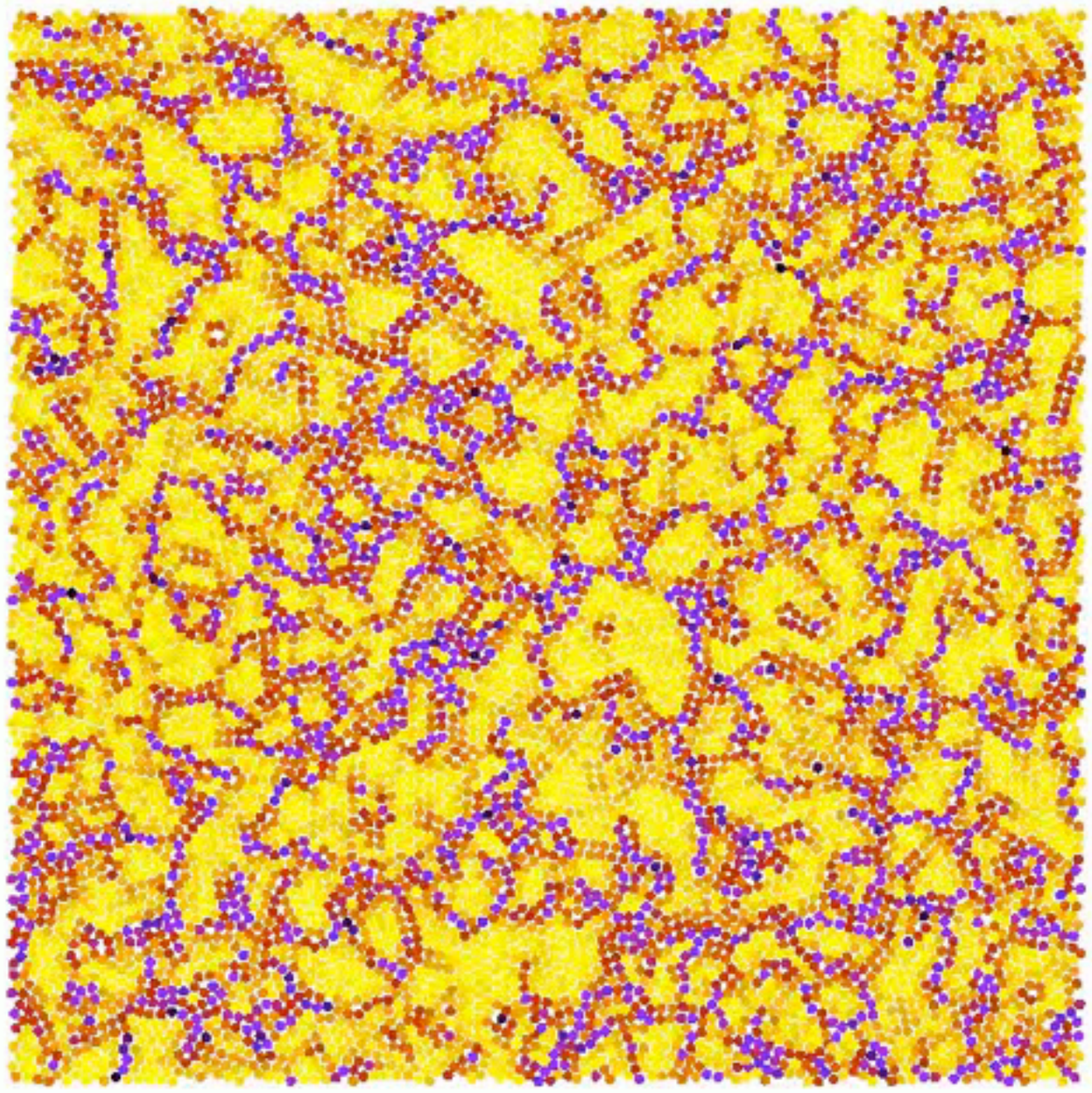


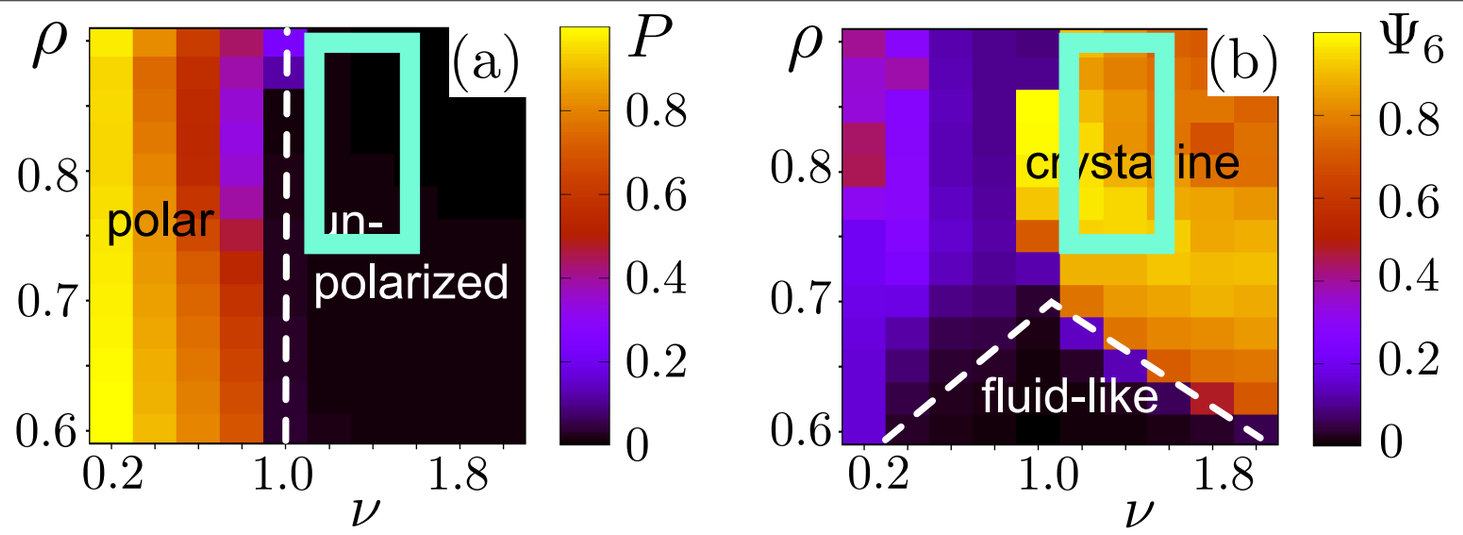








intermittent polycrystal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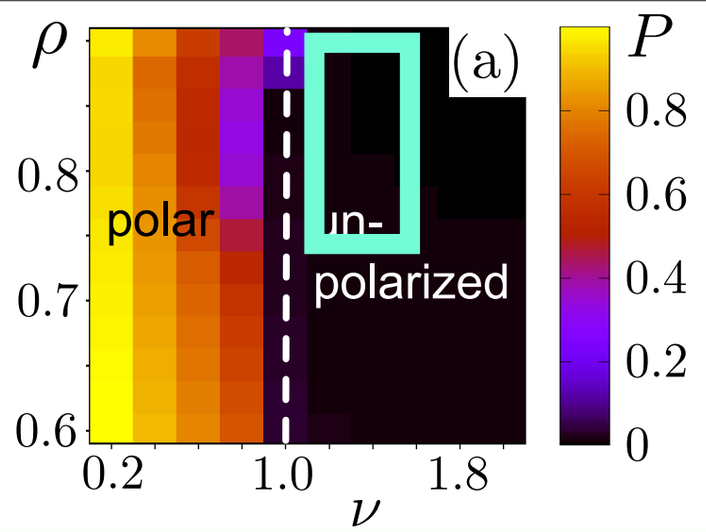
0.7
0.6
0.2
1.0
1.8
ν
(a)
polar
un-
polarized
P
0.8
0.6
0.4
0.2
0
(b)
cr ystal ine
fluid-like
Ψ6
0.8
0.6
0.4
0.2
0


ρ
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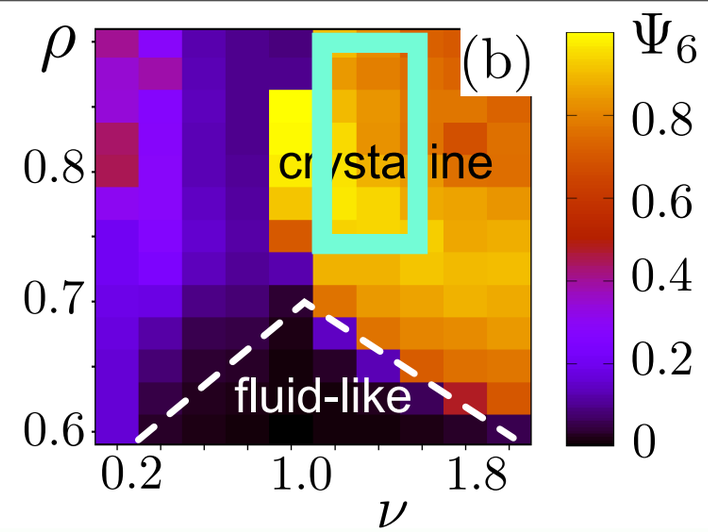
0.7
0.6
0.2
1.0
1.8
ν
(a)
polar
un-
polarized
P
0.8
0.6
0.4
0.2
0


ρ
0.8
0.7
0.6
0.2
1.0
1.8
ν
(b)
fluid-like
Ψ6
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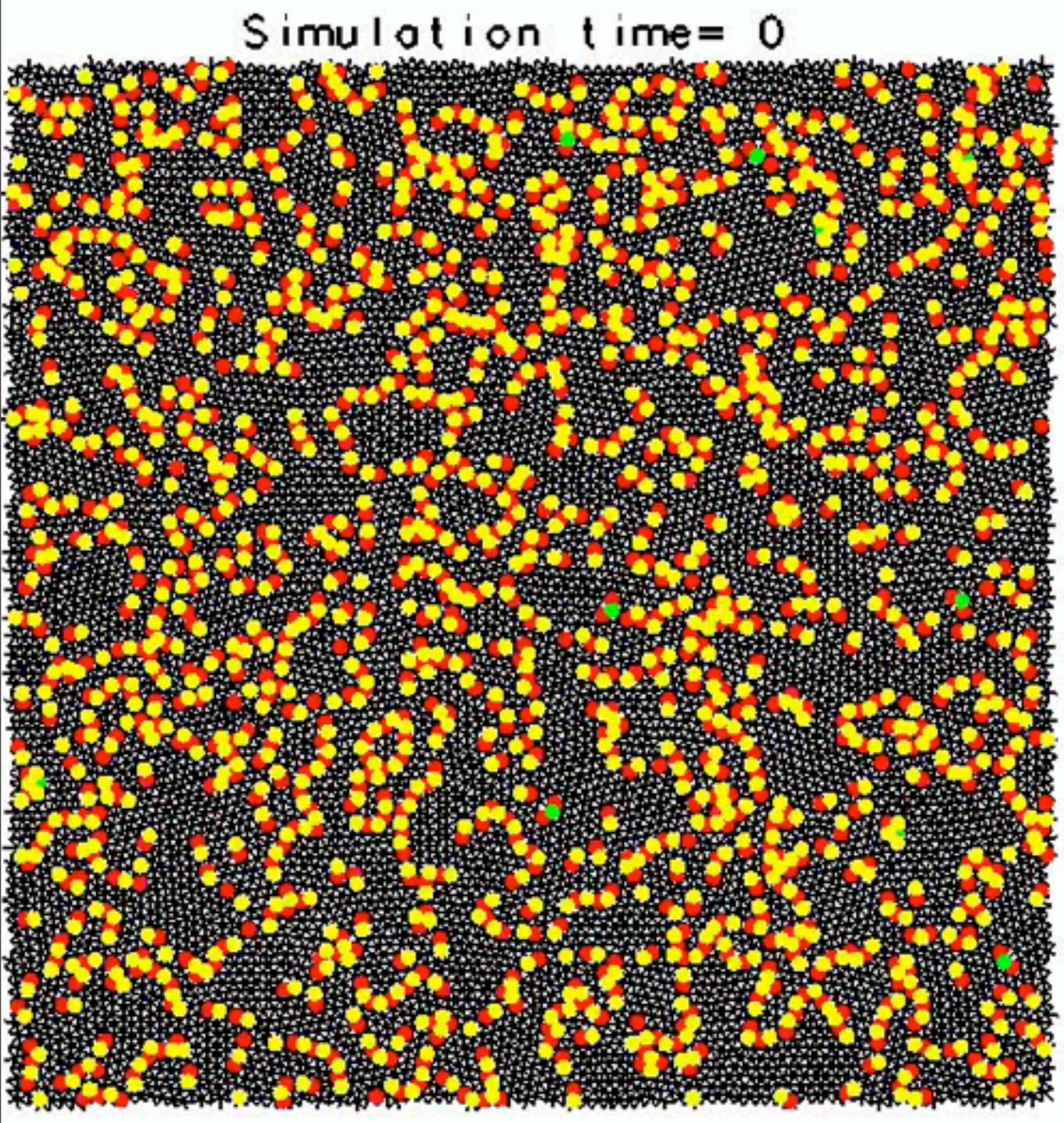
0.6
0.4
0.2
0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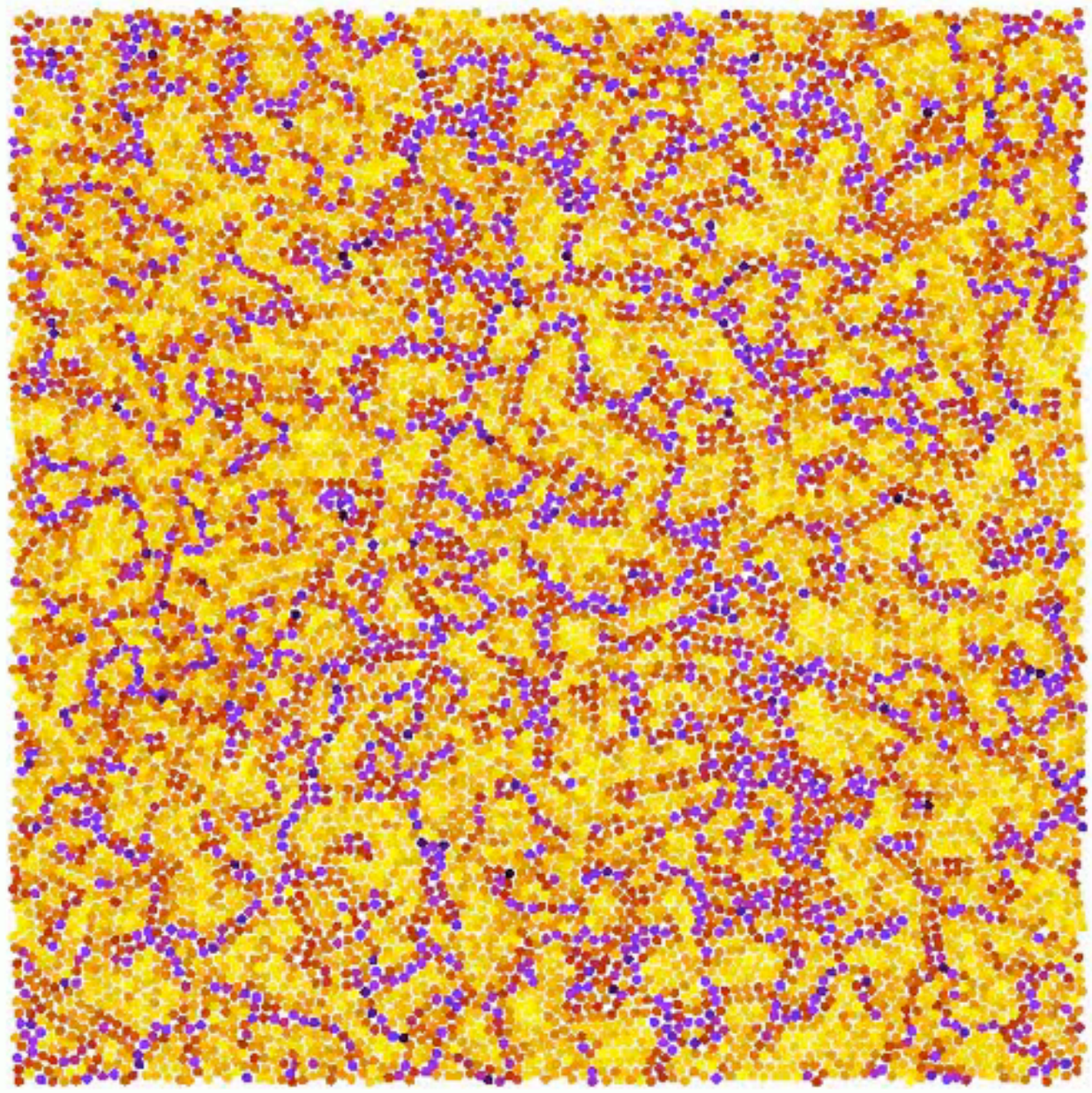
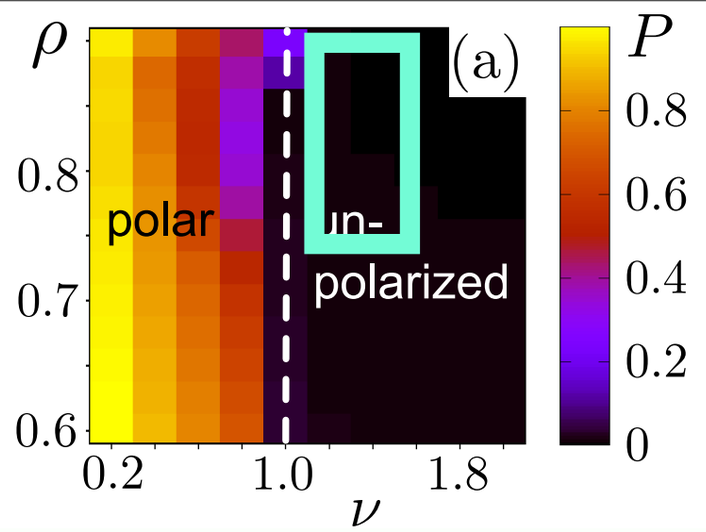
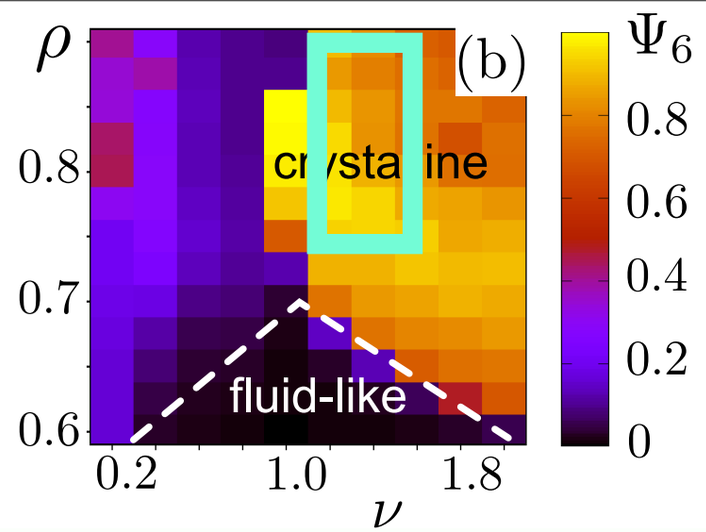
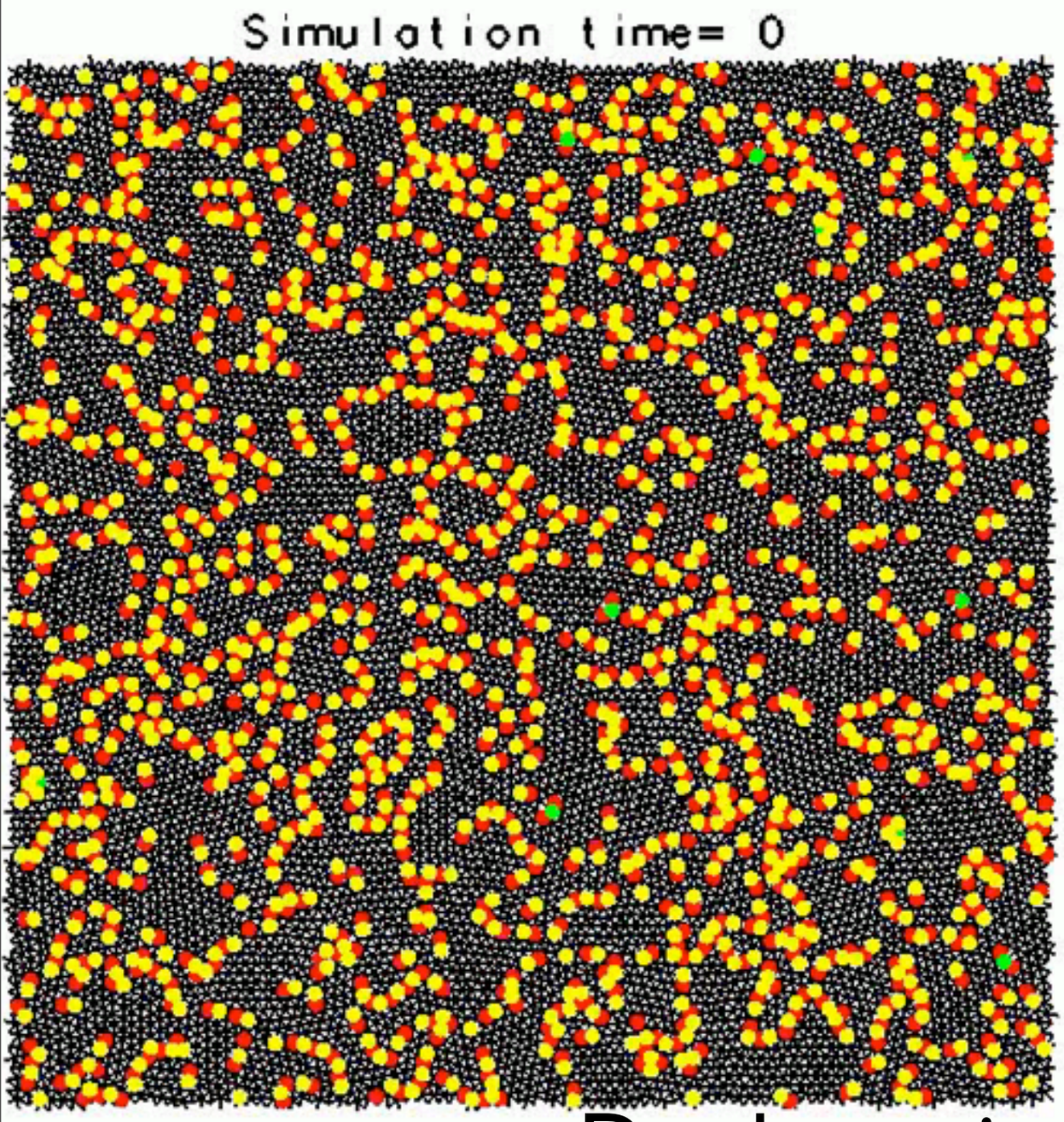
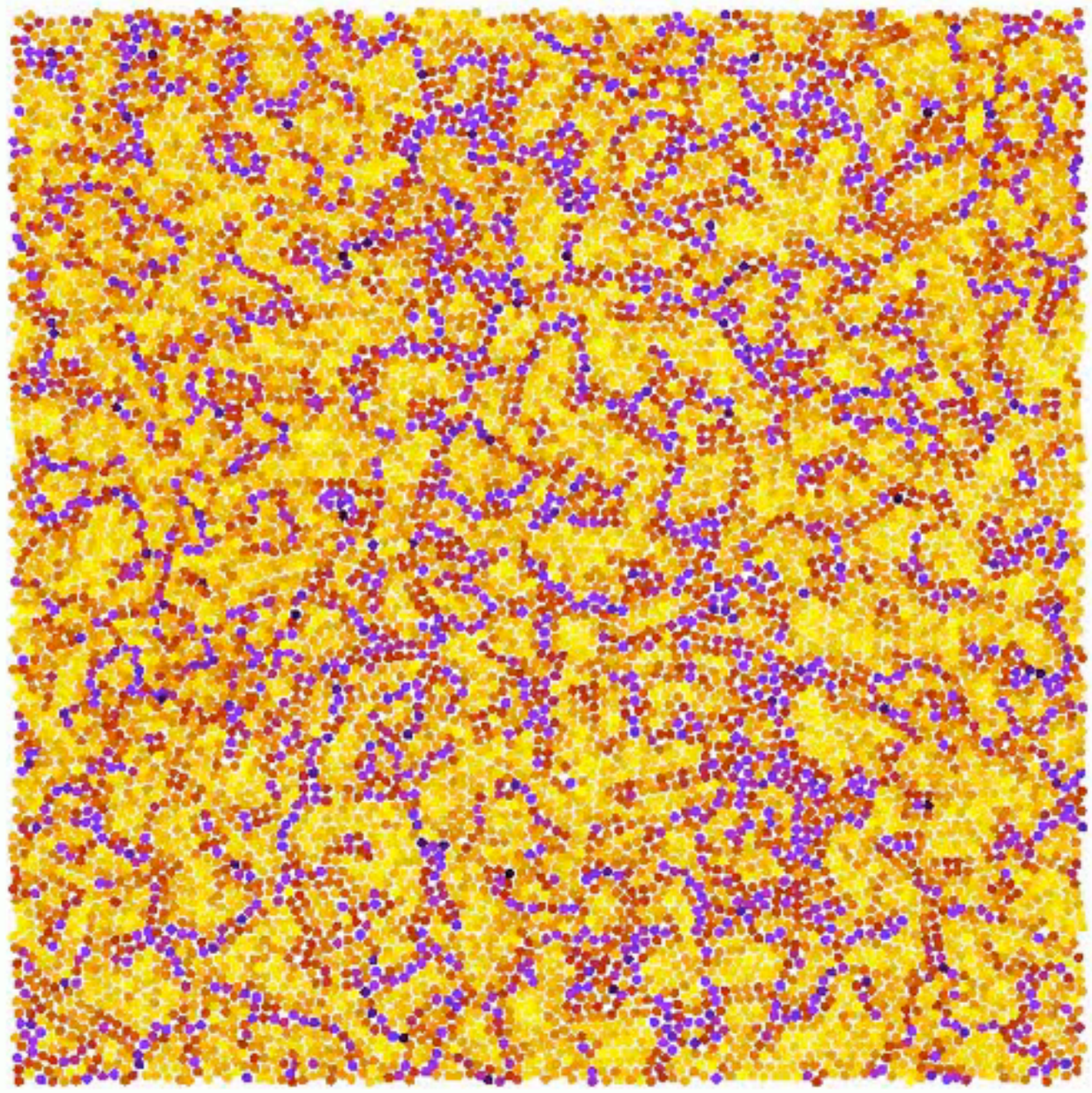


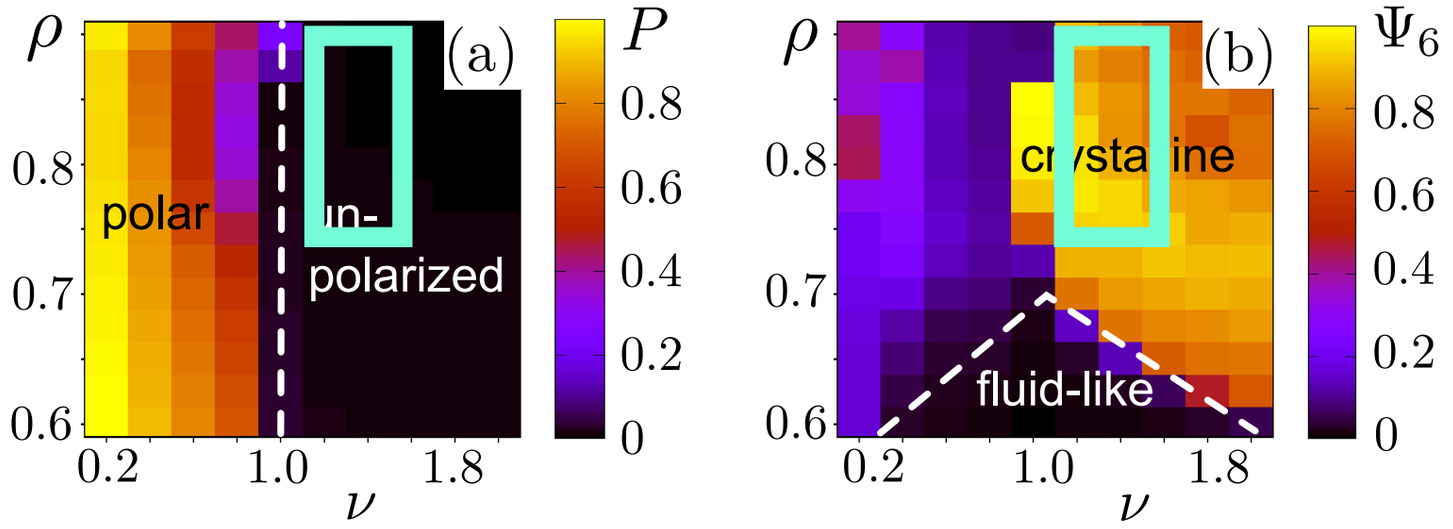








Do the grain boundaries vanish?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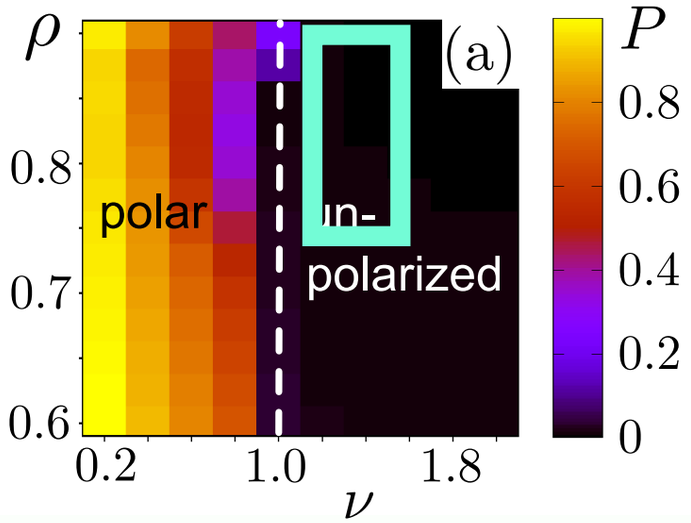
0.7
0.6
0.2
1.0
1.8
ν
(a)
polar
un-
polarized
P
0.8
0.6
0.4
0.2
0
(b)
crystaline
fluid-like
Ψ6


(a)
ρ
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0.7
0.6
polar
un-
polarized
0.2
1.0
1.8
ν
P
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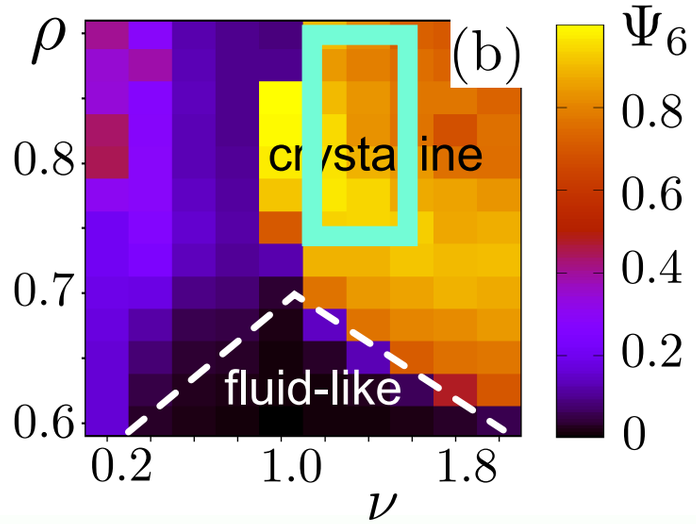
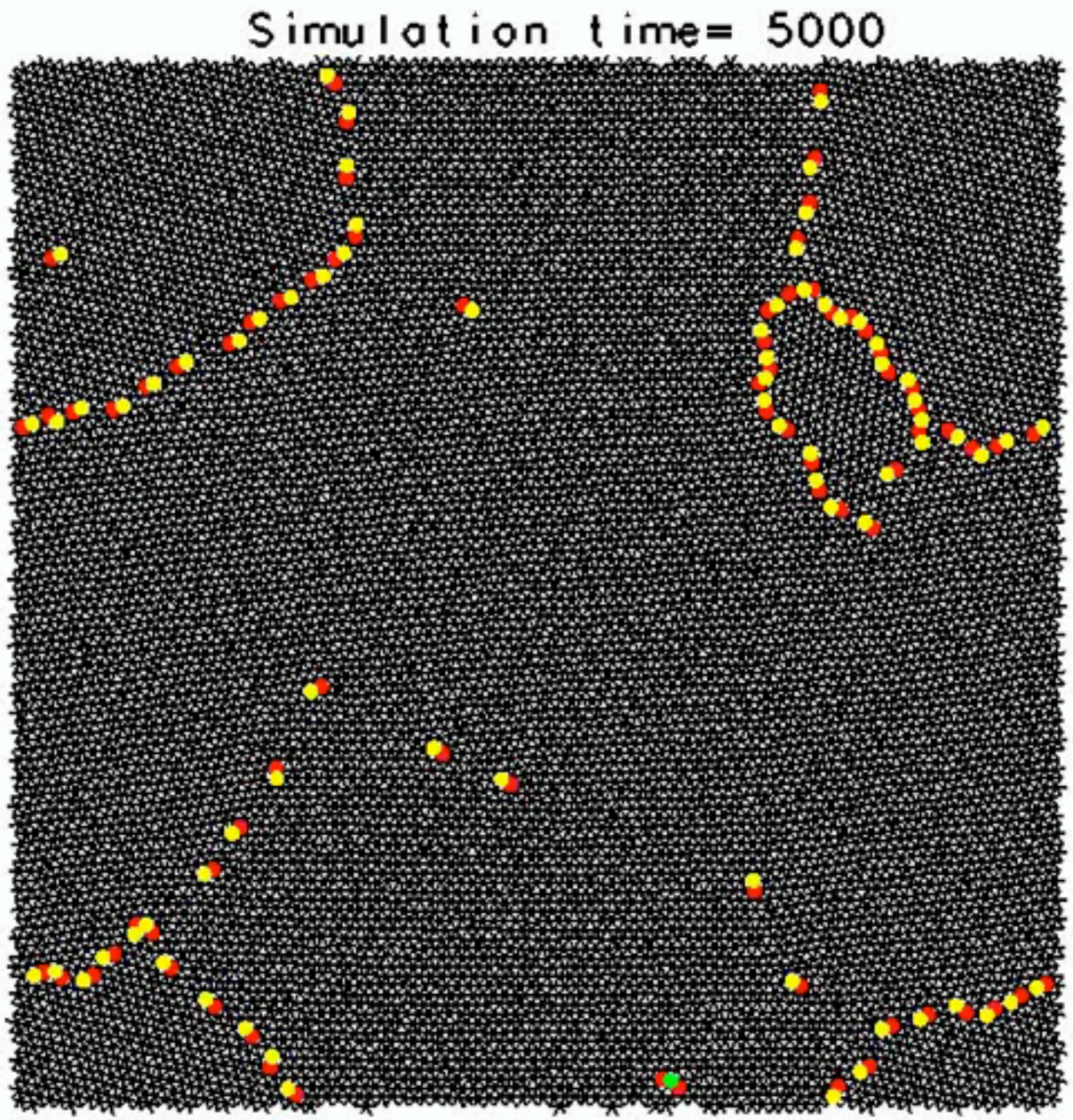
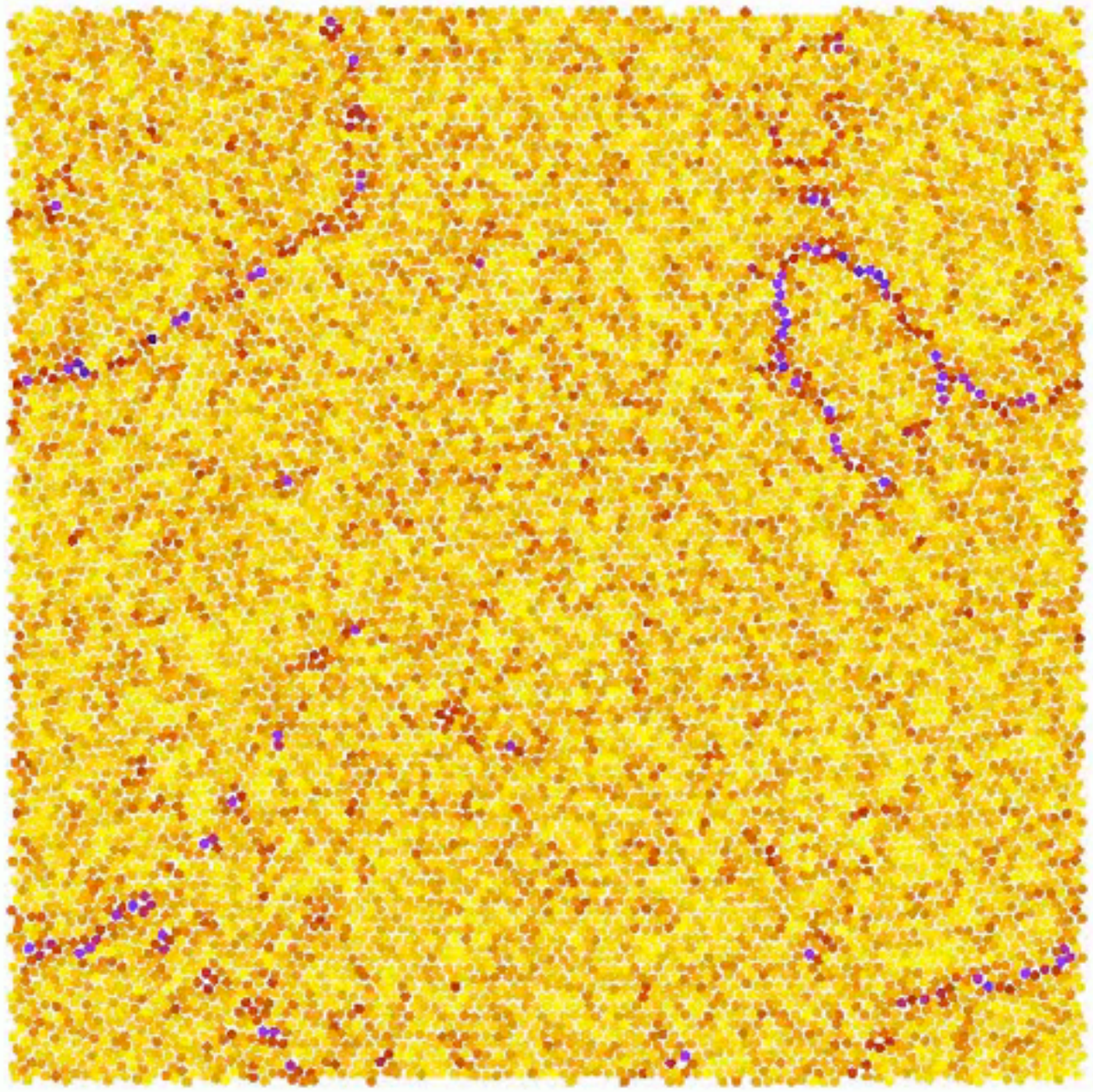
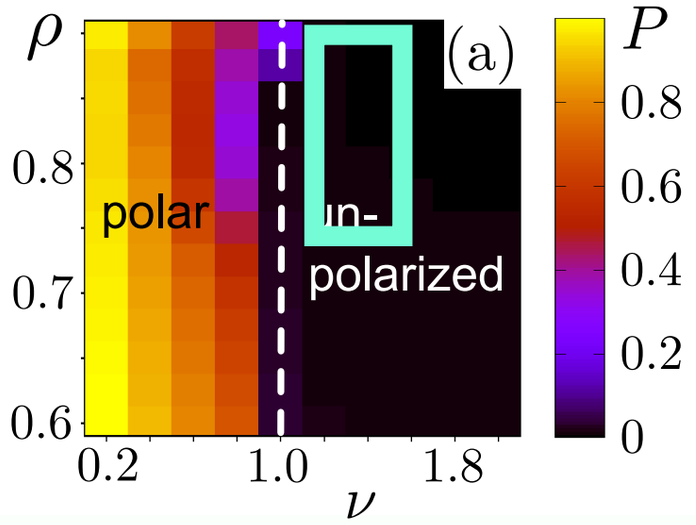
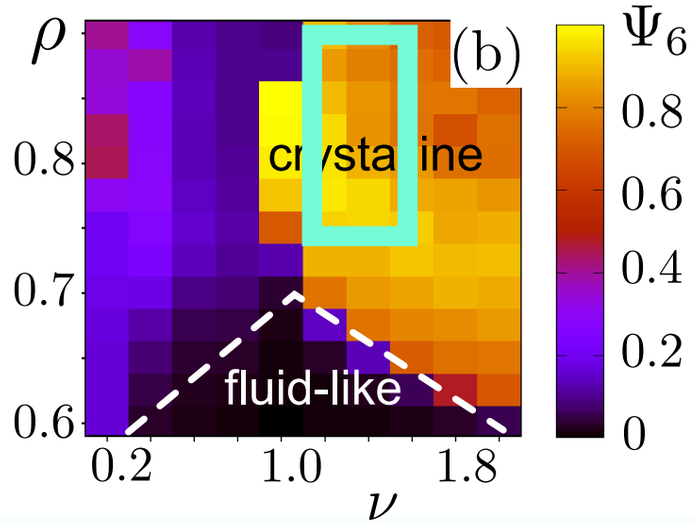
0.6
0.4
0.2
0

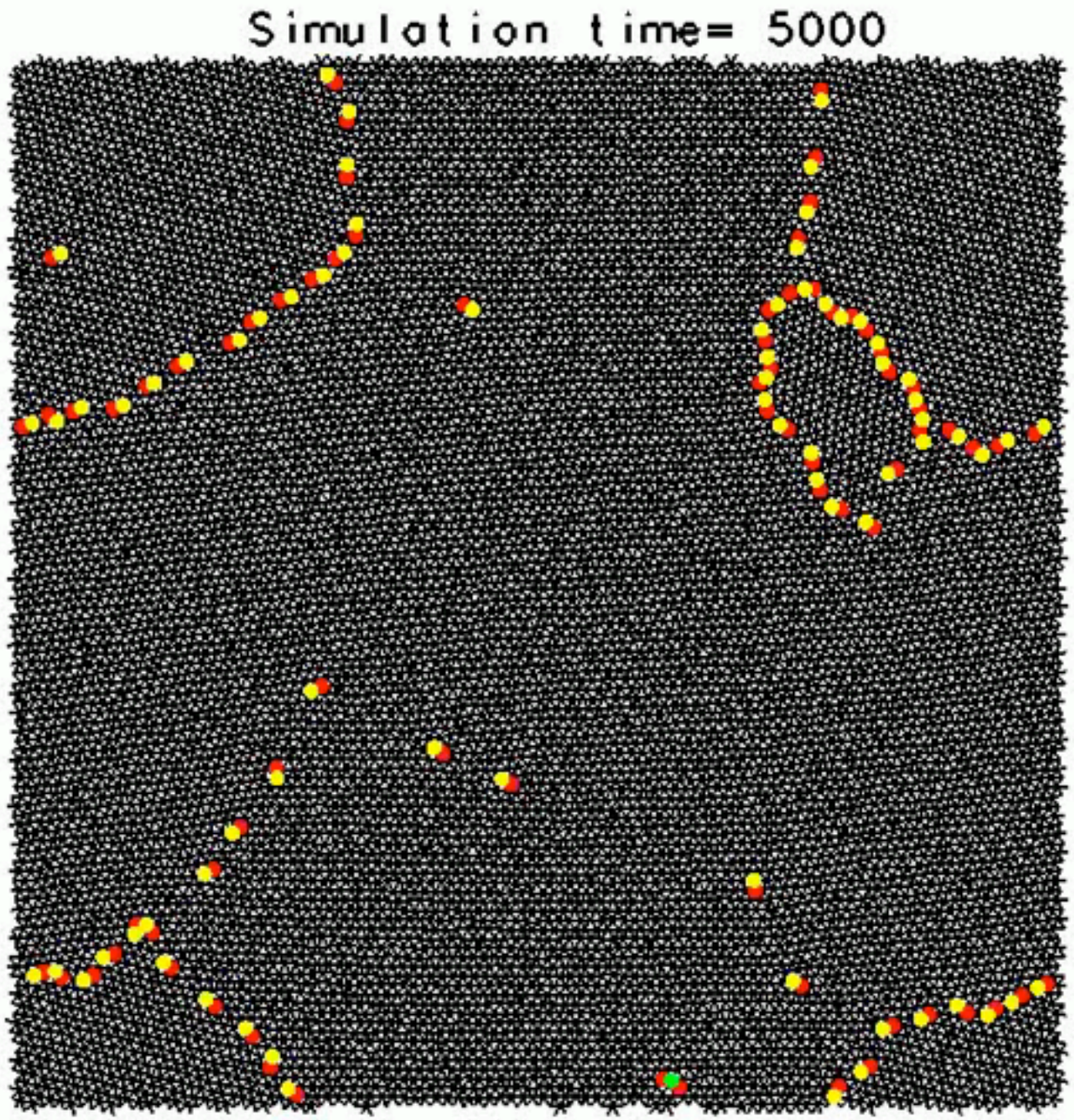

(b)
ρ
0.8
0.7
0.6
crystaline
fluid-like
0.2
1.0
1.8
ν
Ψ6
0.8
0.6
0.4
0.2
0

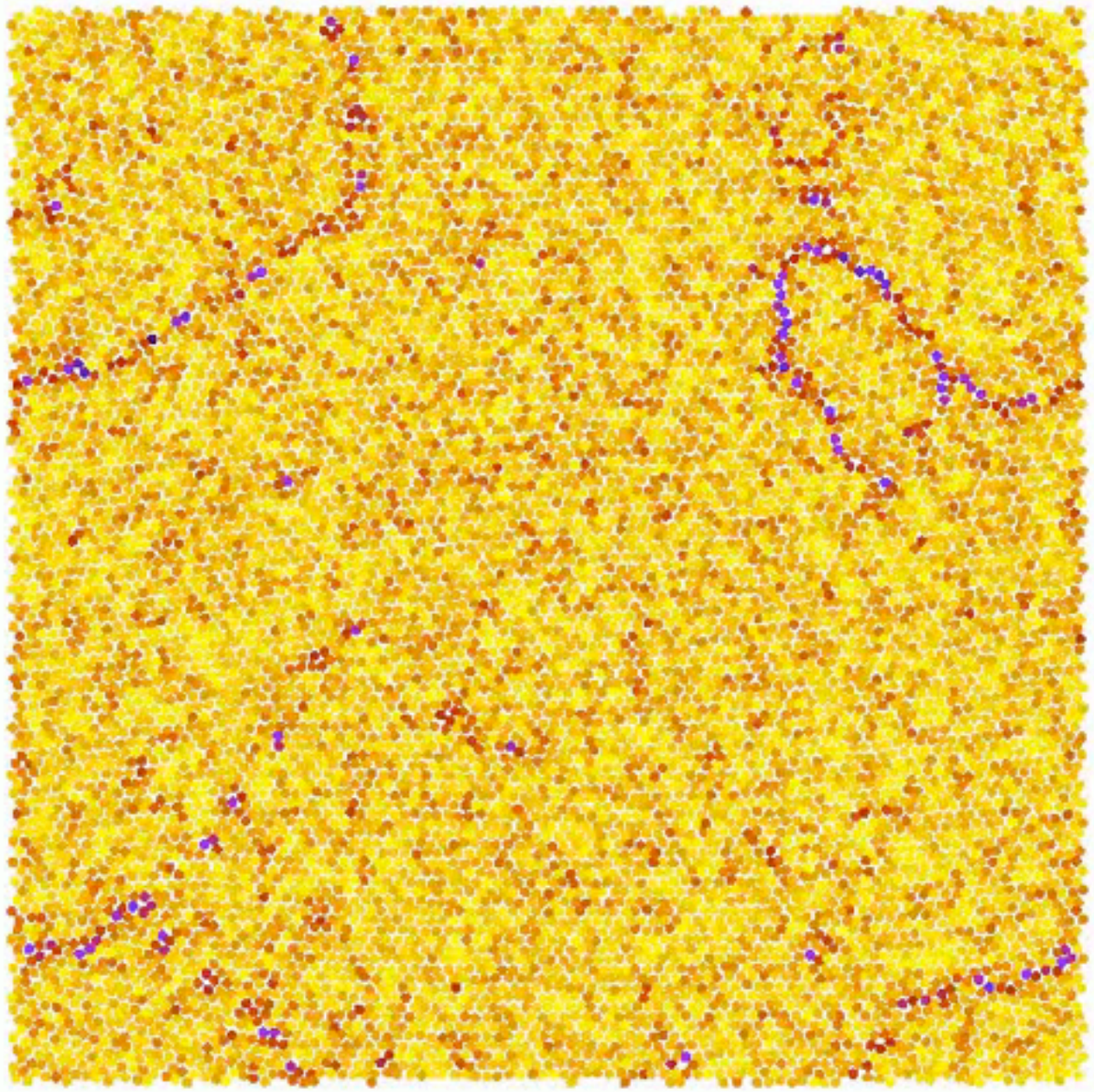

Simulation time= 5000





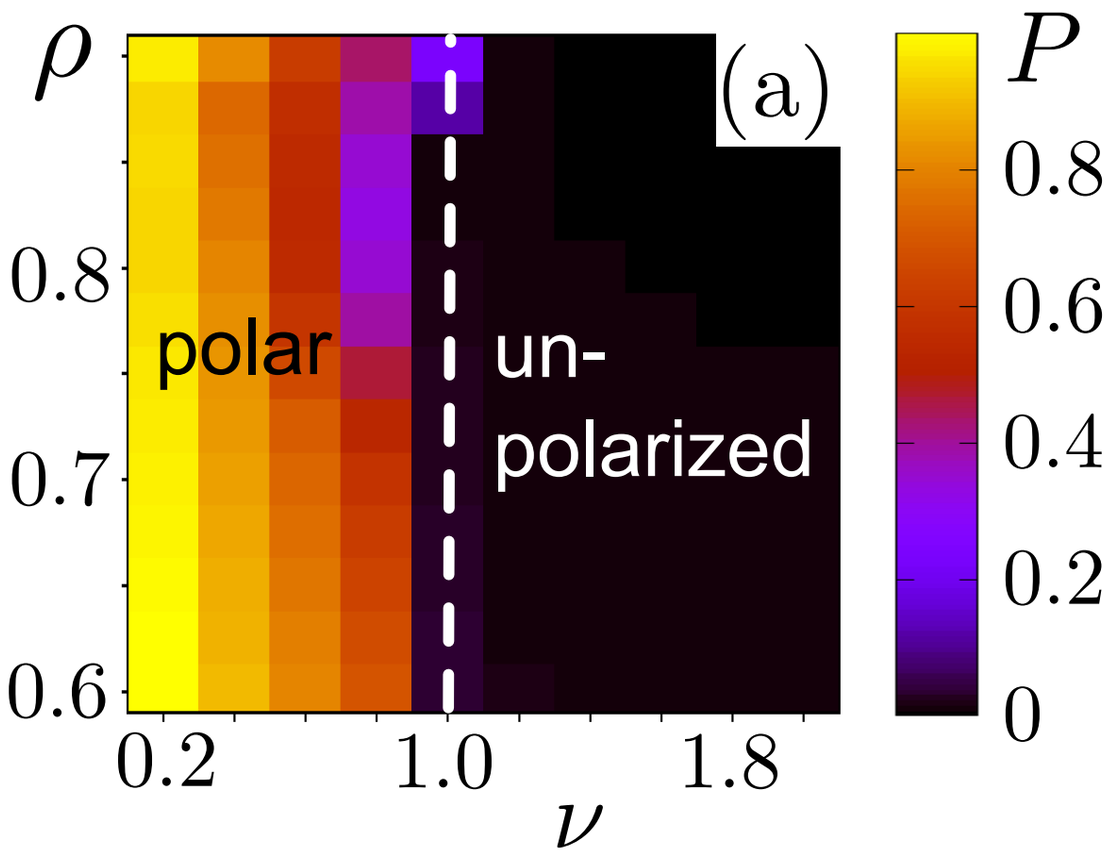


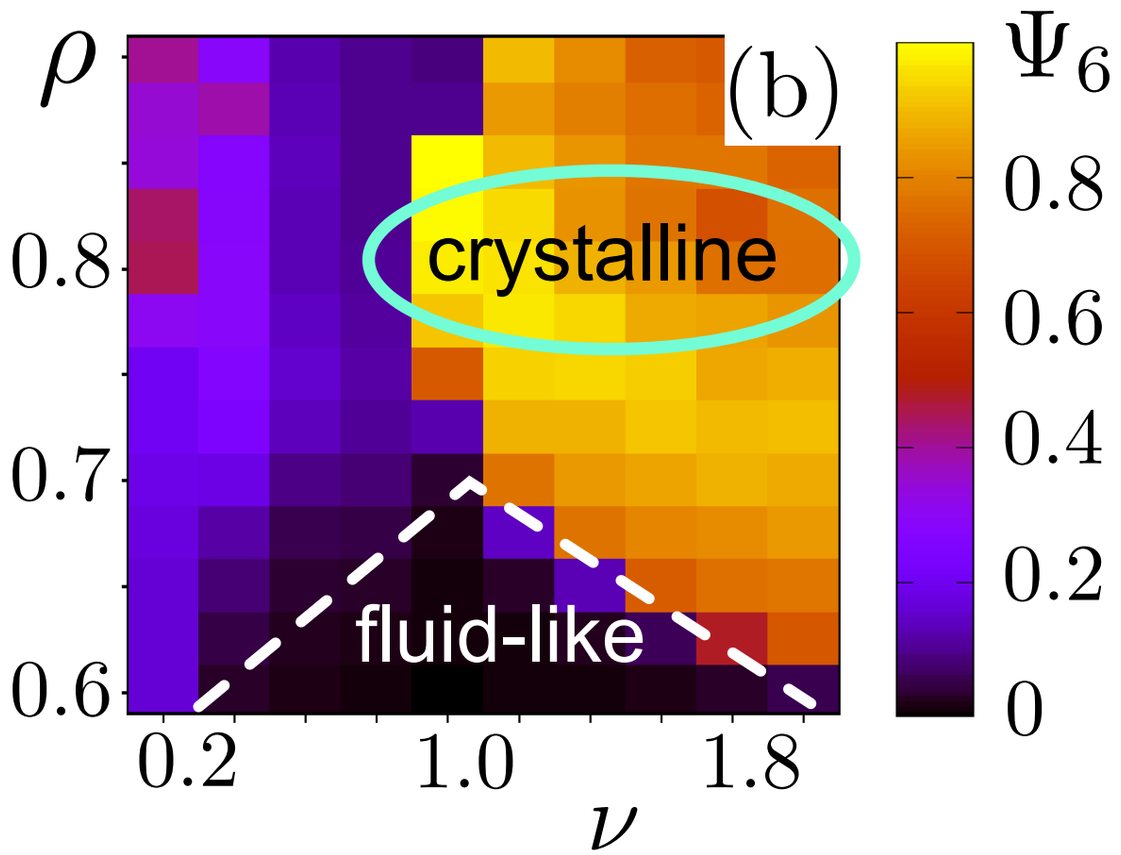




yes, but it take a looong time ....

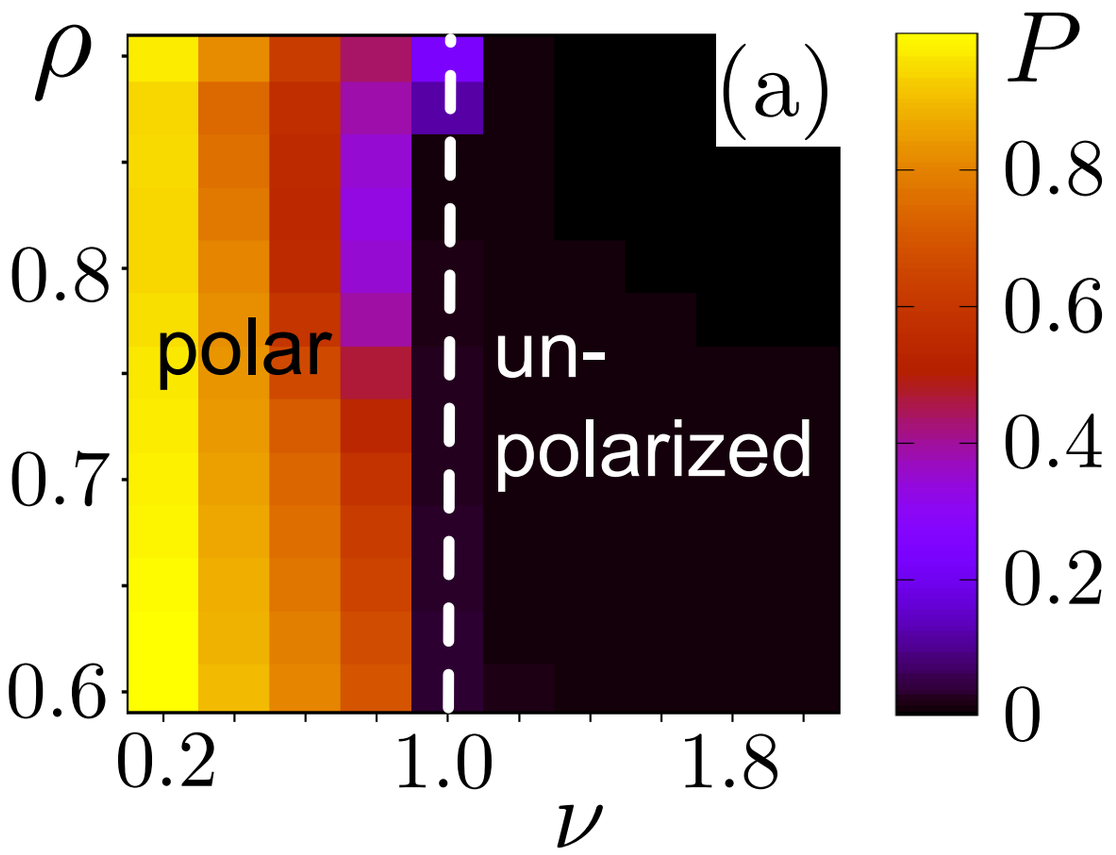
Defect-Mediated Phase Transitions in Active Soft Matter

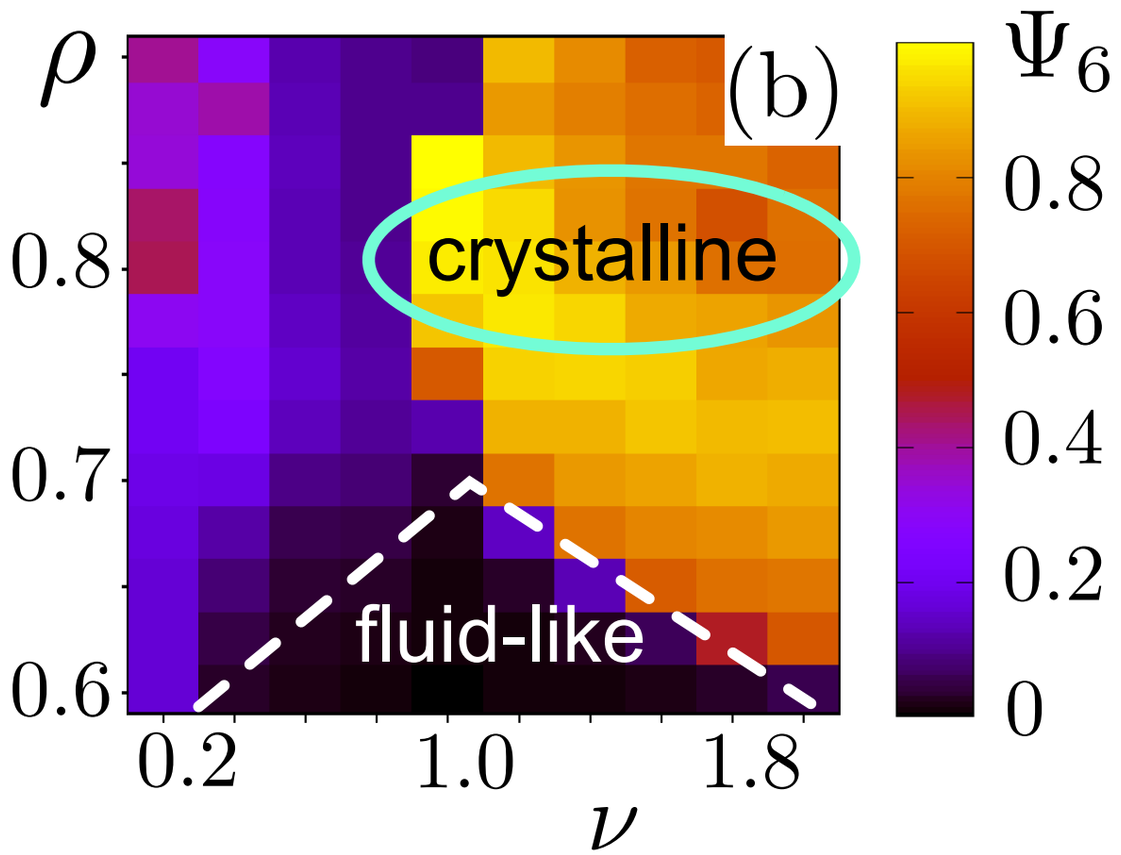




Questions:

Defect-Mediated Phase Transitions in Active Soft Matter

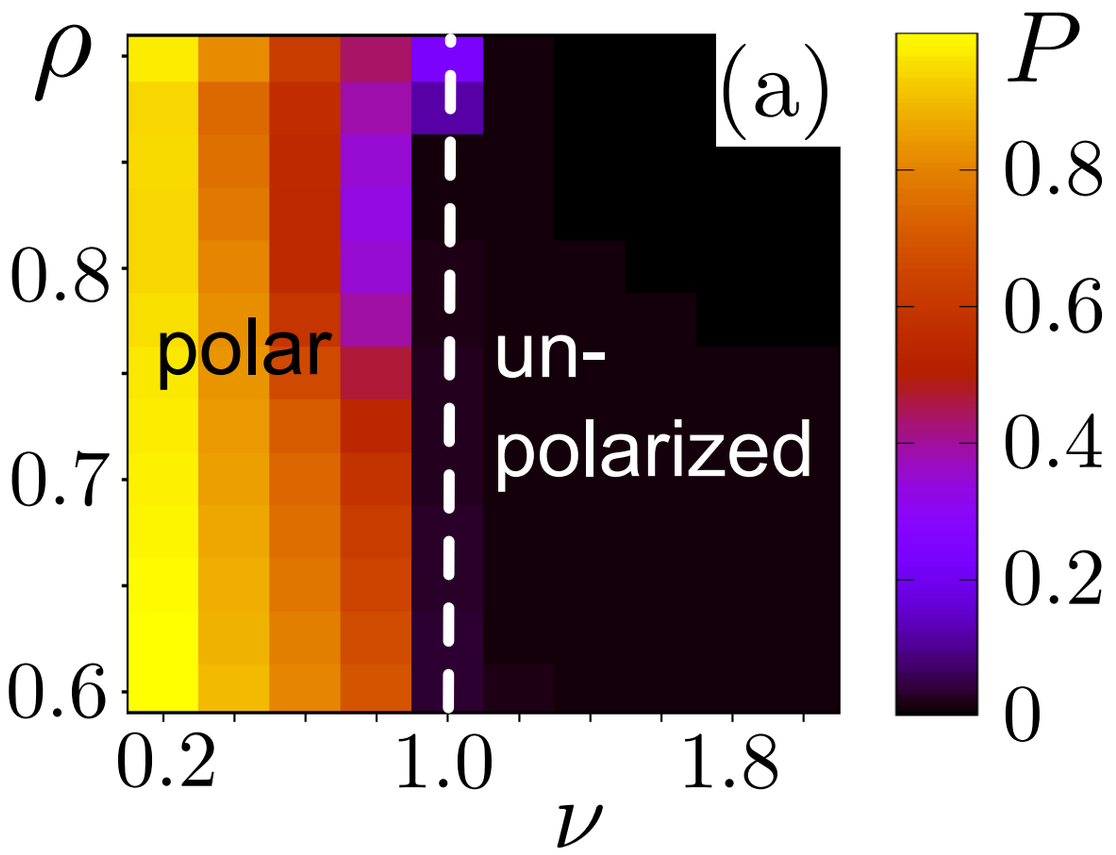


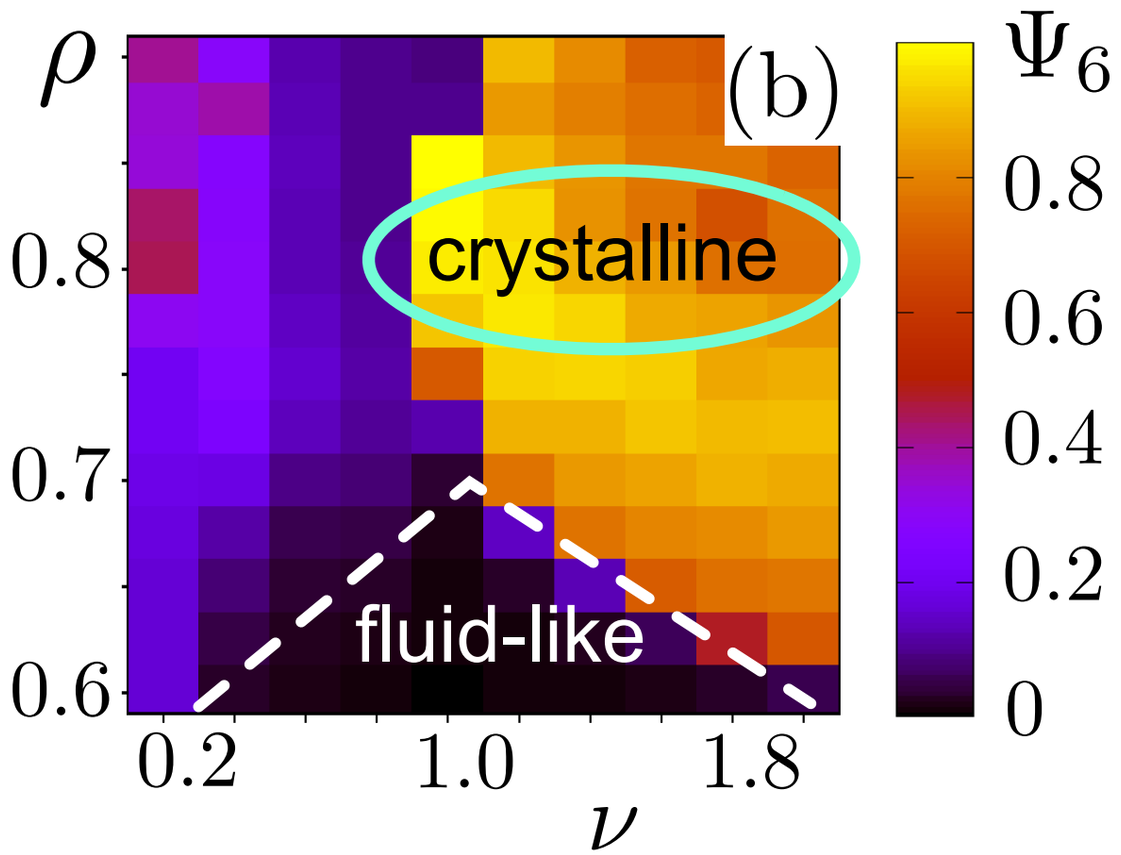


Questions:

What is the degree of translational order in the "crystalline" regime?

Defect-Mediated Phase Transitions in Active Soft Matter





Questions:

What is the degree of translational order in the "crystalline" regime?

What is the role of defects for the selection of states?

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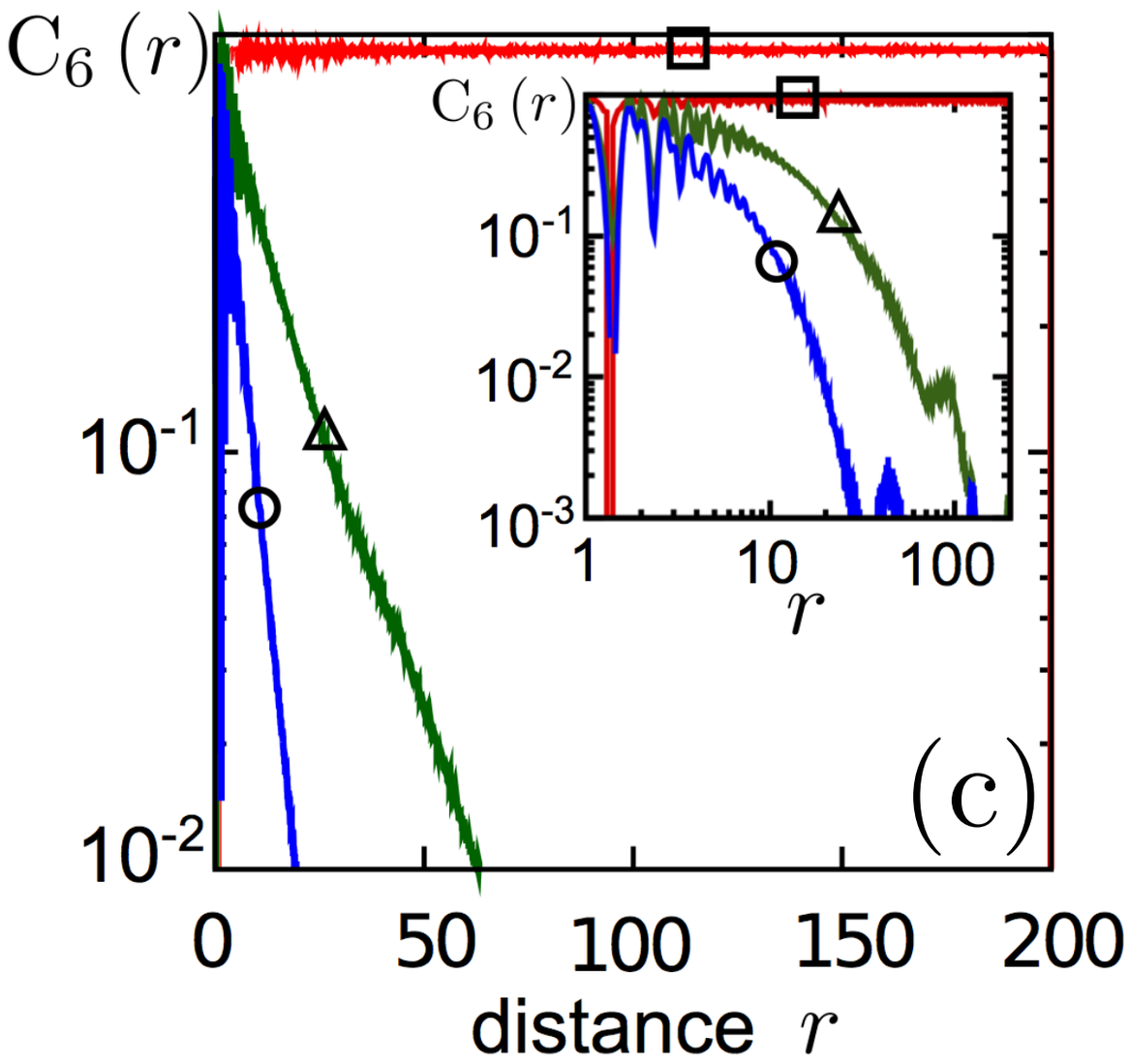

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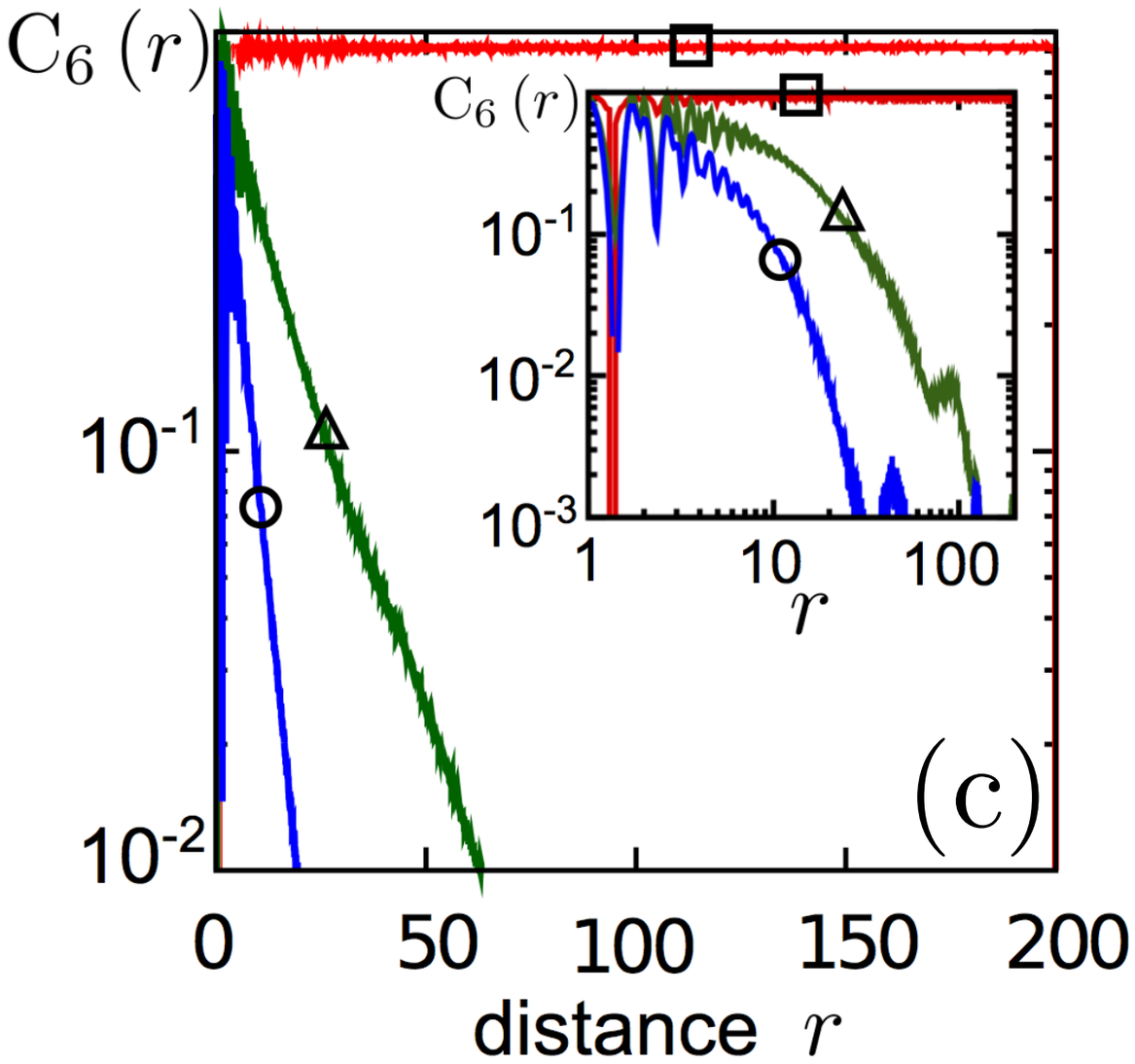

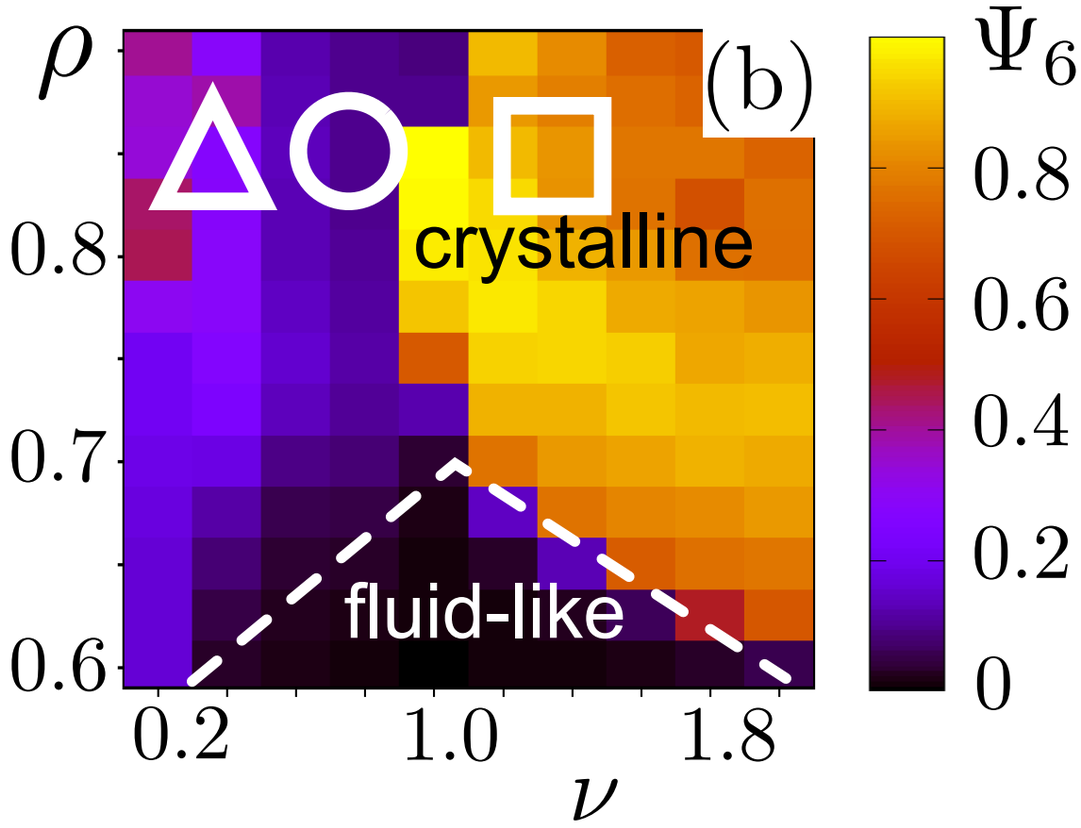

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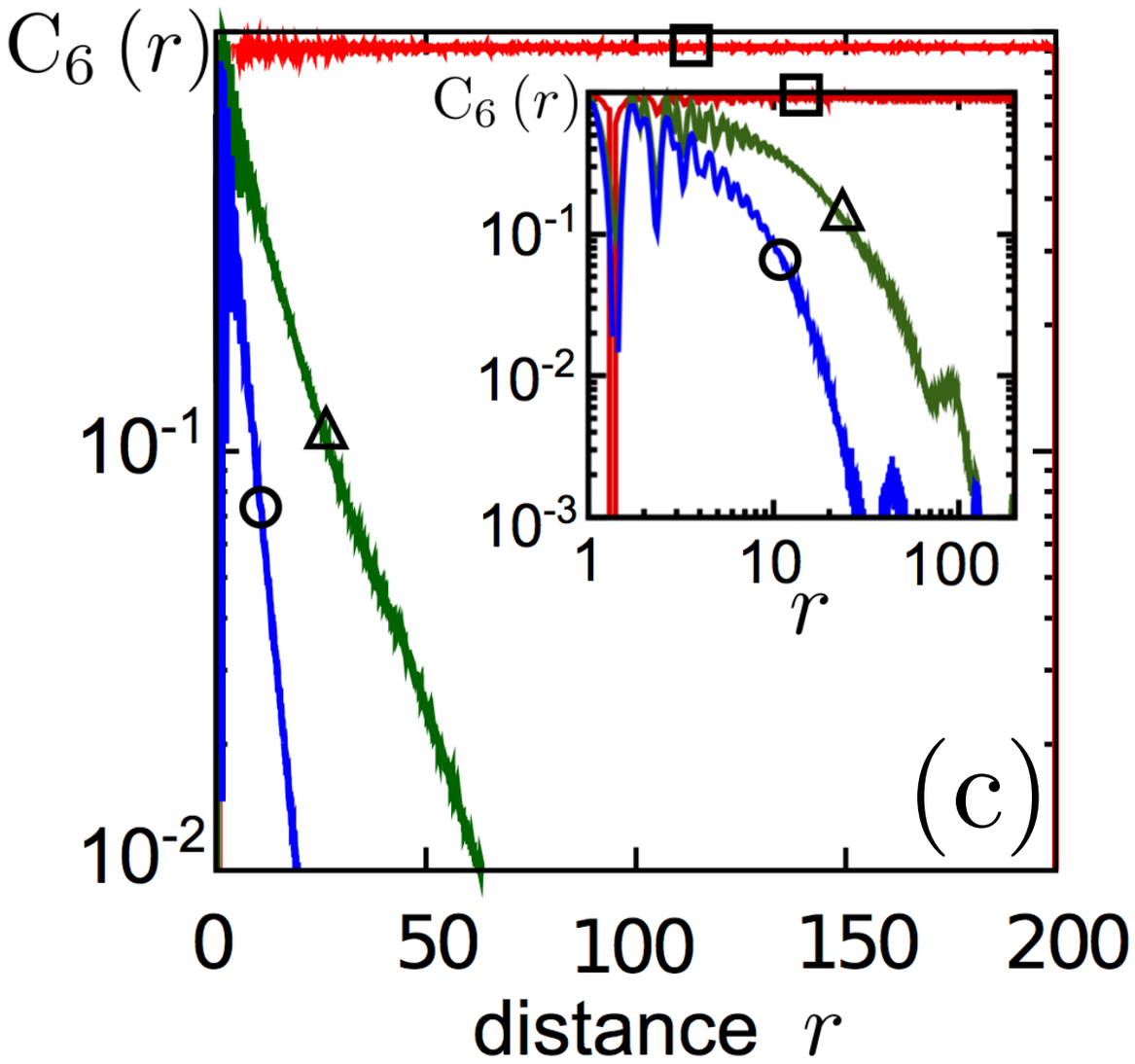
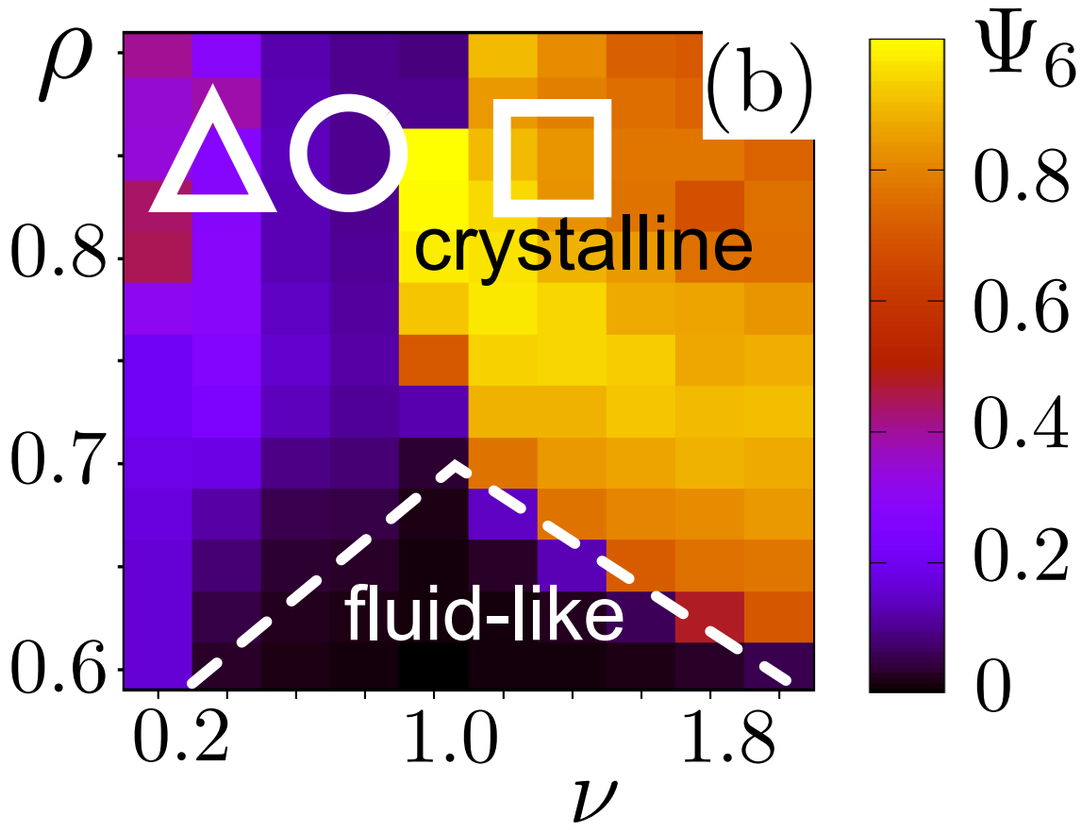


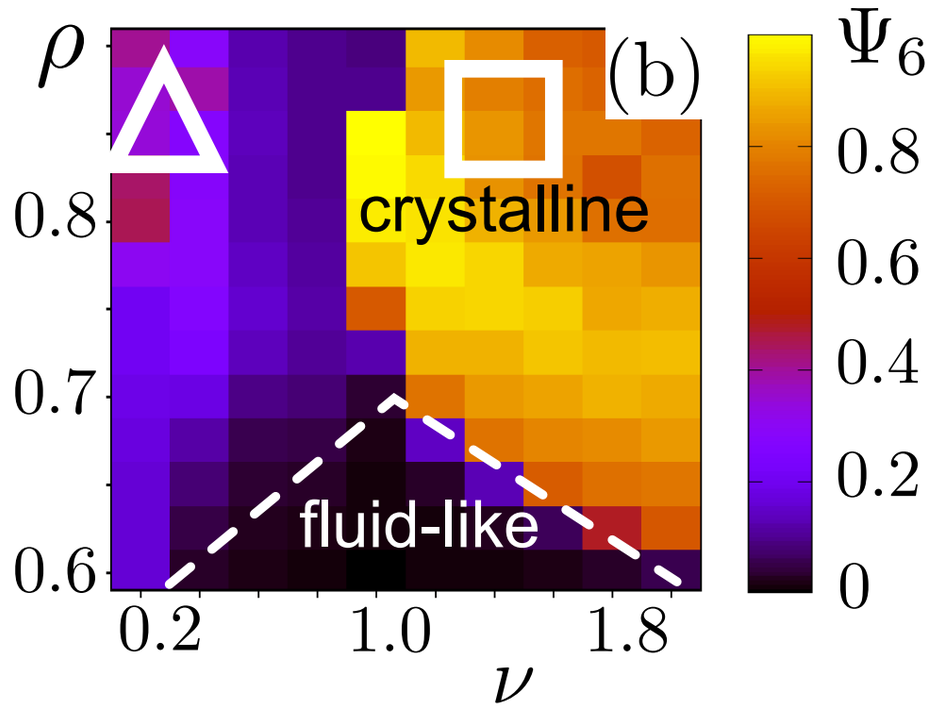


□ long-range hexatic order

△○ short-range hexatic order in polycrystalline state(s)

What is the degree of translational order in the "crystalline" regime?

$$\Psi_{\vec{G},i} = e^{-\imath\, \vec{G}\cdot\vec{r}_i}$$



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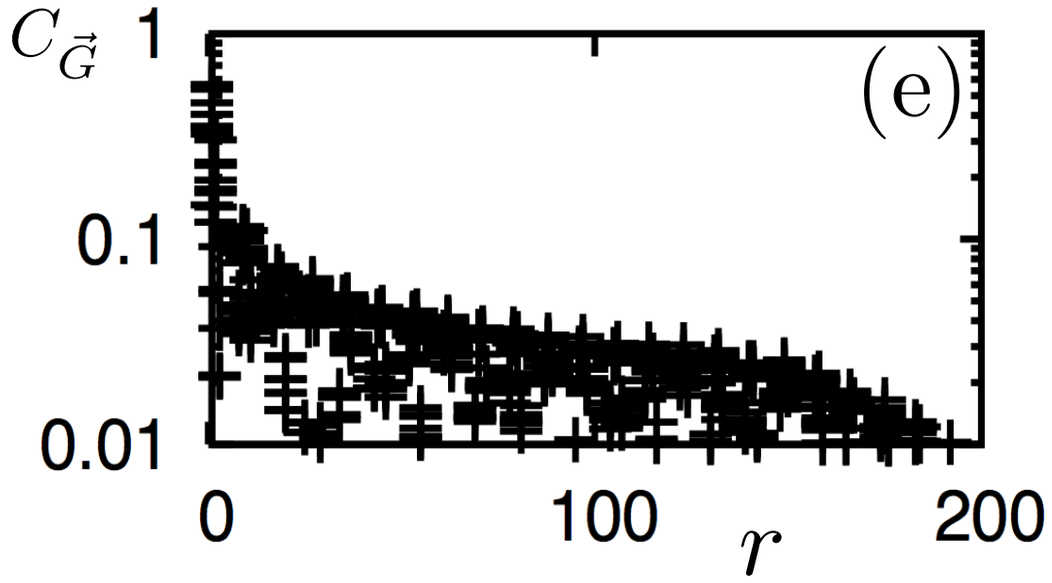

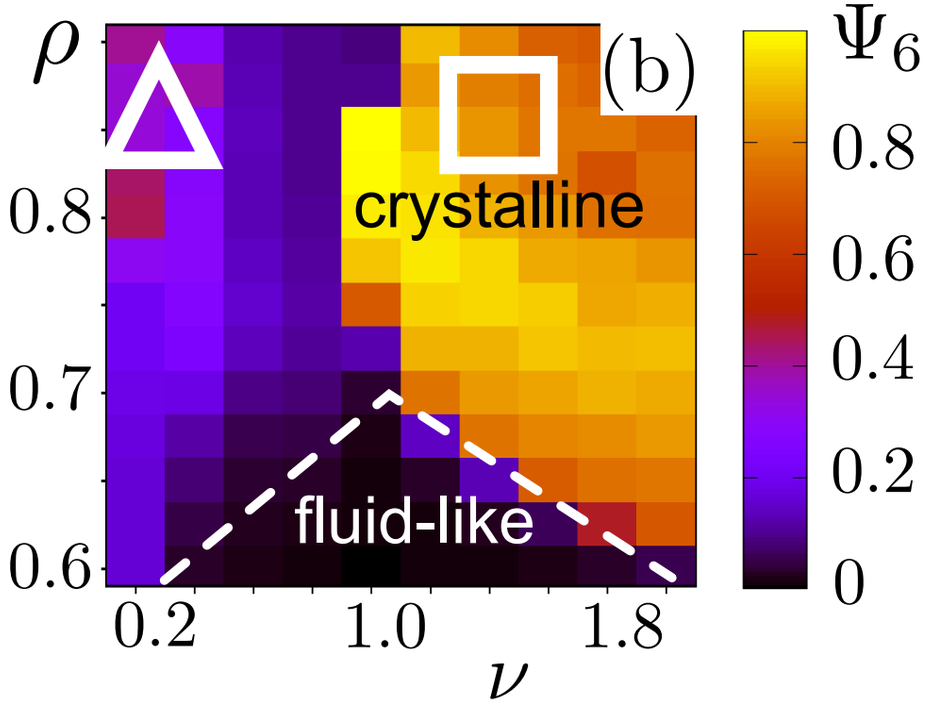

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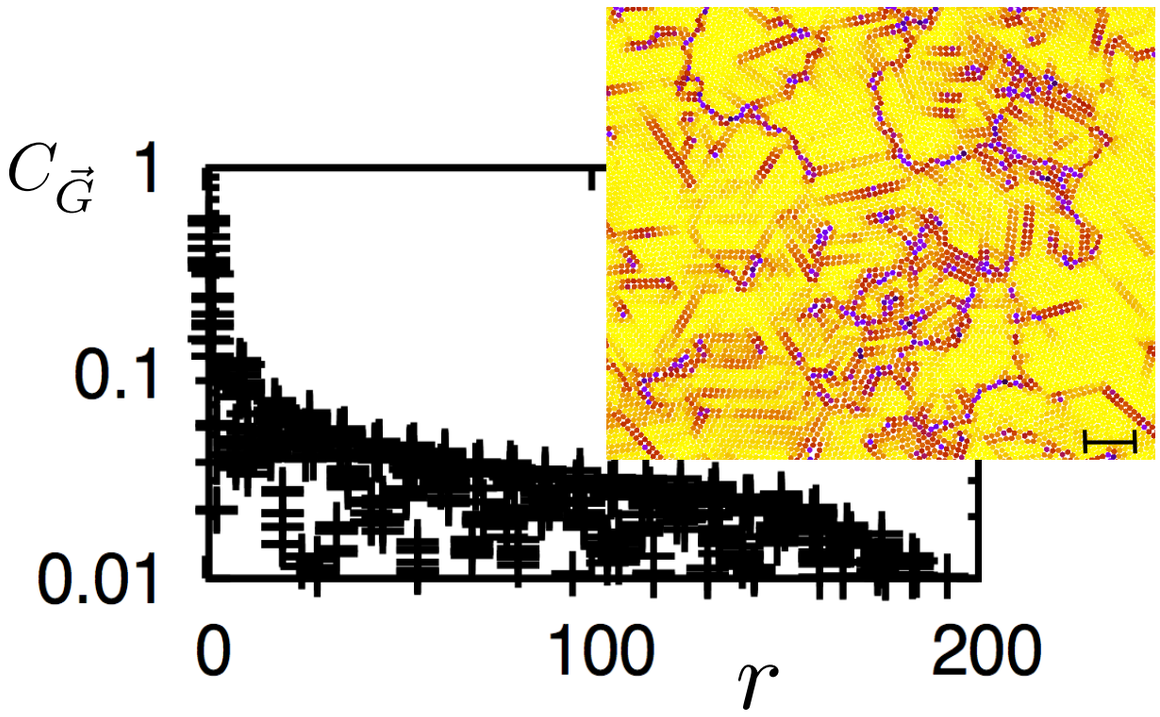

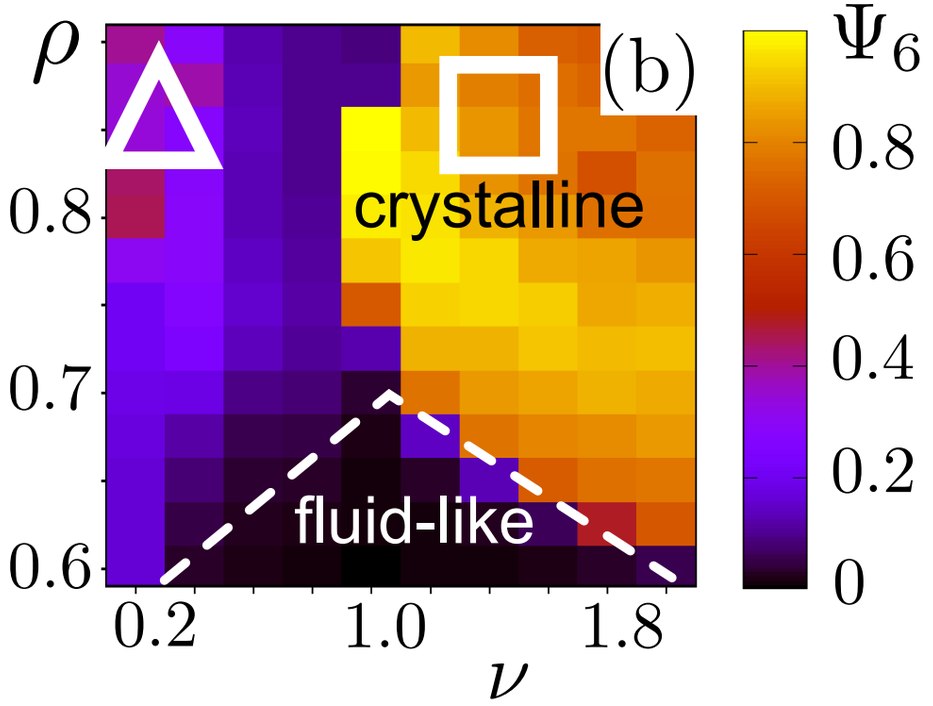

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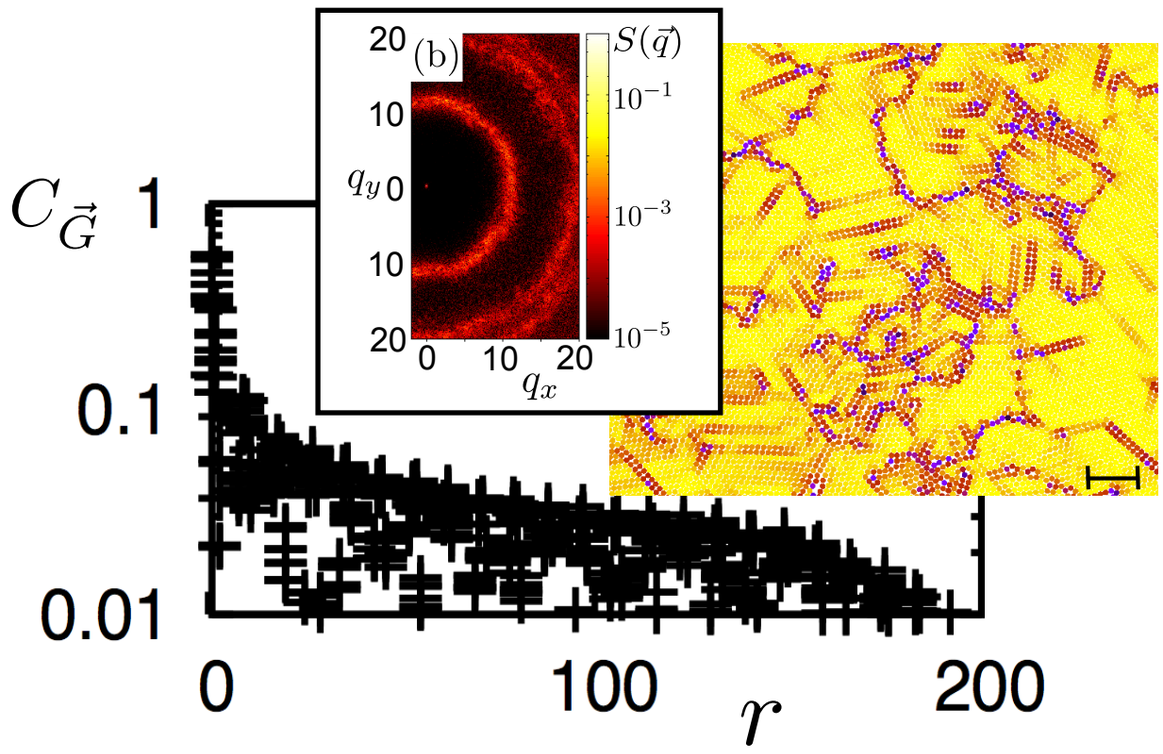

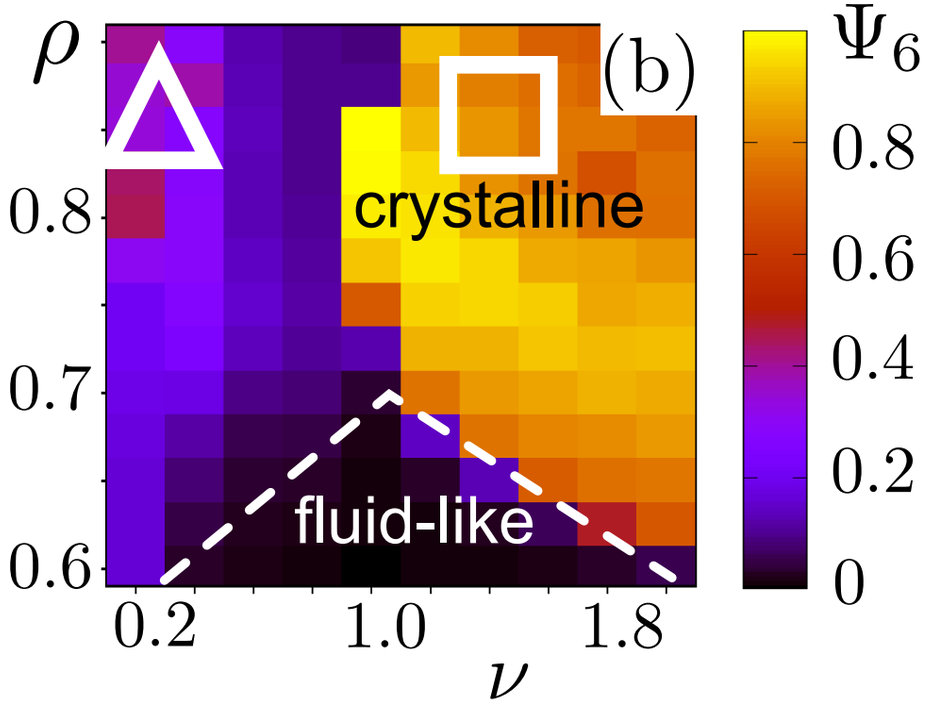

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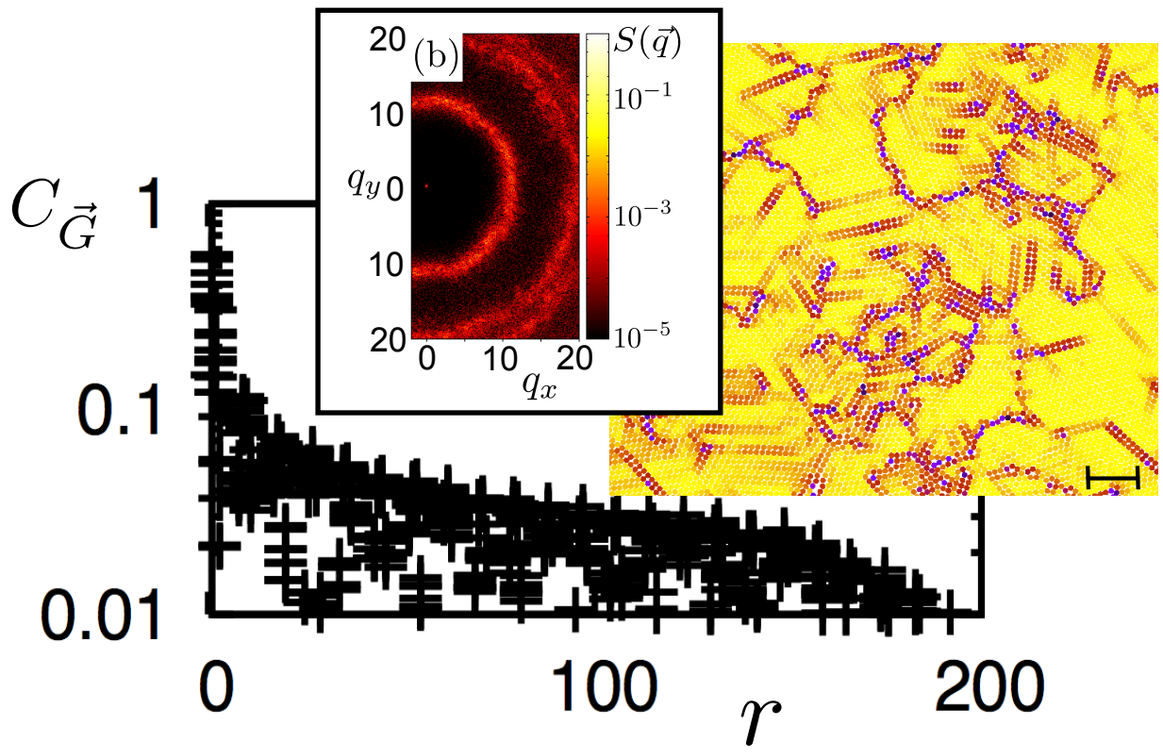
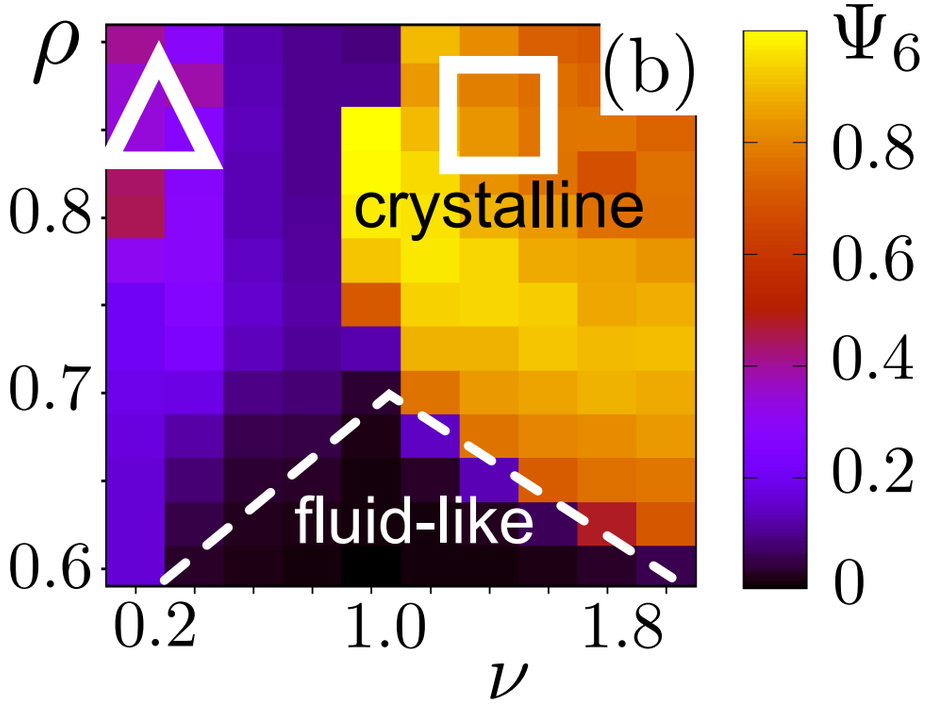


short-range translational order



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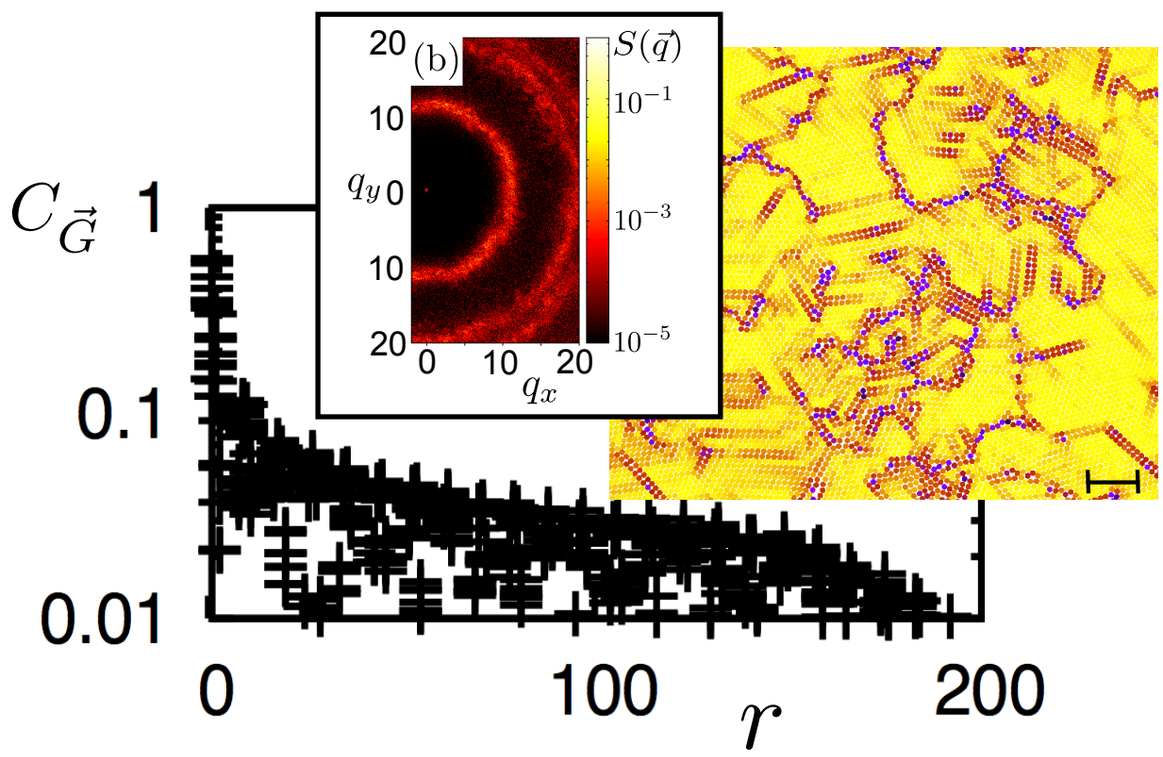
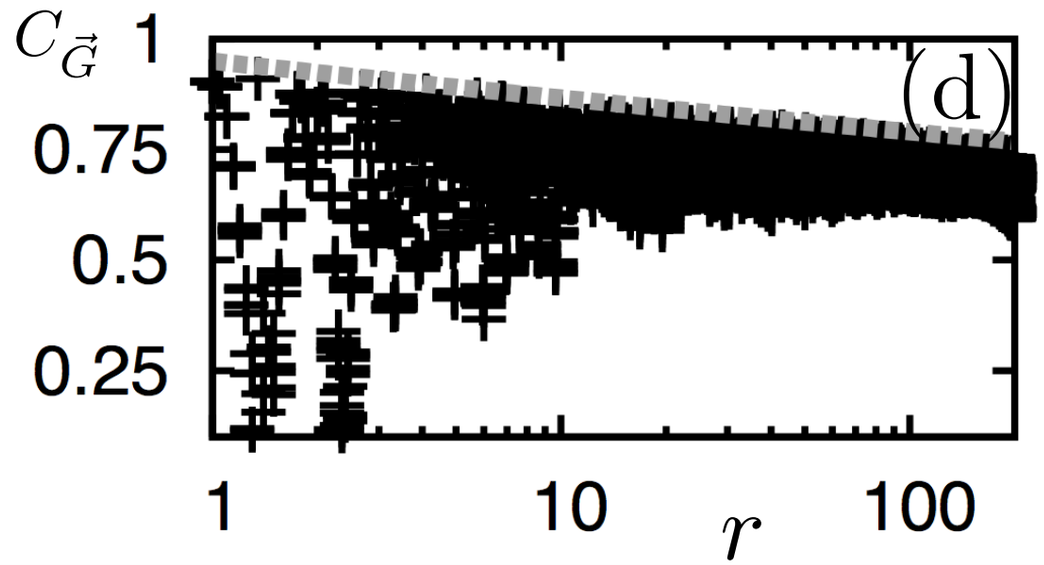
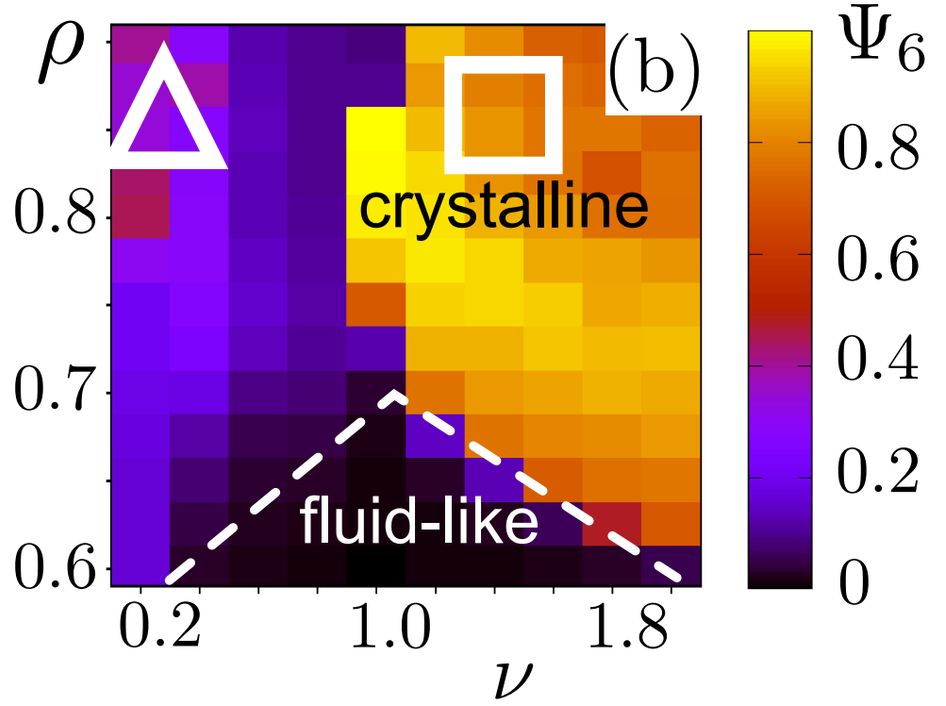
△



short-range translational order

□





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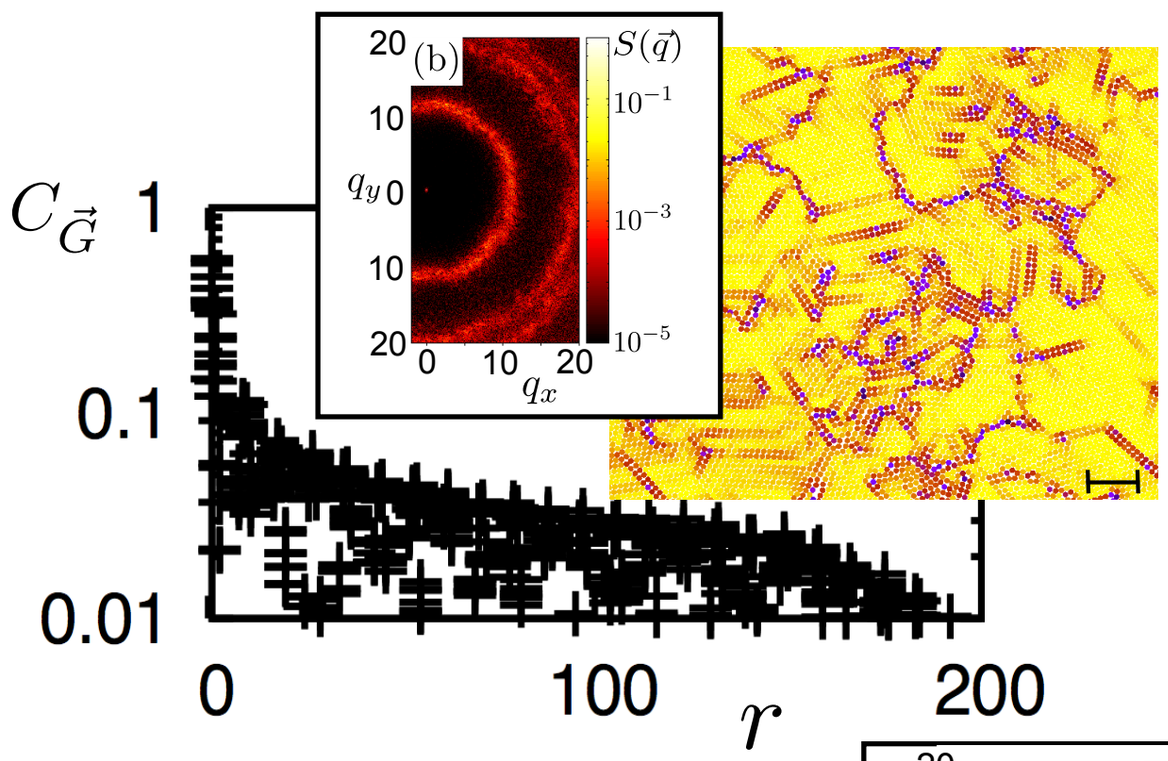

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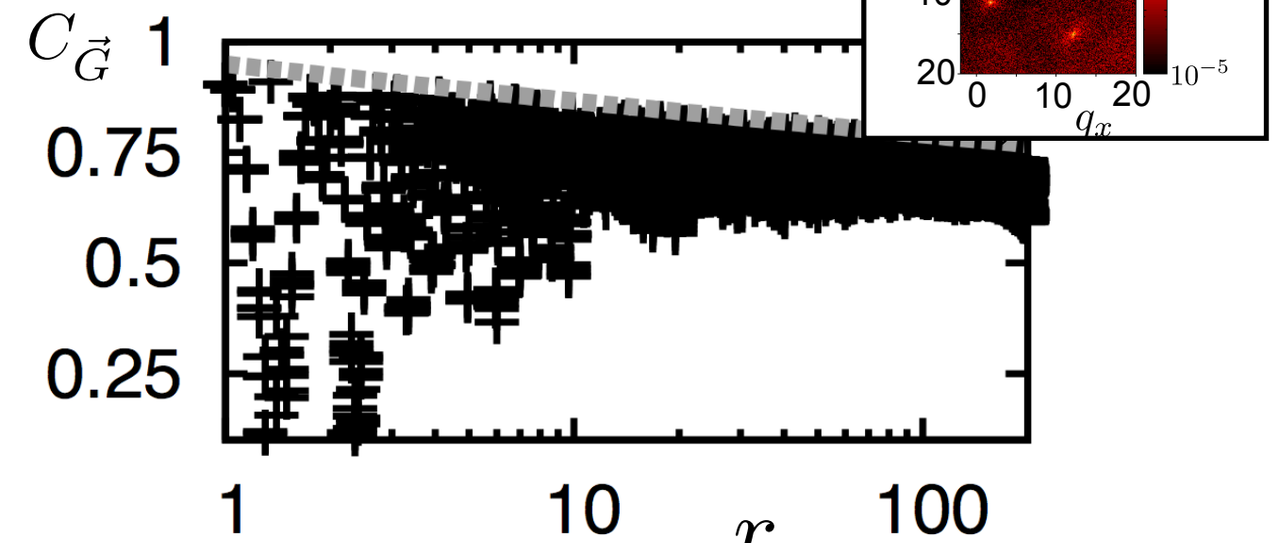

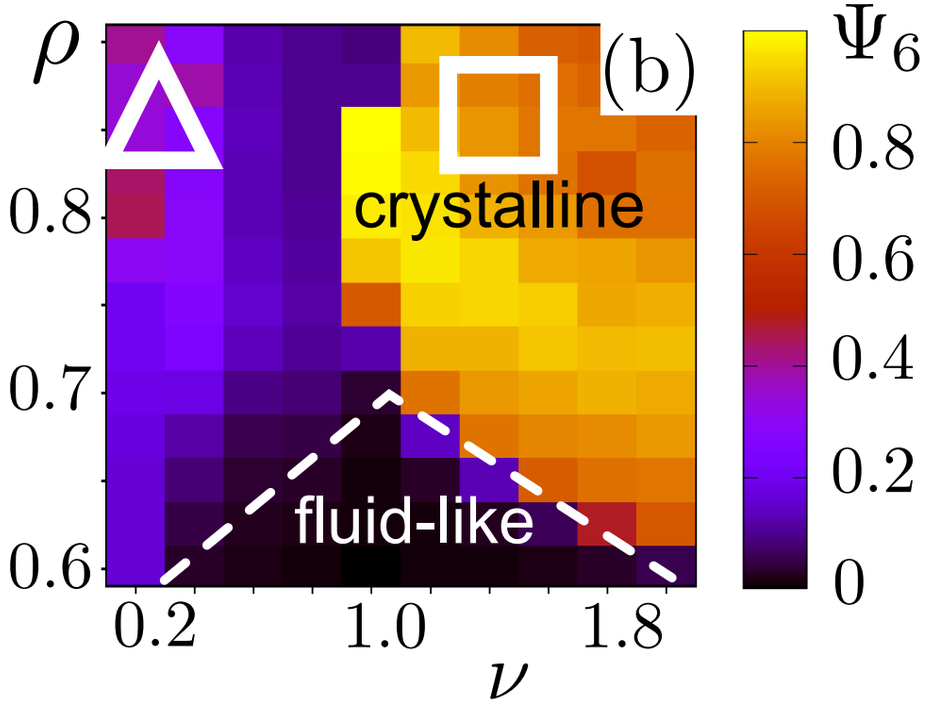

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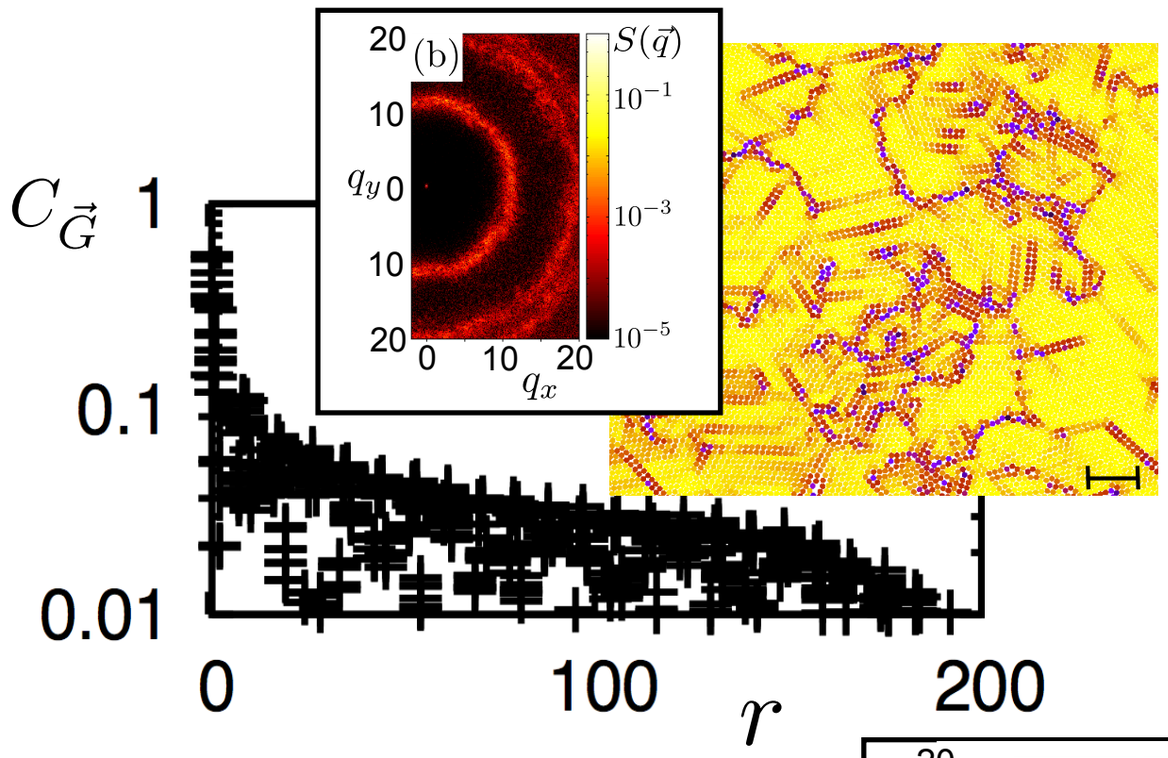
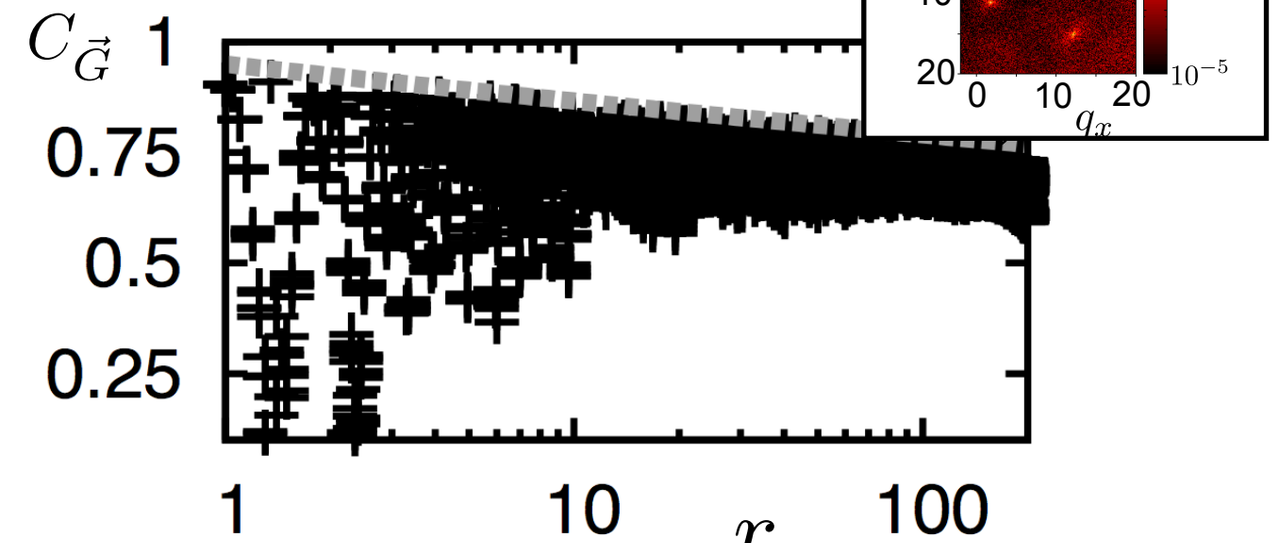
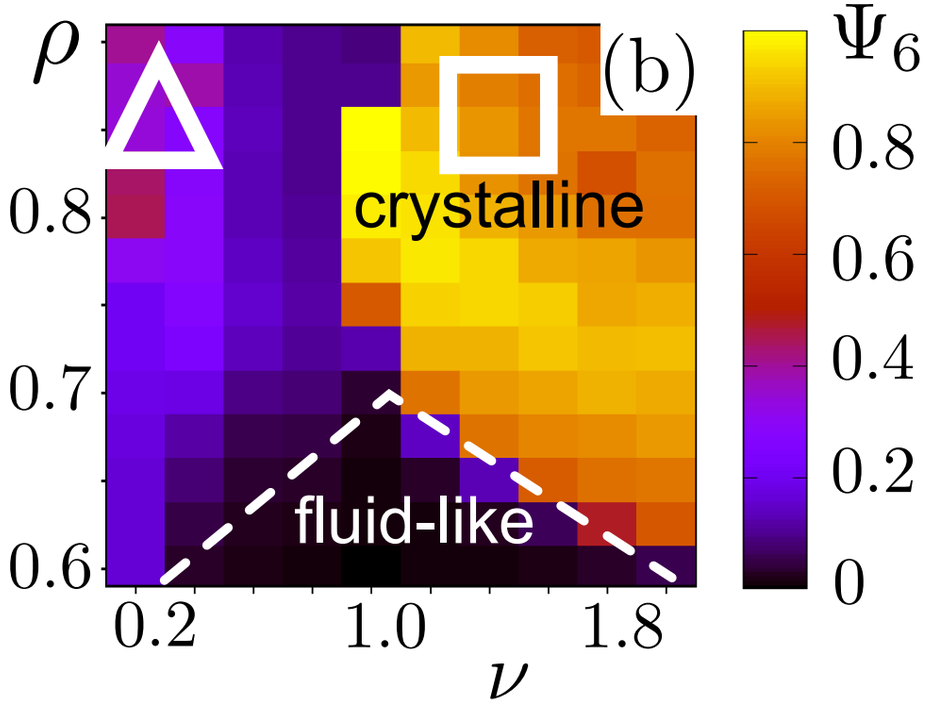
△



short-range translational order

□

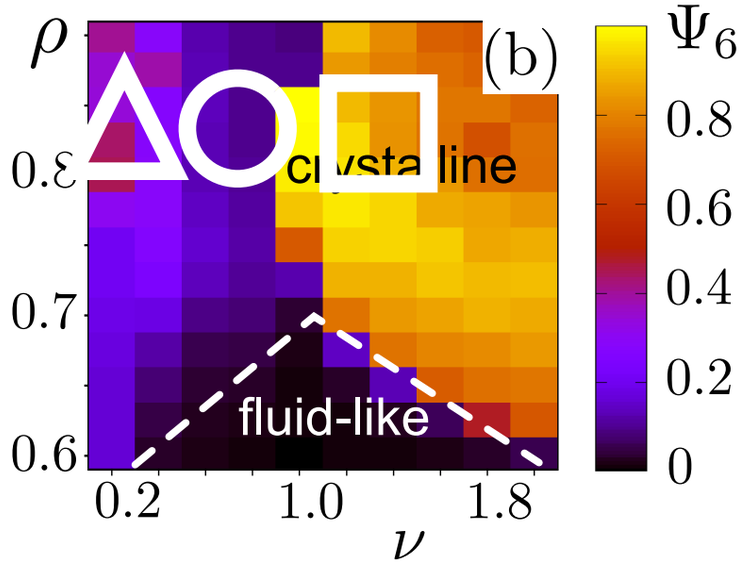




quasi long-range translational order; "active crystal"

What is the role of defects for the selection of the states?

$d =$ defect fraction



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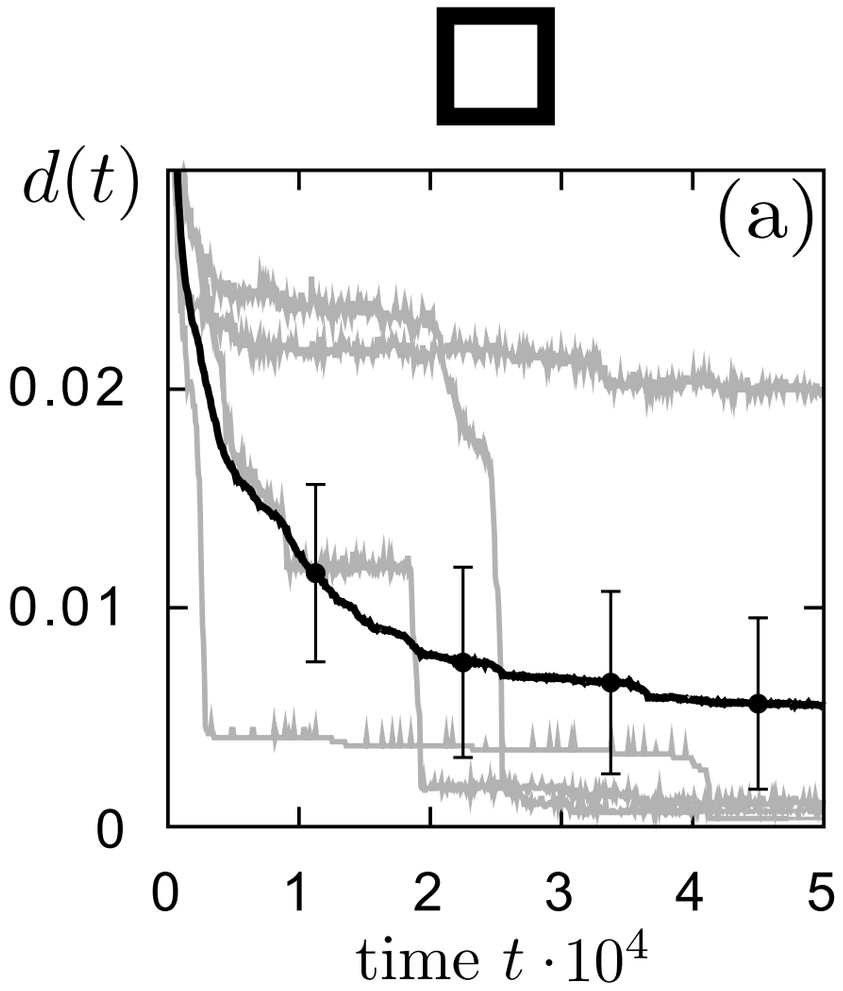

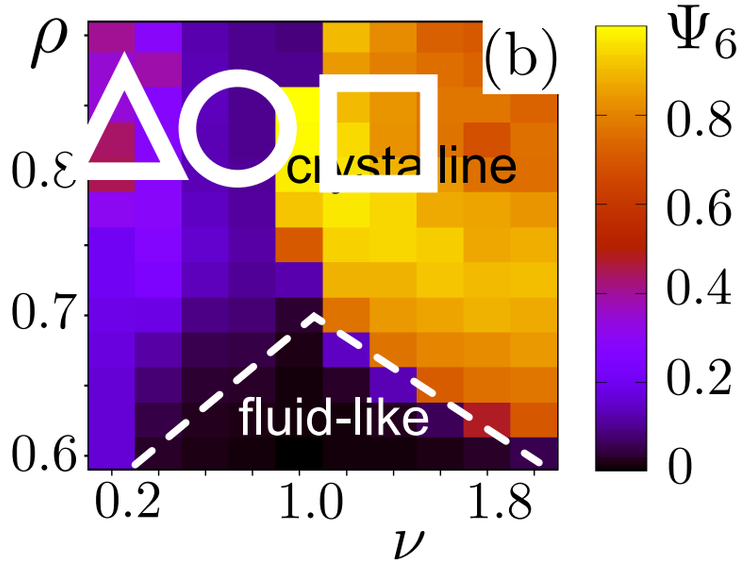

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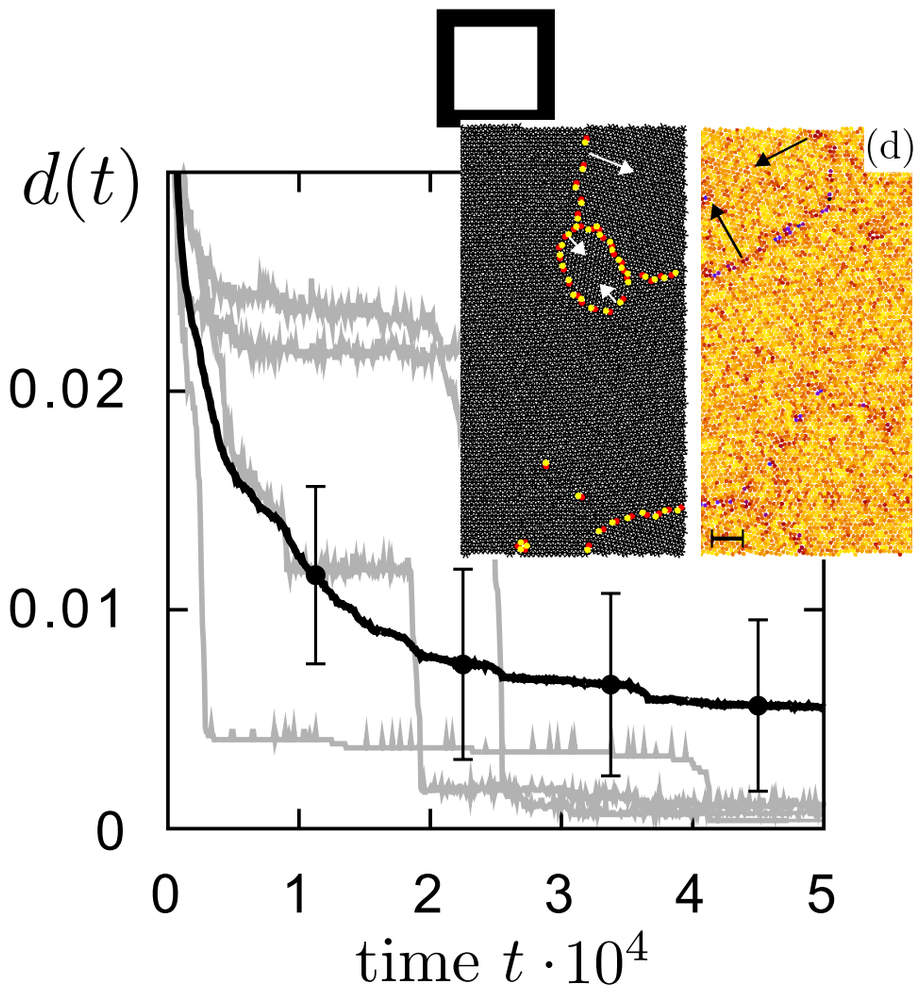

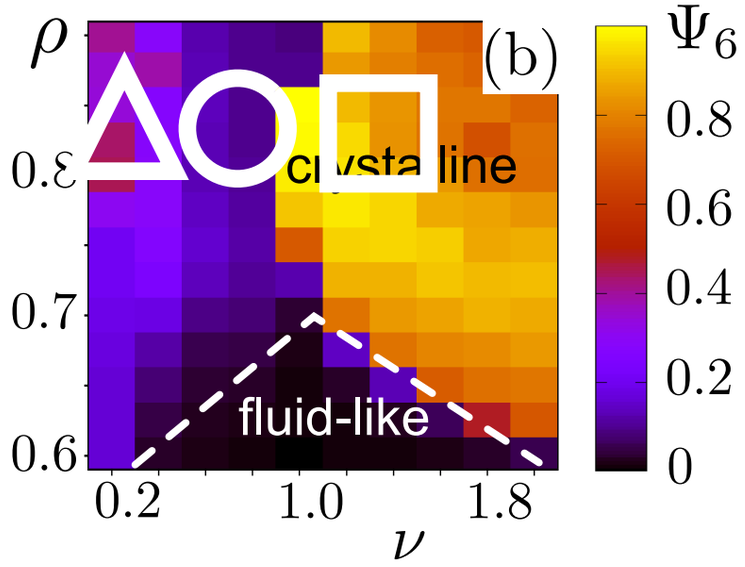

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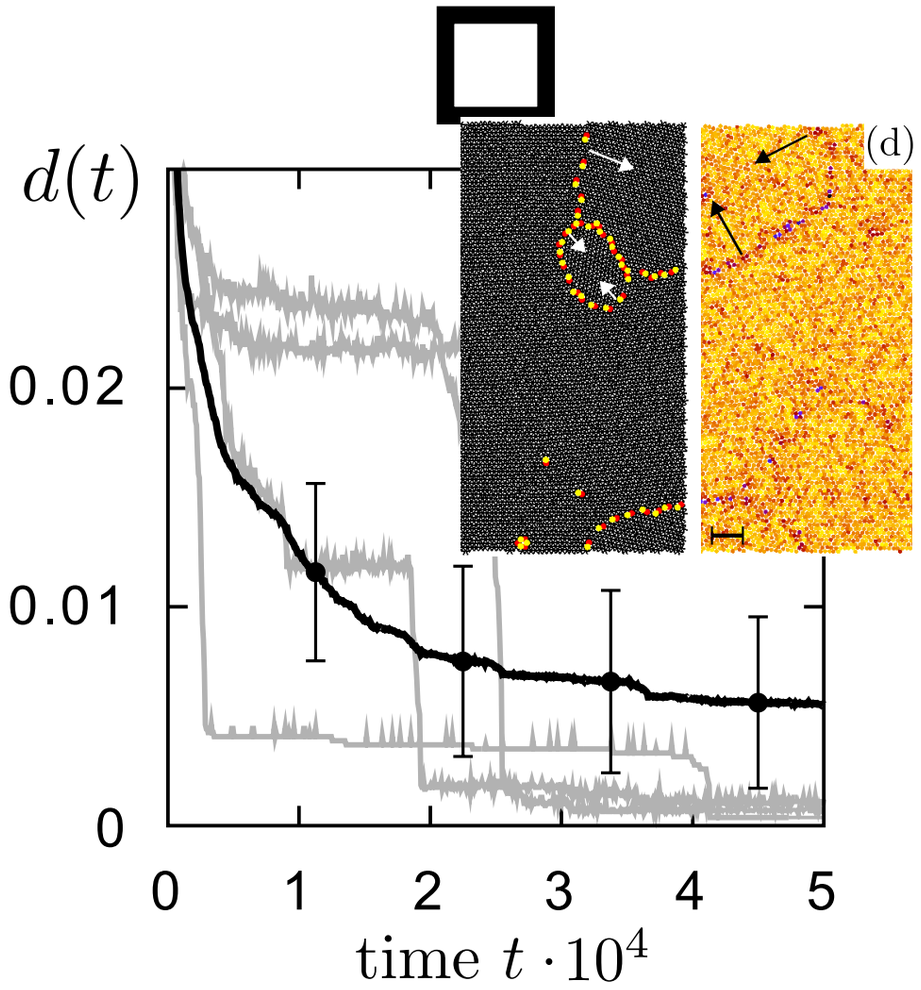

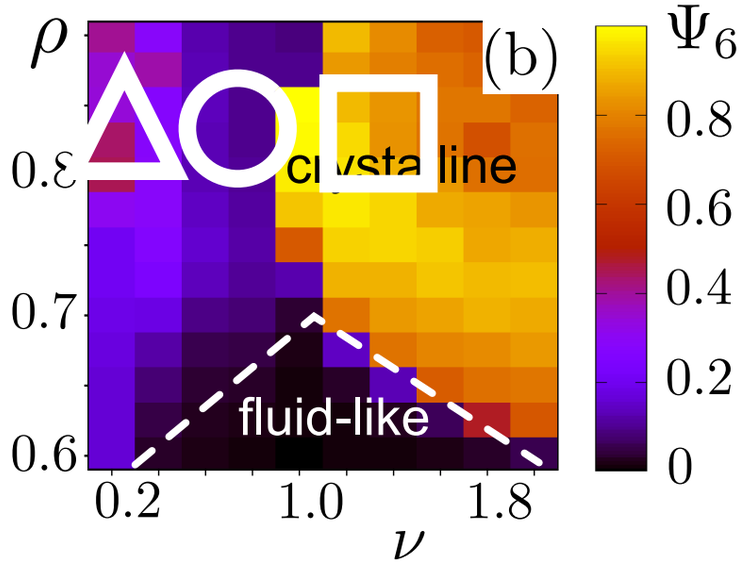

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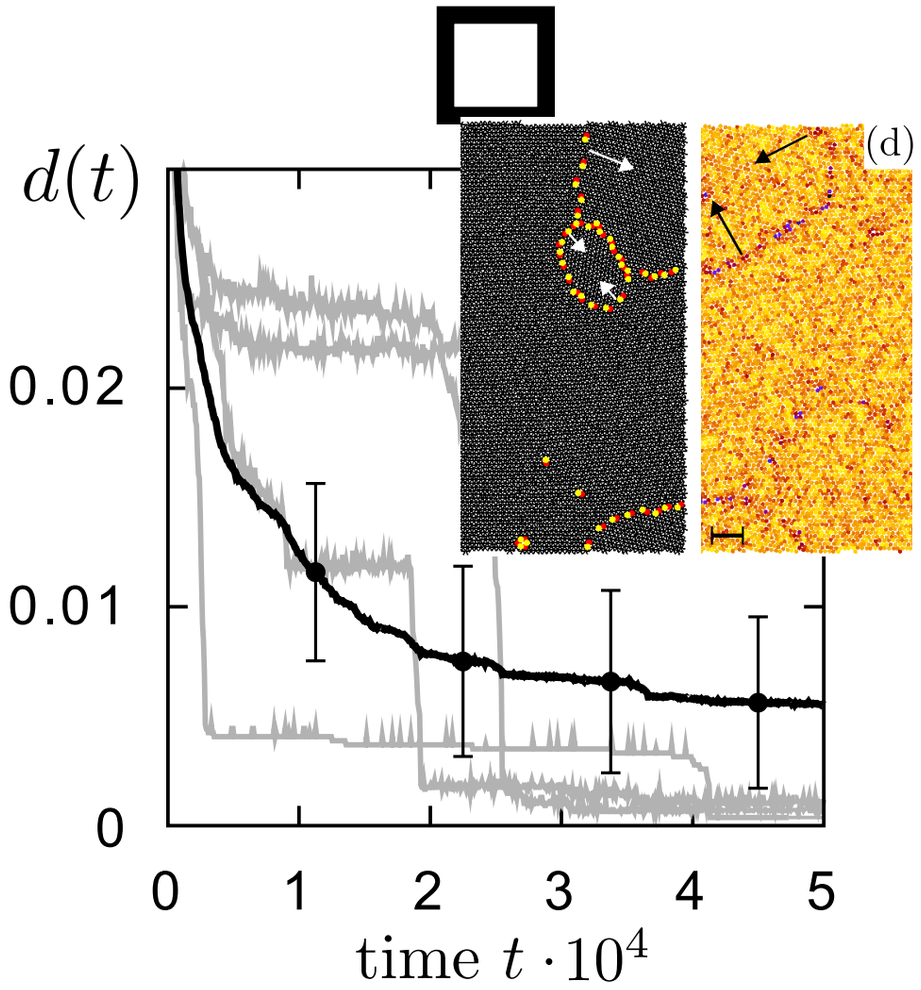

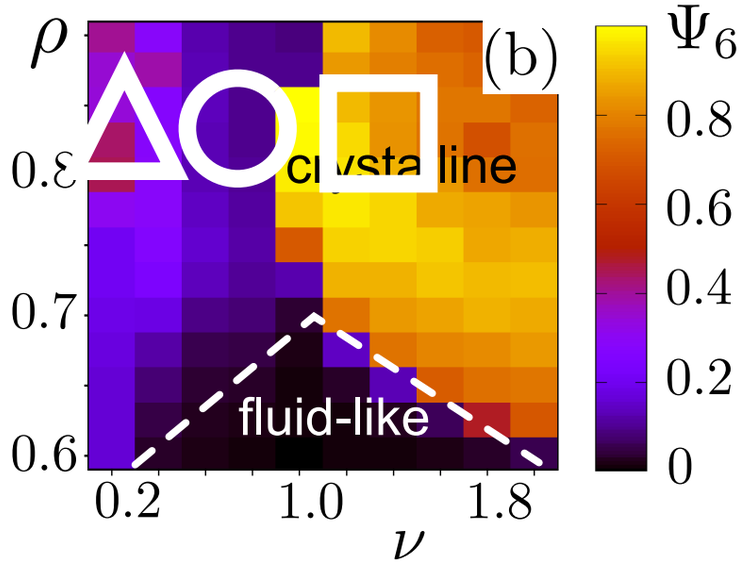

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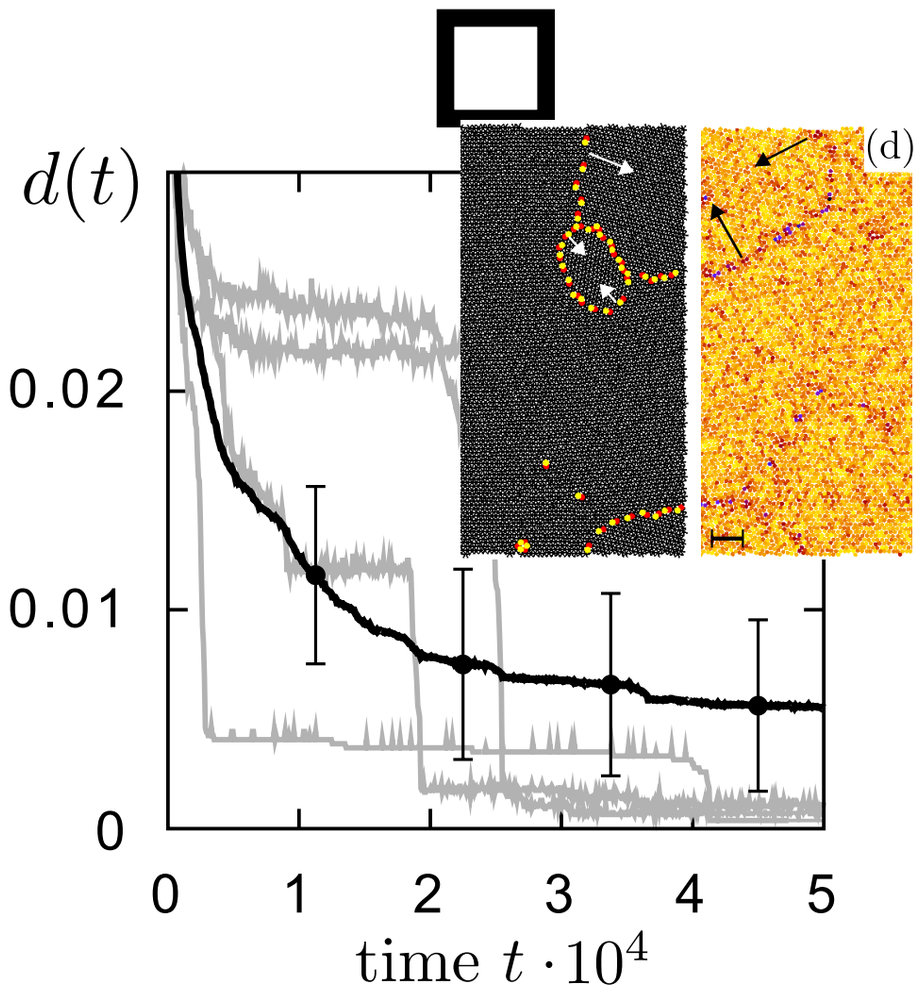

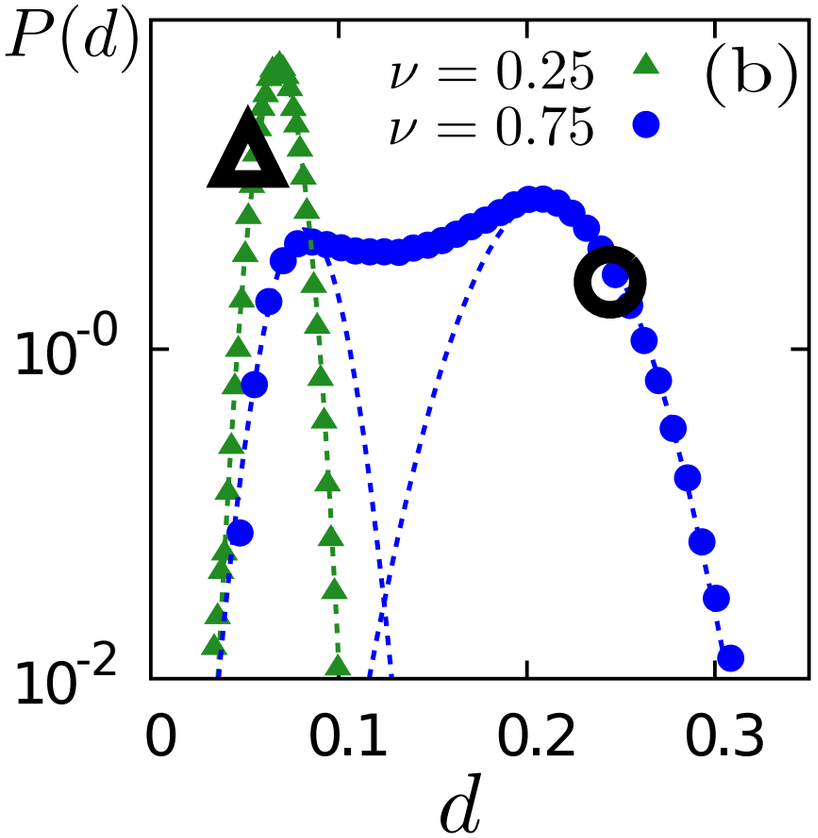

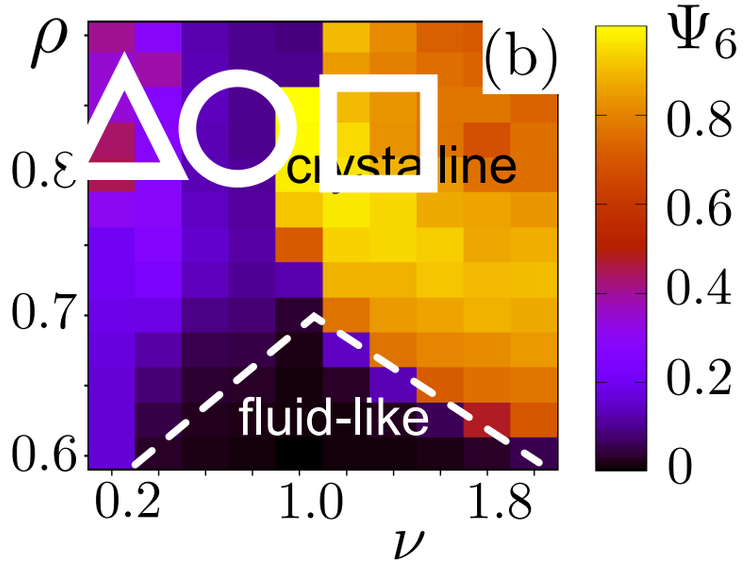

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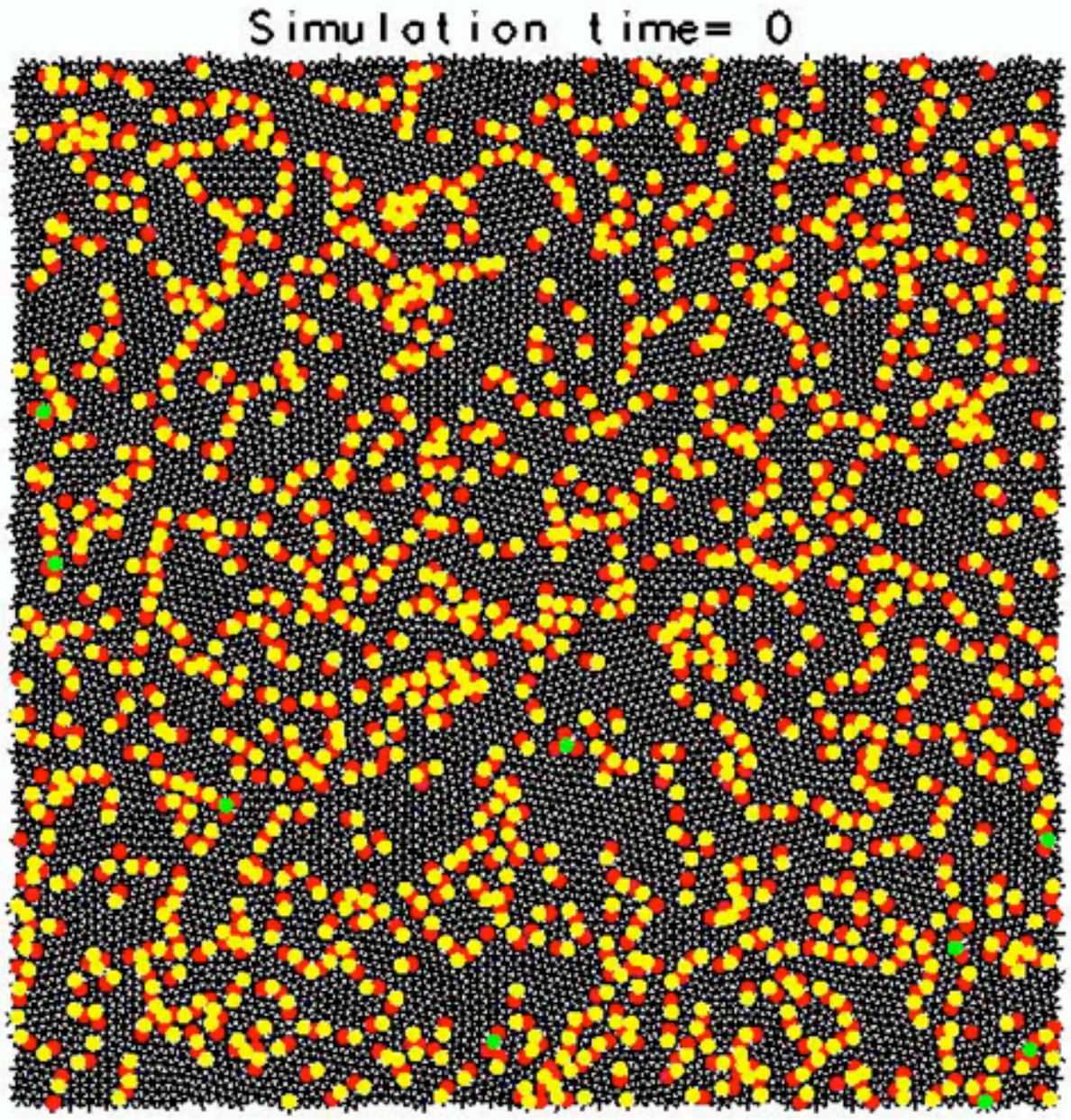

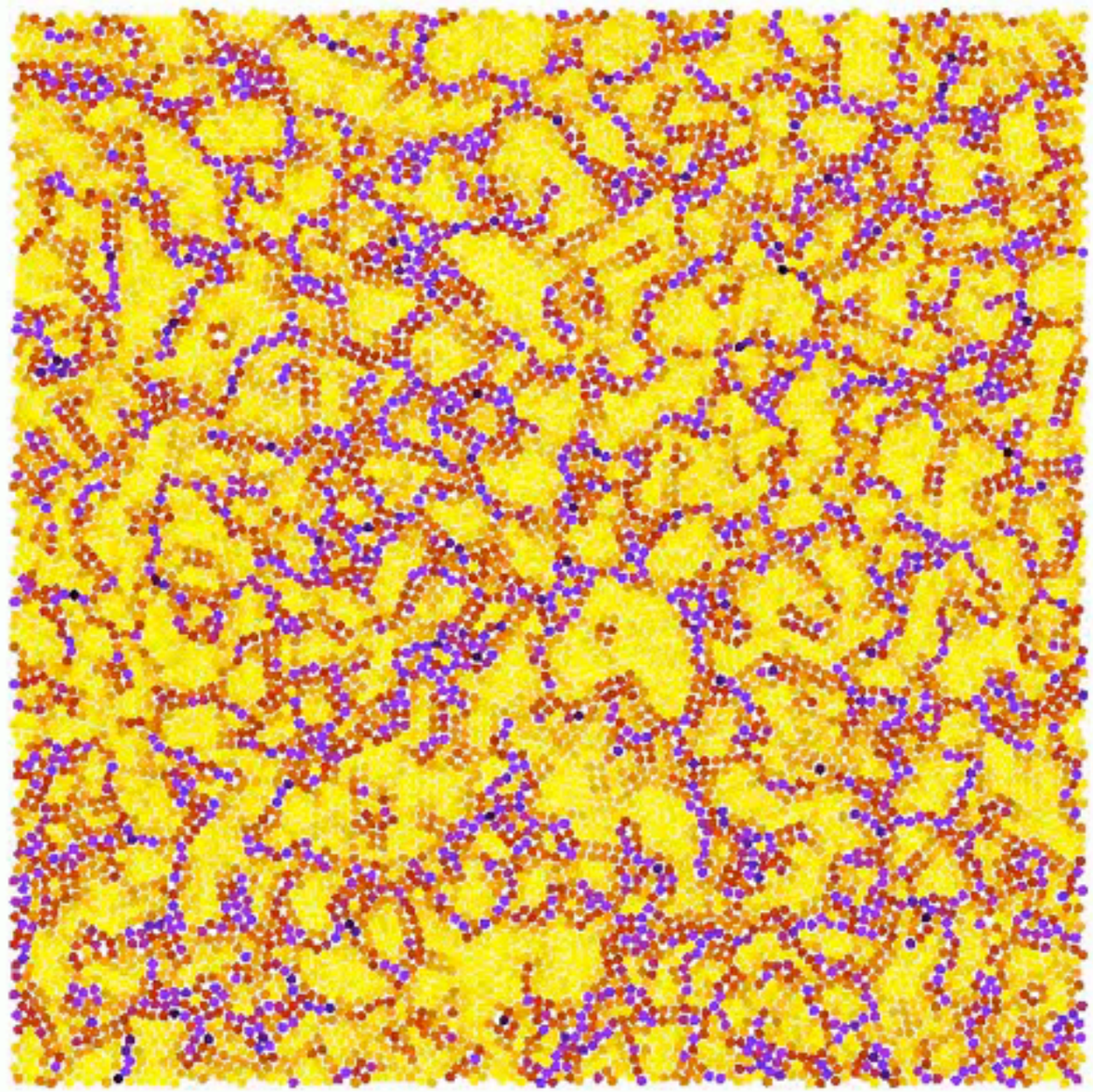

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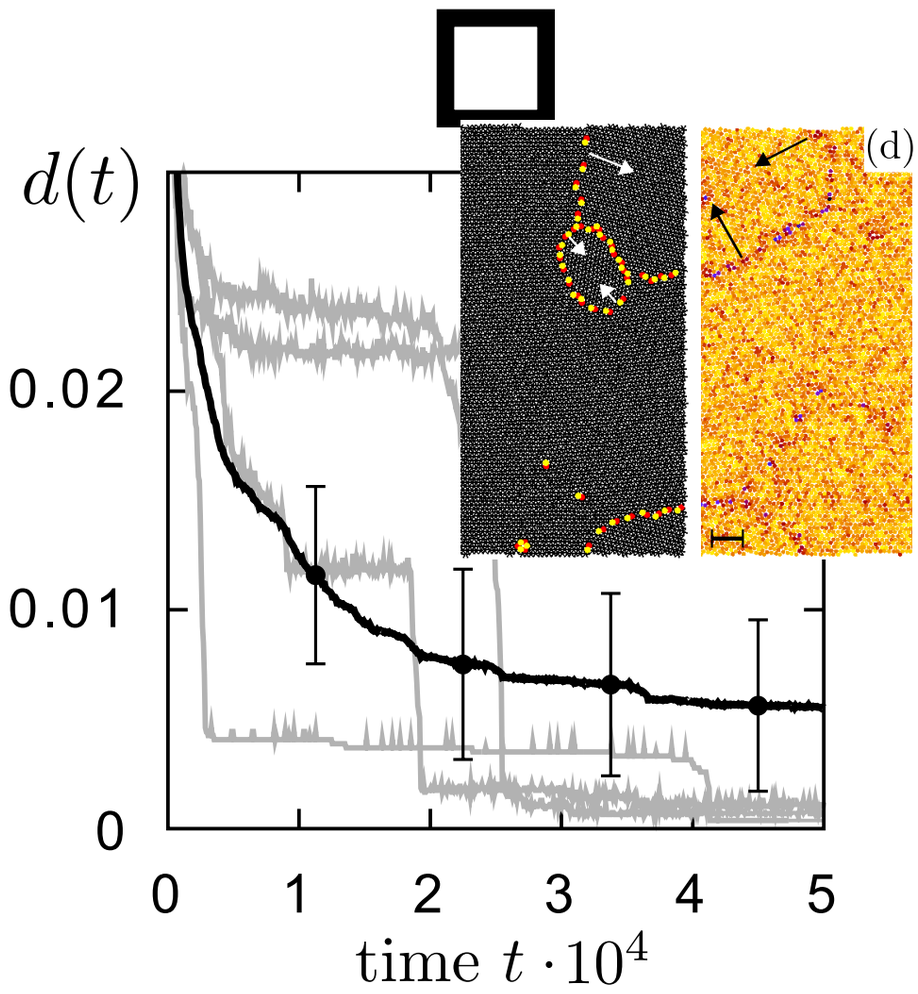

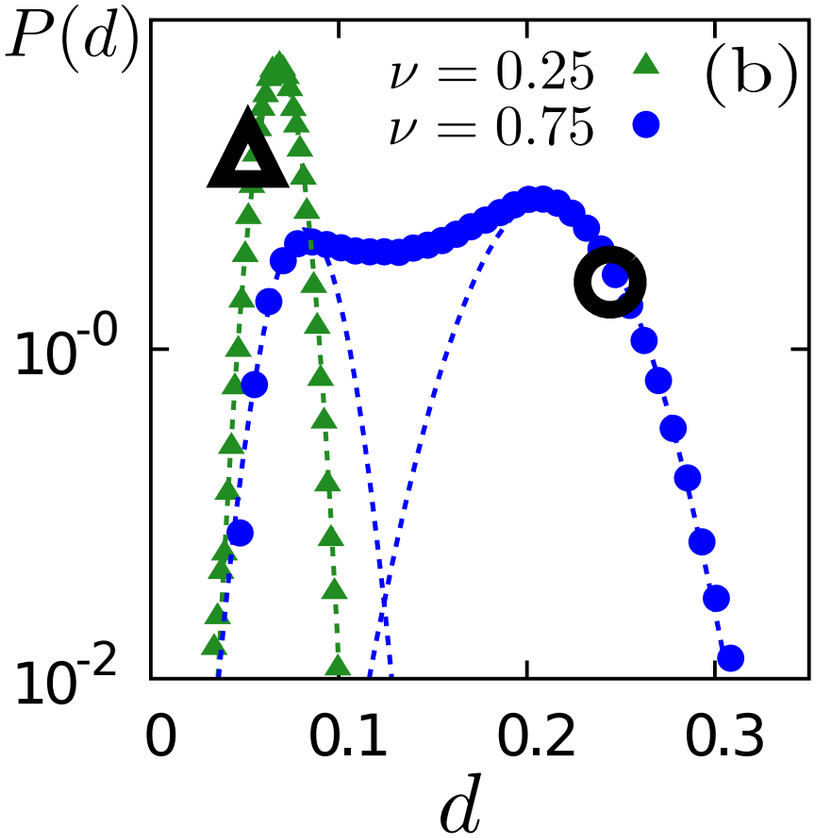

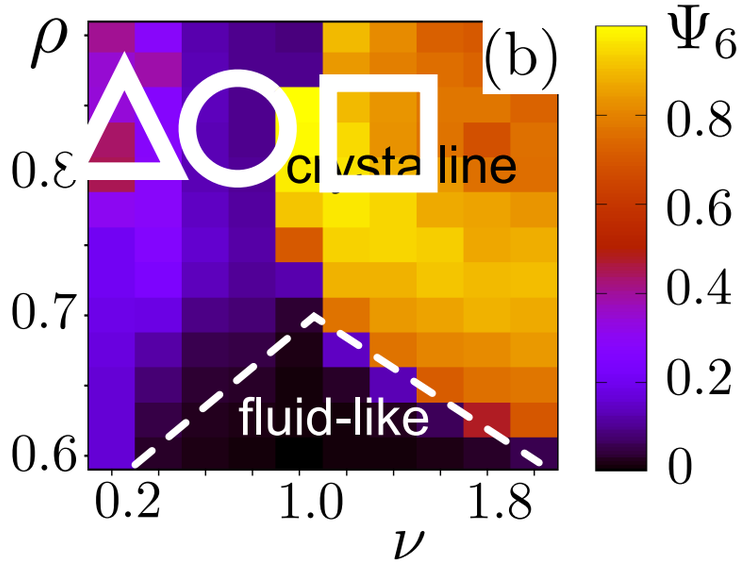

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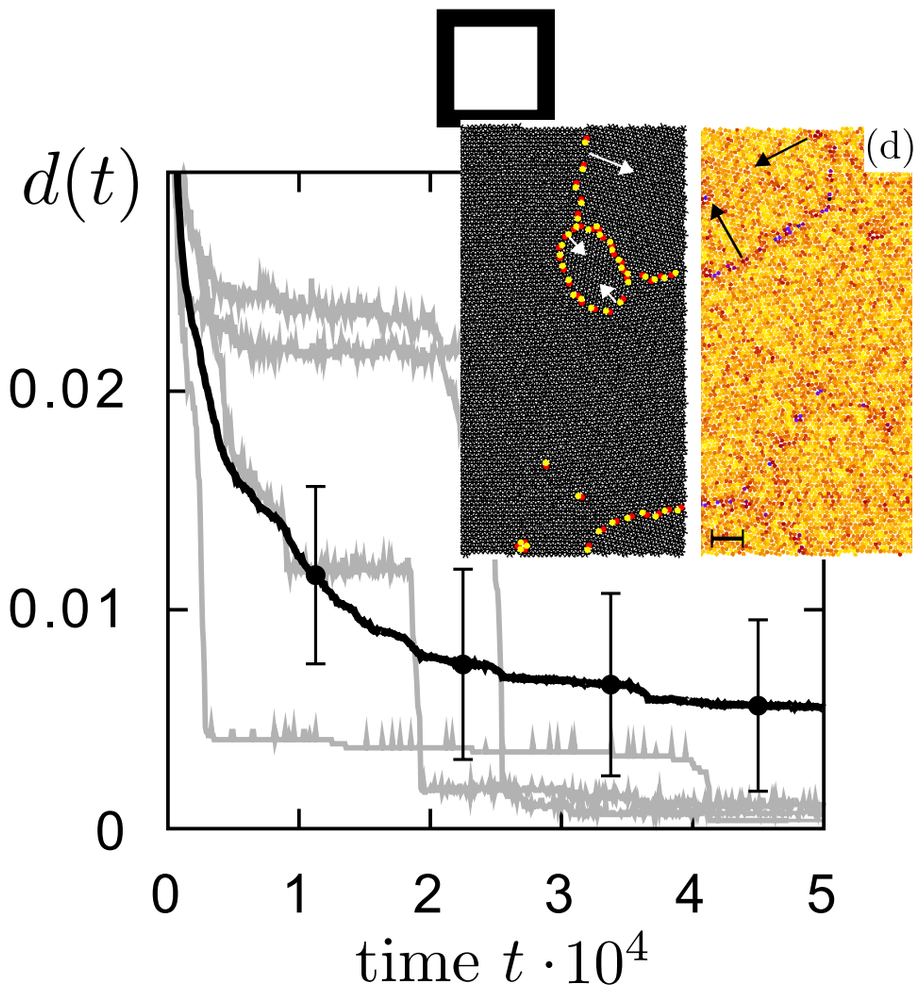

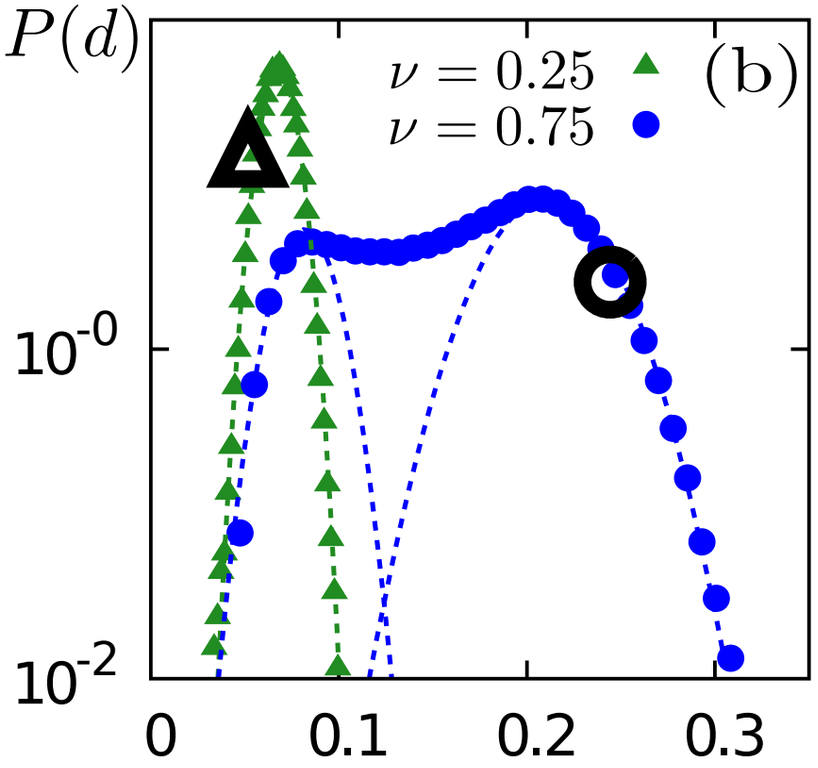

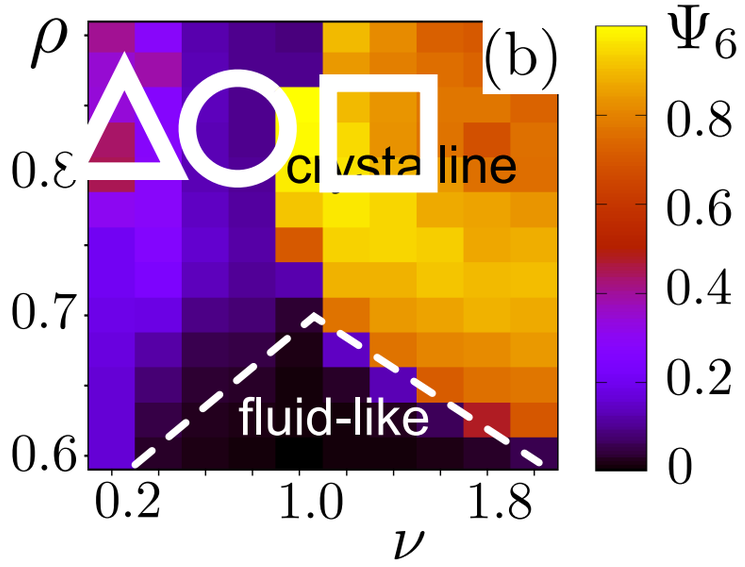

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<u>competition</u> between sound waves and local polar ordering
-> intermittency

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Thanks for listening!