Copepods counter dispersion to maintain high mating-encounter rates
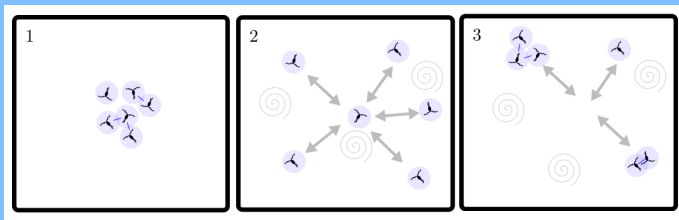
Ron Shnapp[*] **& Markus Holzner**

EGU, Vienna, May, 2022

[*]ronshnapp@gmail.com

Copepod diffusion

Copepods **diffuse** in their environment:

1. due to **turbulent** flows that carry them
2. due to their own **swimming**
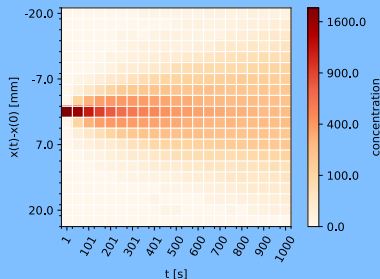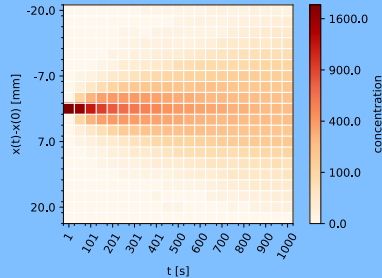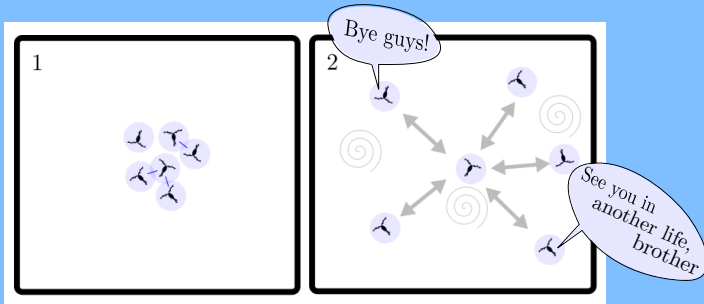
Copepod diffusion

Copepods **diffuse** in their environment:

1. due to **turbulent** flows that carry them
2. due to their own **swimming**

As a consequence, groups of copepods disperse away

The problem:

Copepods reproduce sexually, so males and females must find each other to reproduce. For that, they aggrgate in groups called mating-clusters.[1]
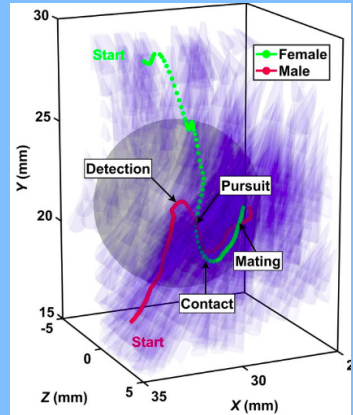
But, how can copepods cluster if their are constantly diffusing away?

[1]Davis et al, *Science*, 1992

Our solution

Male copepods constanlty search for cues from nearby females (hydrodynamical or chemical).[2]
When they pick up a signal, they attempt to make contact and varify whether mating is possible.


Michalec et al., *PNAS*, 2017

Spoiler alert:

**This approach for contact alone
is sufficient to make clustering happen.**

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[2]Bagøien & Kiørboe, *Marine Ecology Progress Series*, 2005

The pair-interaction model

Consider the following dynamical model:[3]

1. copepods wander around randomly in space;
2. copepods have an interaction sphere;
3. if two copepods are within each other's interaction sphere, they move to the same position (high-five);
4. after that, copepods cannot interact for a fixed period;
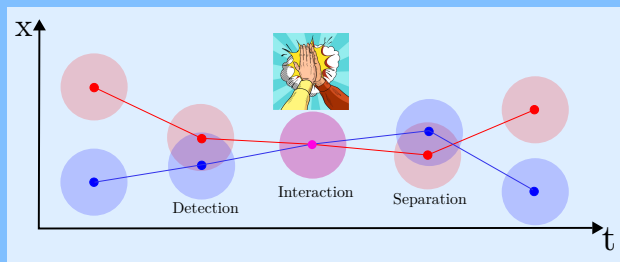
[3]Shnapp et al., arXiv:2205.08927, 2022.

# The pair-interaction model

Interactions support clustering[4]:
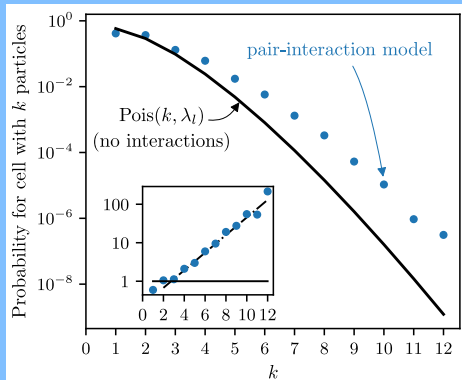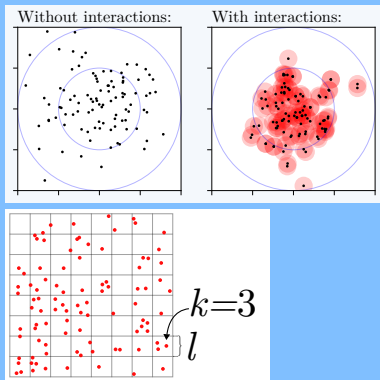
Similar to the aglumeration in colloid suspensions, clustering occurs due to reduced diffusivity of interacting particles.[5]

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[4]Shnapp et al., arXiv:2205.08927, 2022.
[5]Chandrasekhar, *Reviews of Modern Physics*, 1943

Experimental confirmation

We confirm our model using a 3D-tracking experiment[6] using about 65,000 laboratory trajectories[7]
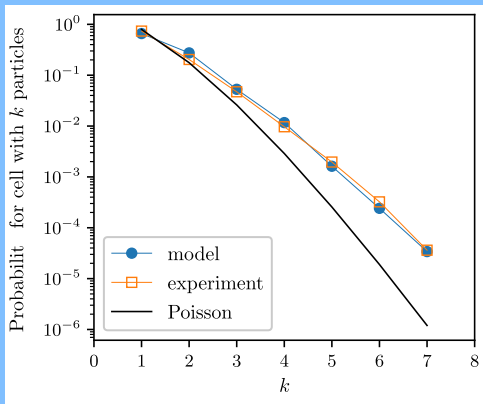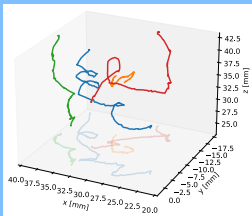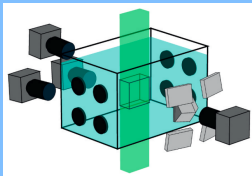
The PDFs of cluster size agree remarkably well, without <u>using any fitting parameters!</u>[7]

[6]Michalec et al., *PNAS*, 2017; Michalec et al., *eLife*, 2020
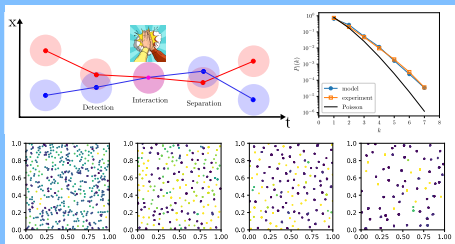[7]Shnapp et al., arXiv:2205.08927, 2022.

Conclusions

Take home message:

(1) For copepods, mating clusters are crucial to maintain high encounter rates

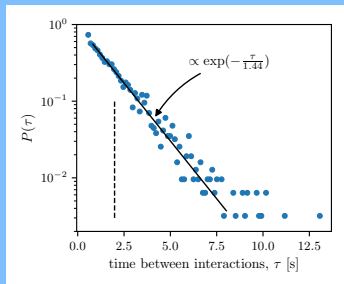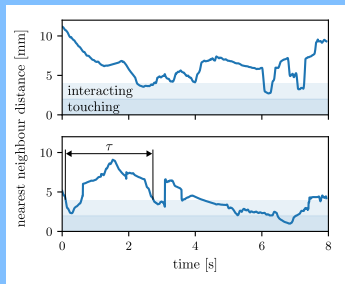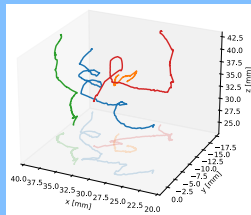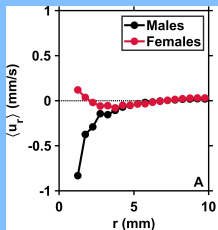(2) Mating clusters are supported by pair-interactions (a *high-five* mechanism)

preprint:
R. Shnapp, F.-G. Michalc and M. Holzner, arXiv:2205.08927, 2022 (submited)

Thank you!

Extra - measuring model parameters

Michalec et al., *eLife*, 2020;

Shnapp et al., arXiv:2205.08927, 2022.