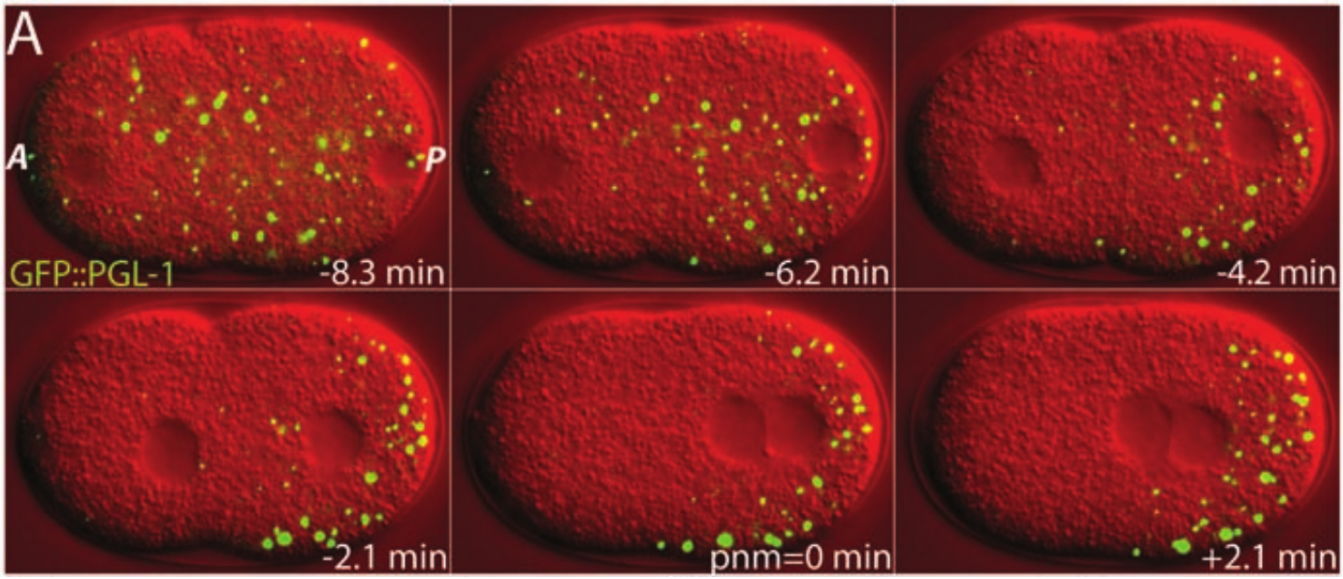
Condensation and decondensation of P-granules

Here, I want to discuss the paper [Germline P Granules Are Liquid Droplets That Localize by Controlled Dissolution/Condensation (http://science.sciencemag.org/content/324/5935/1729)](http://science.sciencemag.org/content/324/5935/1729) in a bit more detail.

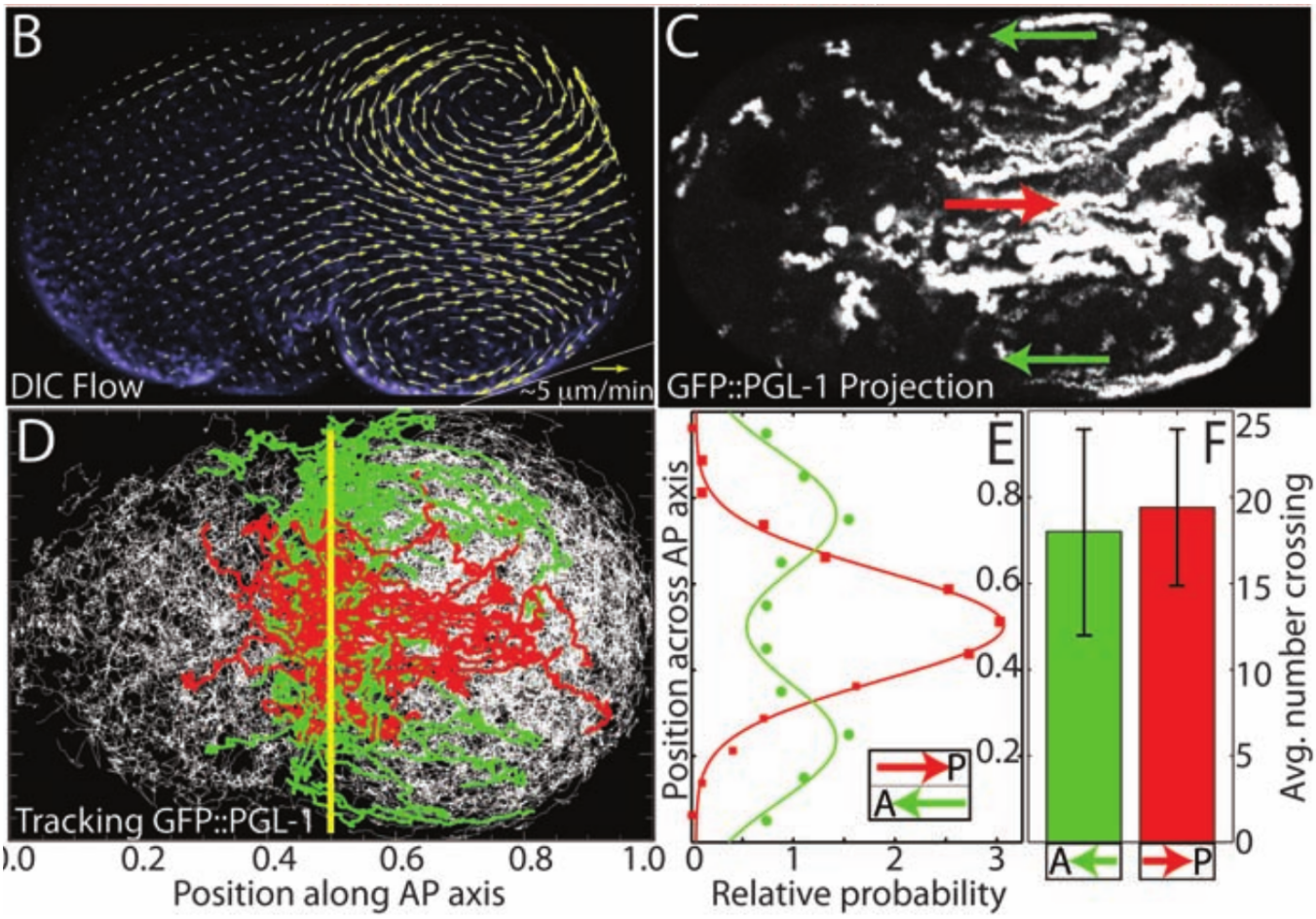
- one of the first paper to implicate phase transitions in these droplets
- extensive physical characterization of P-granules

P-granules are little organelles that all end up in the posterior cell in the first division of a C. elegans embryo.



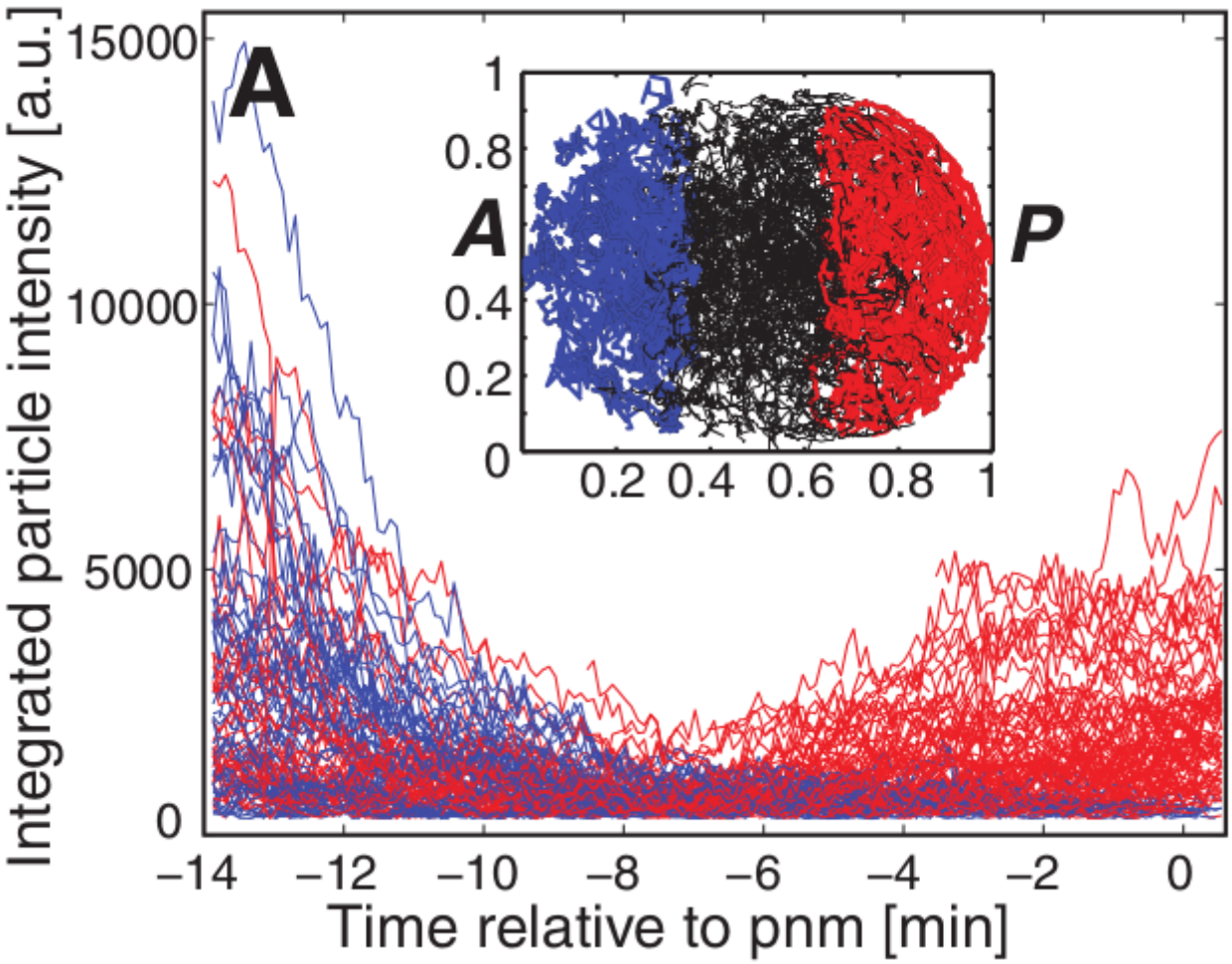
How the localize was a primary question of the paper.

The hypothesis that they localize due to flow patterns was not confirmed:

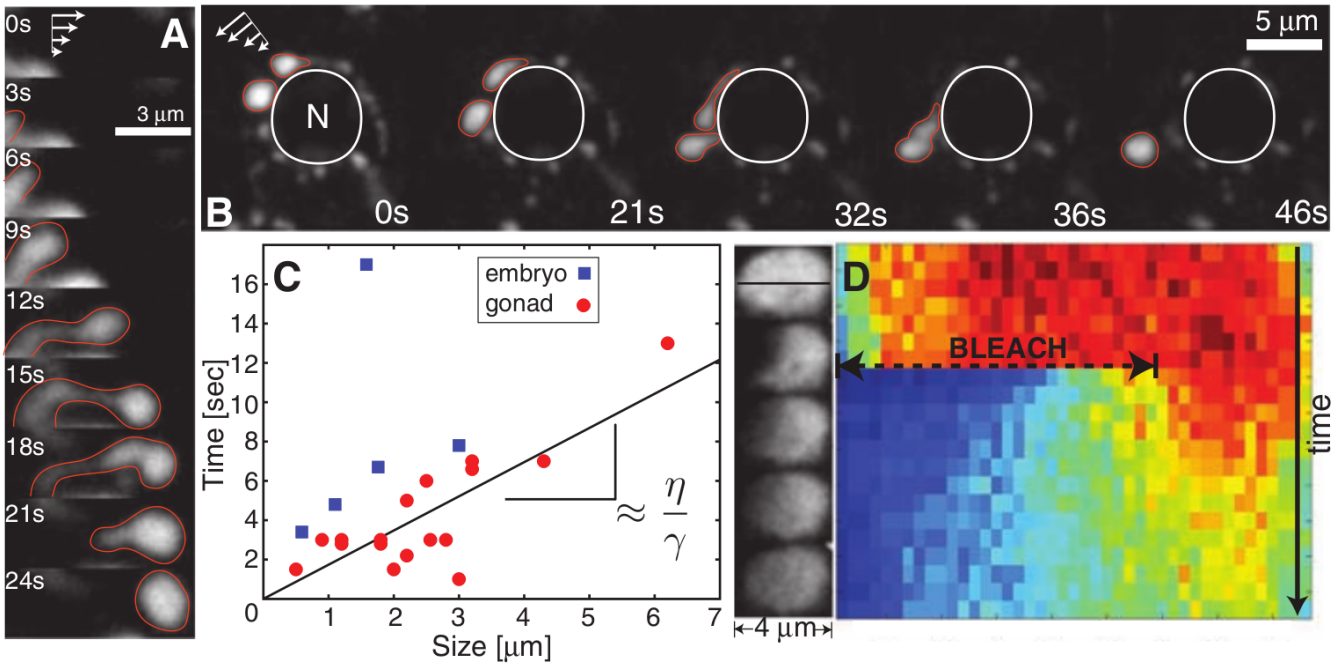


Droplets cross the midline left to right as often as right to left!

Initially, droplets tend to shrink left and right, but at some point they start growing on the right:

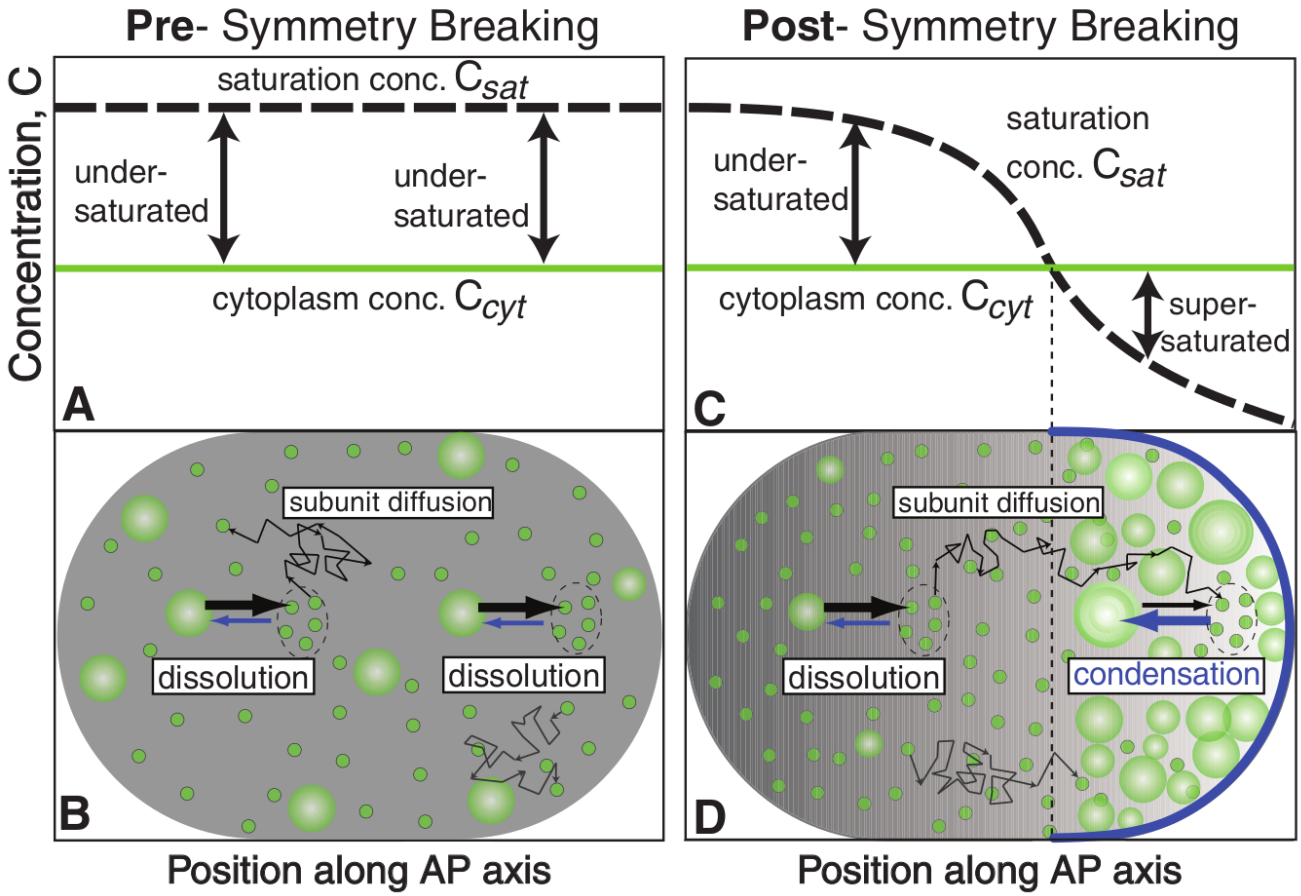


P-granules behave like liquids!



- in shear flow, they wet, drip, and fuse
- the time scale of fusion and break up increases linearly with diameter. This is expected for liquids, where this time is given by the diameter times the ratio of viscosity and surface tension.
- FRAP experiments thow that GFP diffusion is rapid within droplets: $D \sim 0.4 \mu m^2/s$ ($\tau \approx 5s$, $\Delta x \approx 2 \mu m$) but considerably slower than in the cytosol.

Model of P-granule dynamics



- initially, conditions left and right are such that P-granules dissolve
- protein gradients in PAR-1 and MEX-5 change conditions on the right
- cytosol is now super-saturated, resulting in growing droplets

This mechanism effectively sorts all the P-granules to the right of the cell and then into the germline cell lineage.

Summary

- Excellent example of using concepts in physics to explain complex biological phenomena.
- Rarely ideas from physics apply one-to-one, typically evolution has added complications to the problem.
- But these ideas from physics can explain the essence of the behavior.
- Tony Hyman explains p granule dynamics in this video (https://youtu.be/HRlOlu5NsqQ) in greater detail (youtu.be/HRlOlu5NsqQ).