Physical studies of cell membrane and membrane protein biophysics

Collaboration between
Catherine Crouch (Physics)
and Kathleen Howard (Chemistry)
Cell membrane curvature

- Membrane shapes change in many critical cellular processes (such as movement, division)
- How are such changes caused by:
  - Protein structure
  - Membrane structure
Possible simple mechanism

Proposed mechanism for surface binding proteins

(Bhatia, Stamou, et al, EMBO J. 2009)

- Hydrophobic part wedges into membrane defects
- Higher curvature (bending membrane more) $\rightarrow$ more defects

Do membrane proteins use this mechanism?

Experiments

- Need to understand and optimize physical properties of simple model system (vesicle with just the membrane protein of interest)
  - Light scattering
  - Fluorescence correlation spectroscopy
Fluorescence correlation spectroscopy

Probes diffusion of single fluorescent objects
Fluorescence correlation spectroscopy

Probes diffusion of single fluorescent objects

![Diagram of fluorescence correlation spectroscopy](image)

- Fluorescence signal
- Autocorrelation function
- Graph showing intensity over time (log(t))
- Representation of 0.3 µm and 1.5 µm dimensions
Vesicle dynamics

Can we observe *rotational* diffusion in vesicles with only a few fluorescent molecules?

Involves:
- Bench chemistry preparing vesicles
- Optical experiments
- Data analysis
What makes teaching physics effective for life science students?

Collaboration with colleagues at University of Maryland and Ben Geller and Ann Renninger (Education)
Research questions

☐ Do students carry what they learn in physics forward into later biology courses and research?

☐ What aspects of a physics course support students to do so?
To learn more ....

I’m always happy to talk about these exciting questions!

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