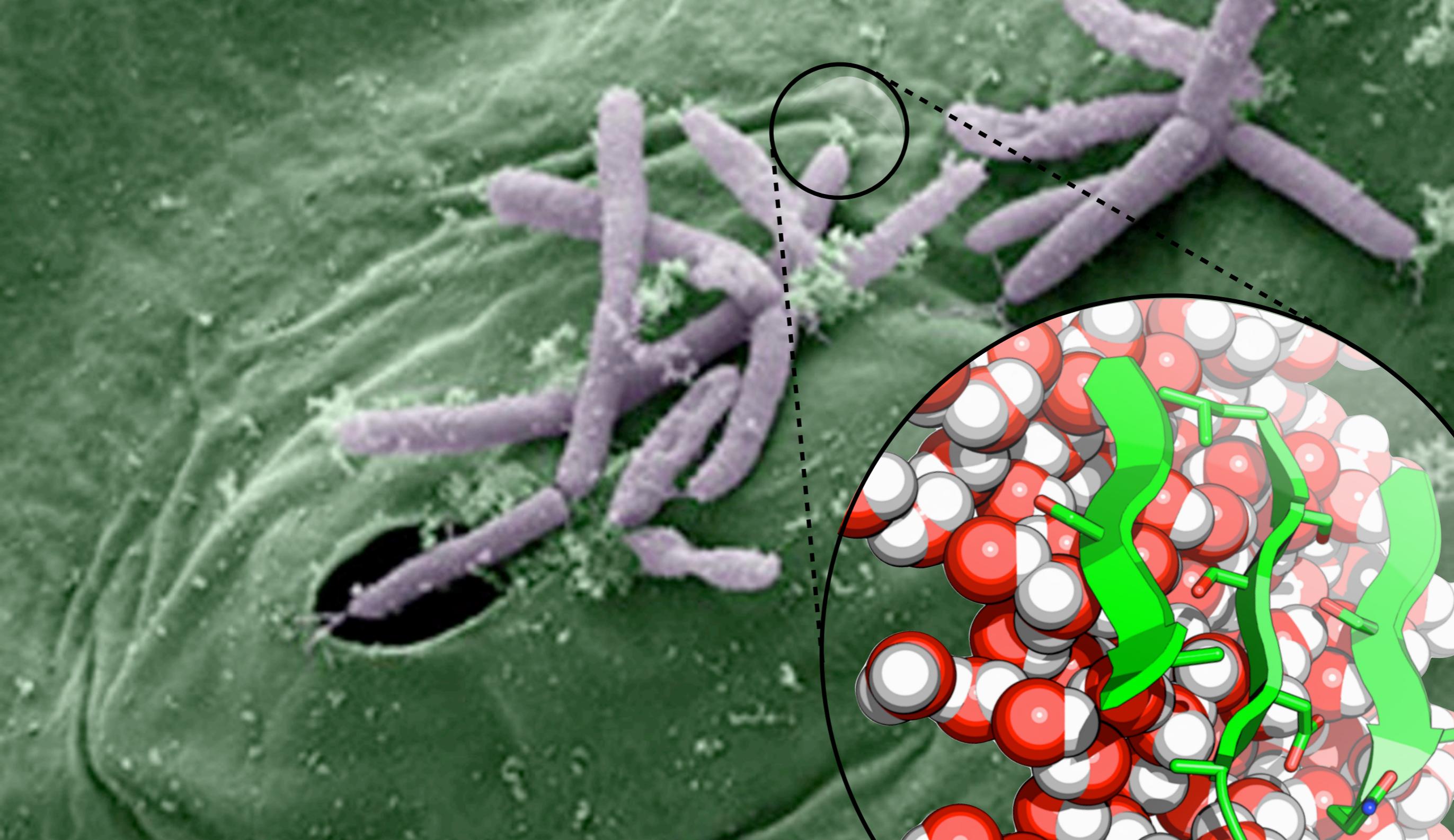


Winter is coming: How bacteria make snow

Tobias Weidner



Grow ice on plants and atmosphere
Pseudomonas Syringae

Ice bacteria travel the planet

1982: Russell Schnell notes a tea plantation in Western Kenya was having hailstorms 132 days of the year. The hail was forming around *P. syringae* that were kicked up by tea pickers in the fields.

2008: Microbiologist at Louisiana State University discovered 70-100% of ice nucleators in snow fallen in Montana and Antarctica were biological.

2012: Researchers at Montana State University found high concentrations of bacteria in hailstones that had fallen on campus.

Since then many research groups have reported large amounts of ice bacteria in the atmosphere and the water cycle.

Ice proteins affect global precipitation patterns

Is there an entire ecosystem of rain-making bacteria living and reproducing up in the stratosphere?

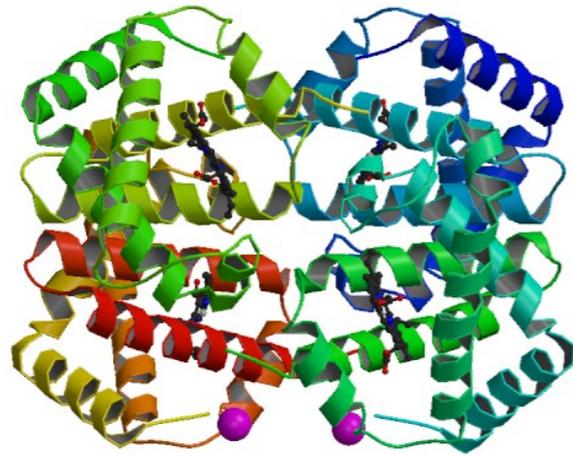
Ice bacteria seed clouds in the atmosphere.

So, what temperature are needed to make ice?

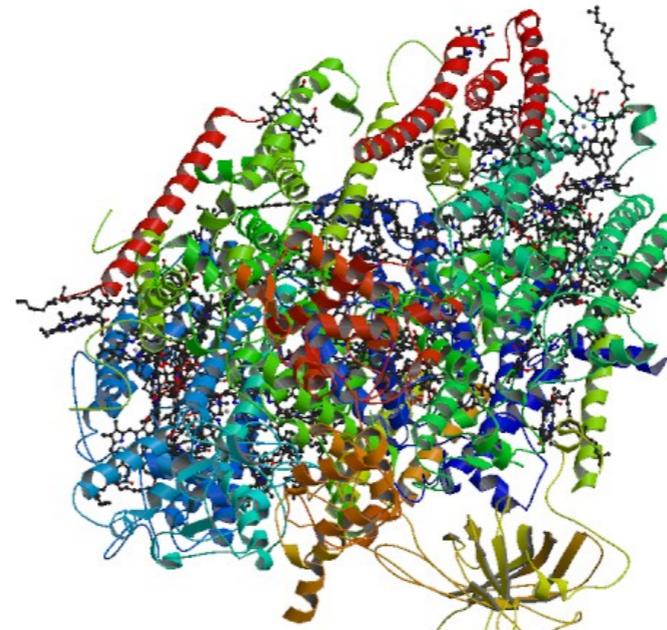


Water freezing: -40°C
Soot, dust, clay: -20°C
Ice bacteria: -5°C

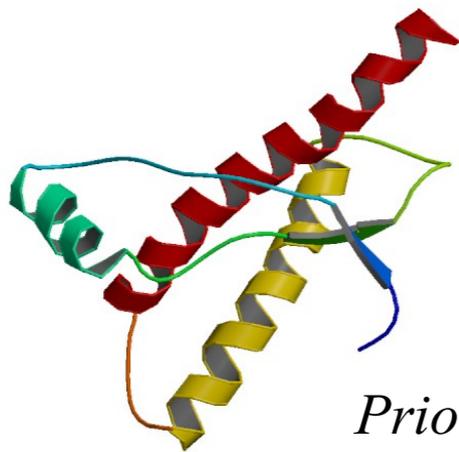
Proteins are the machines of life



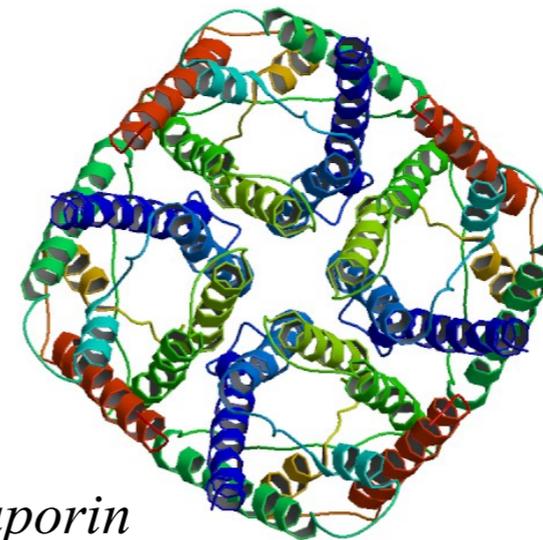
Hemoglobin
(Let's you breathe)



Photosystem Protein
(Convert Sunlight)



Prion Protein
(Mad Cows)



Aquaporin
(Water Pore)

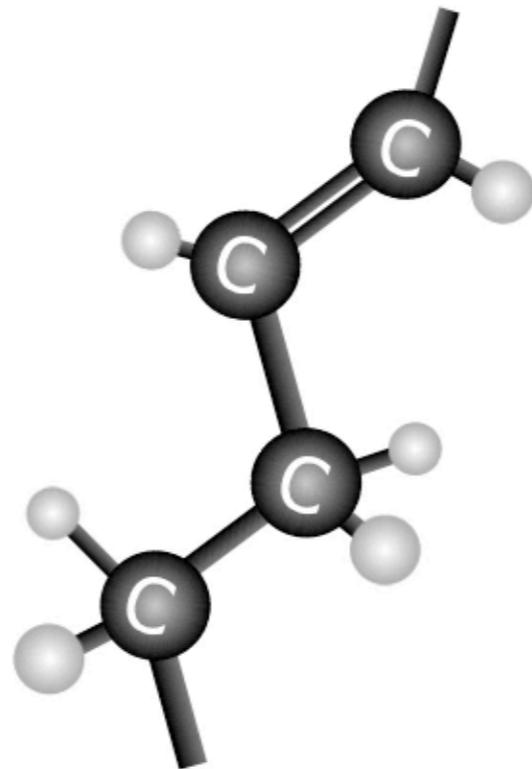
Methods

Vibrations report back on biomolecular structure:

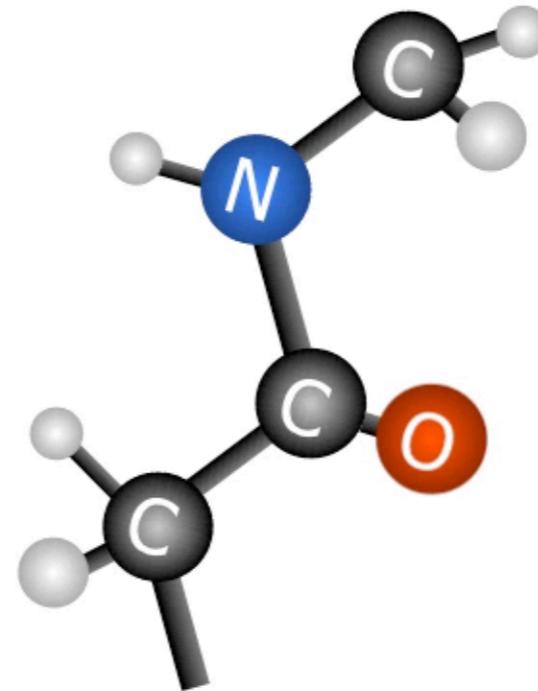
Water



Side chains

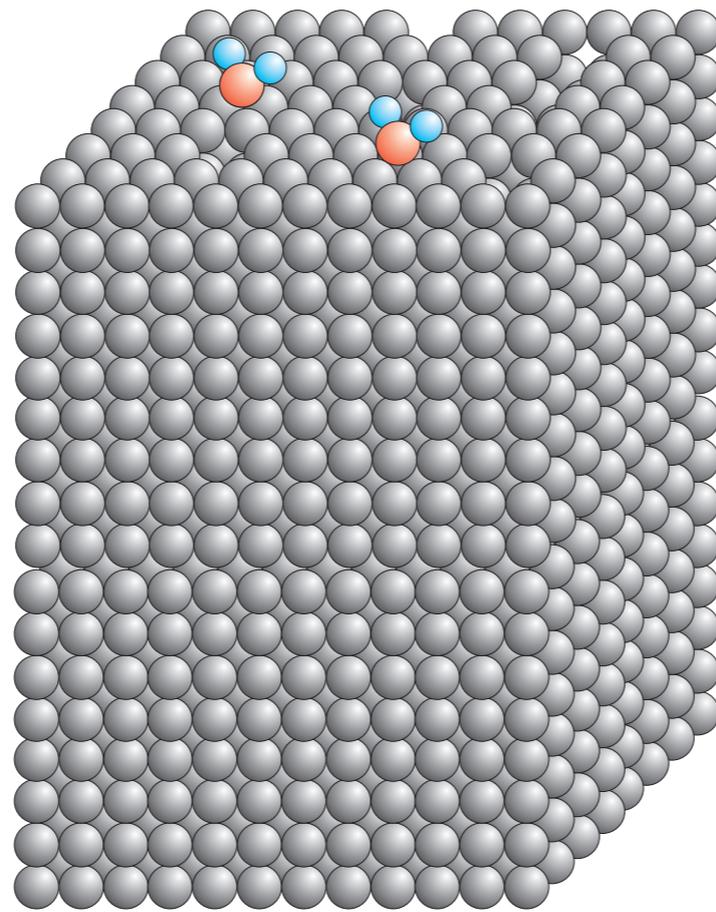


Proteins

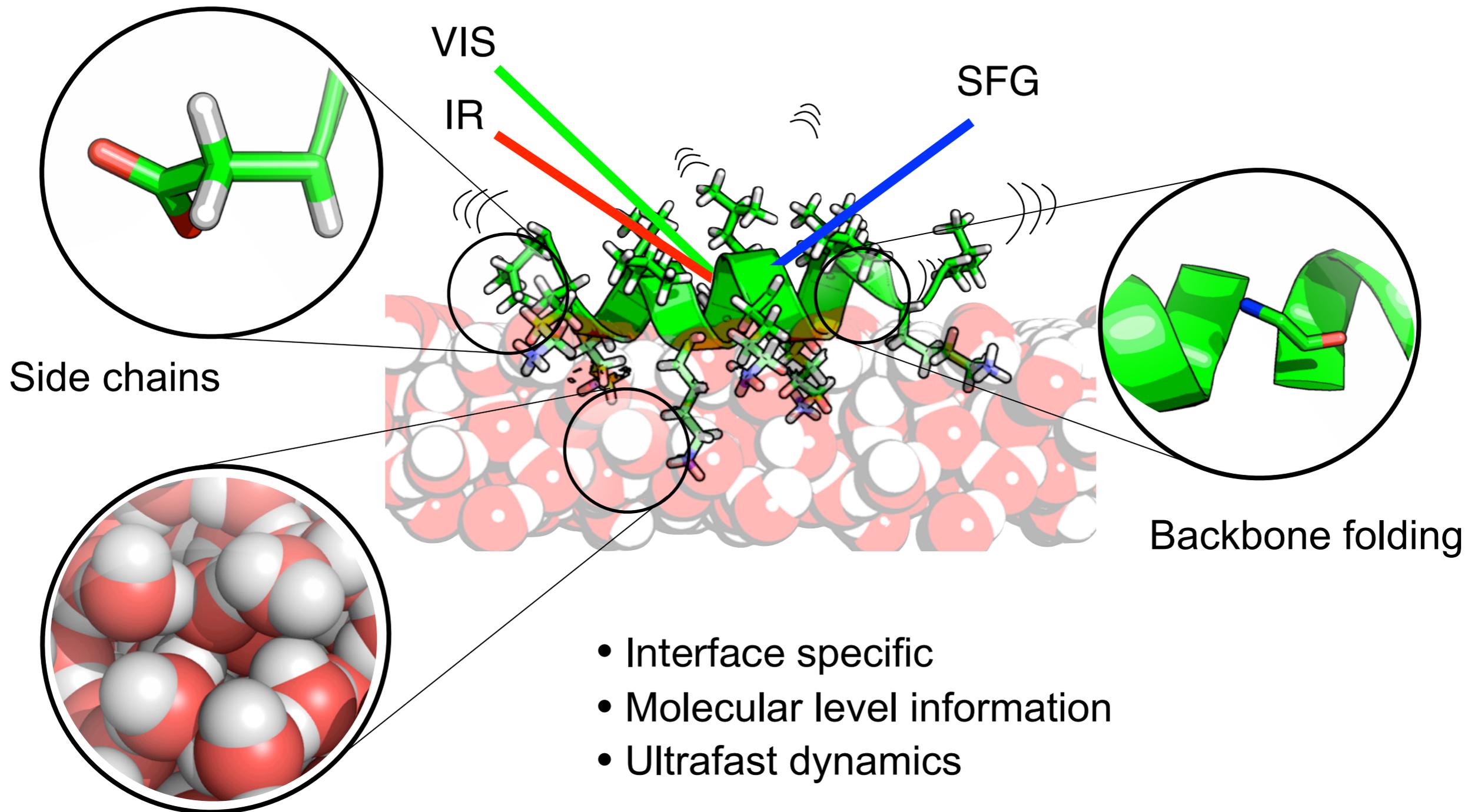


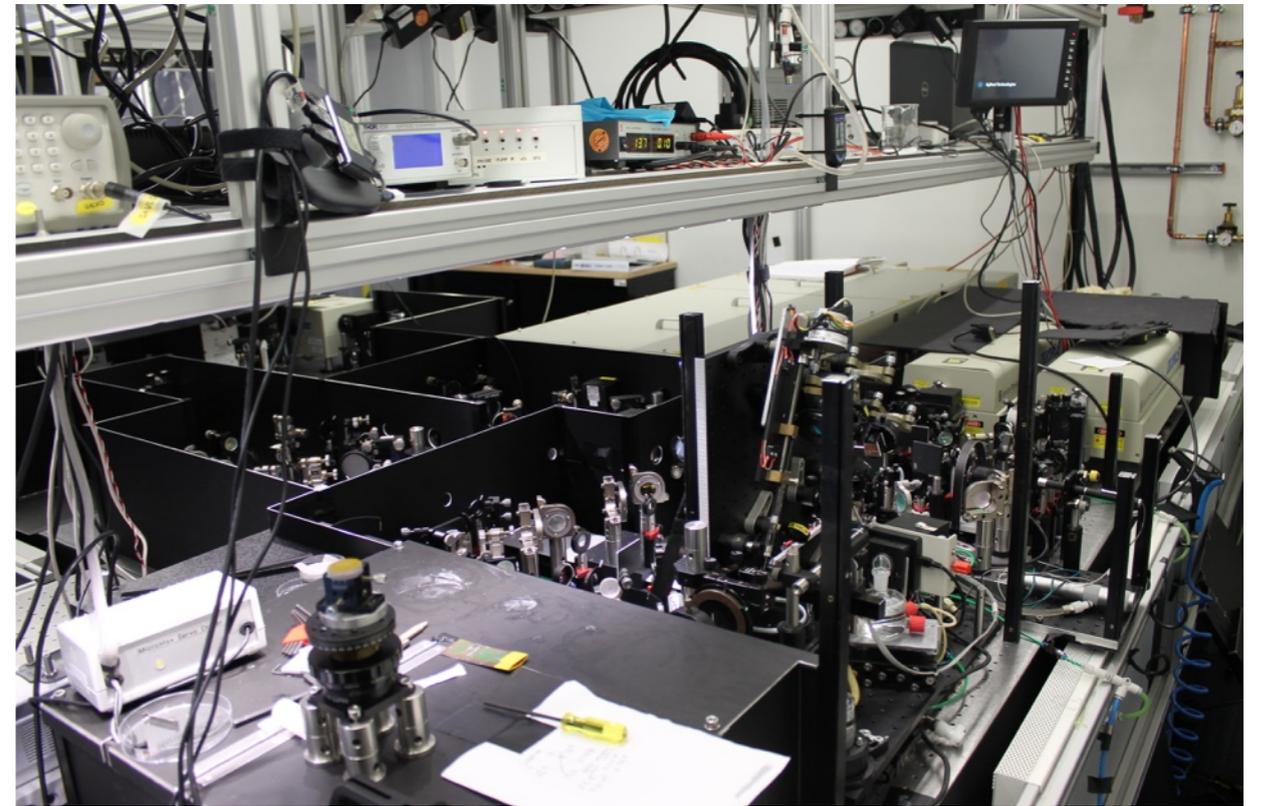
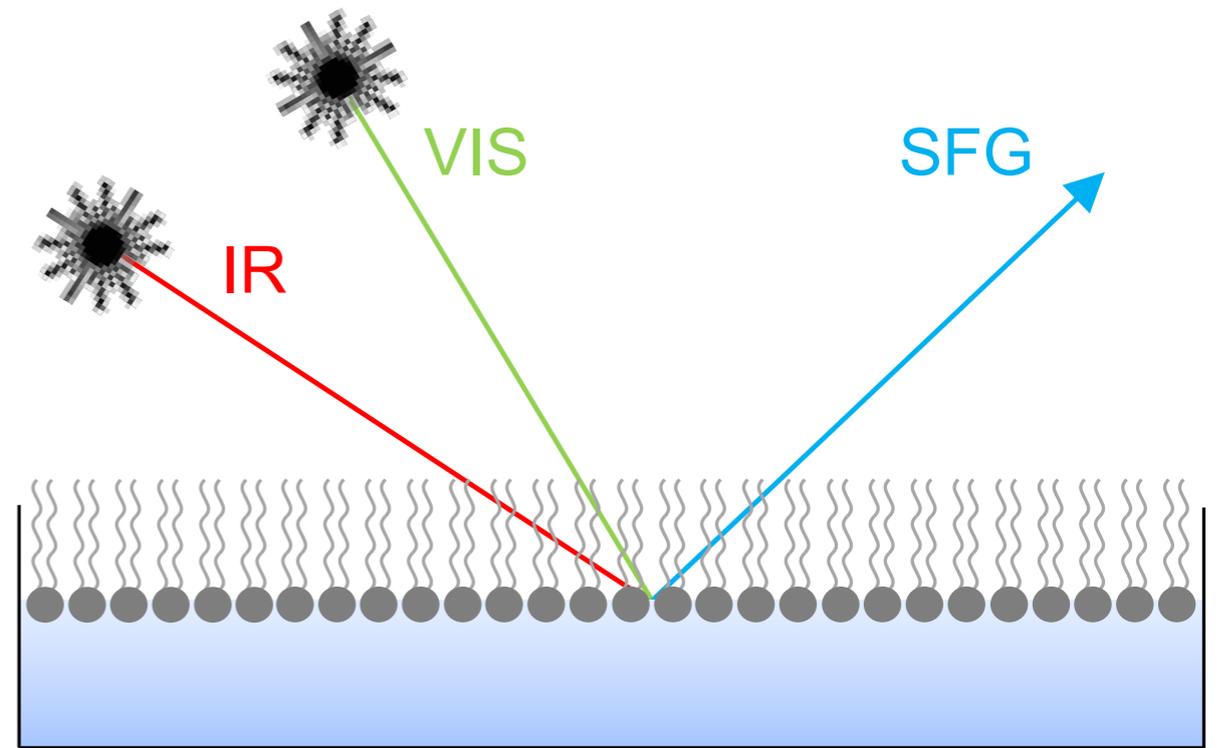
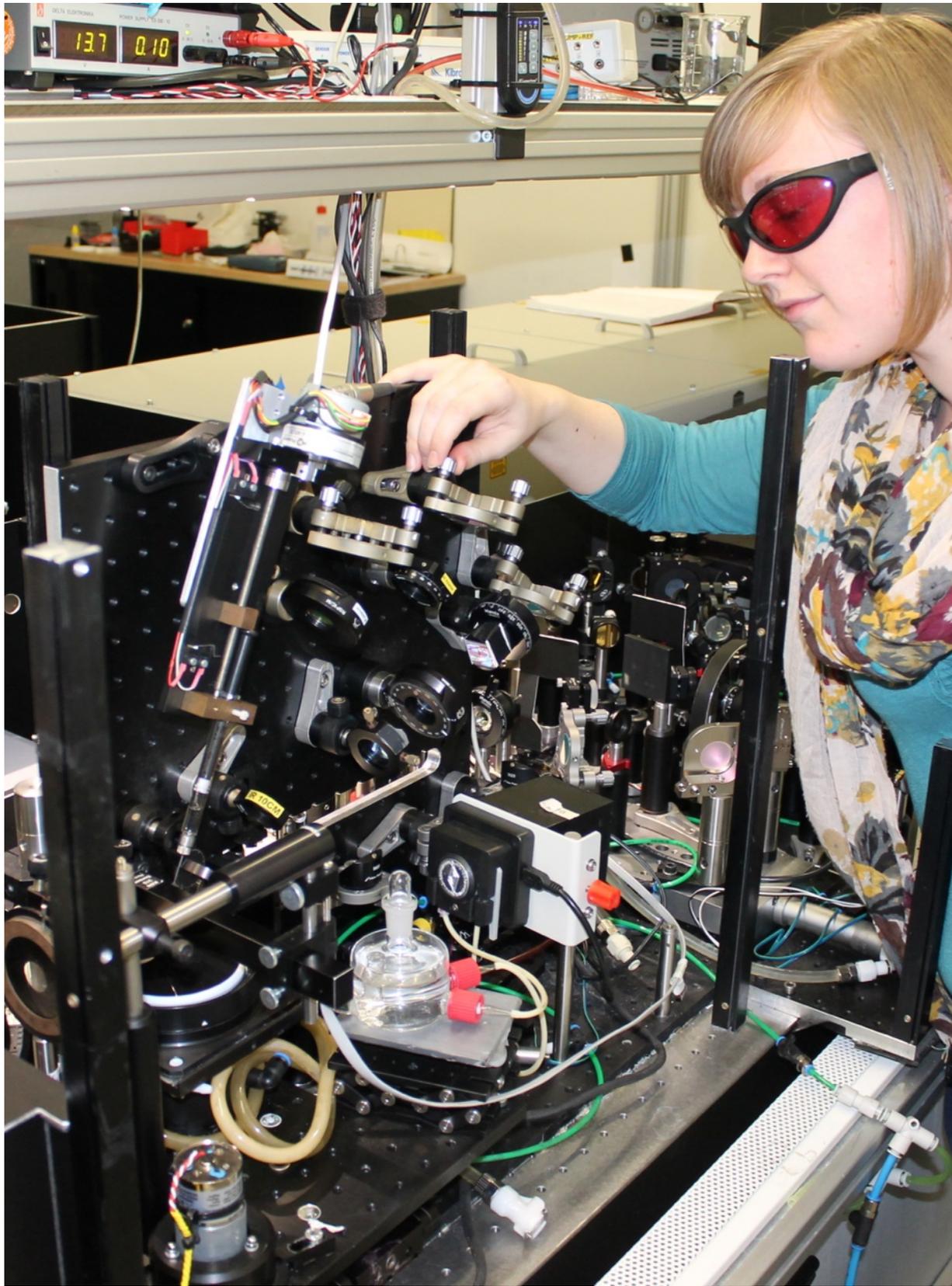
A chemical bond is just like a spring: the oscillation frequency is given by the strength of the chemical bond and the masses of the atoms involved.

How to track the vibrations?



Method: Sum frequency generation spectroscopy

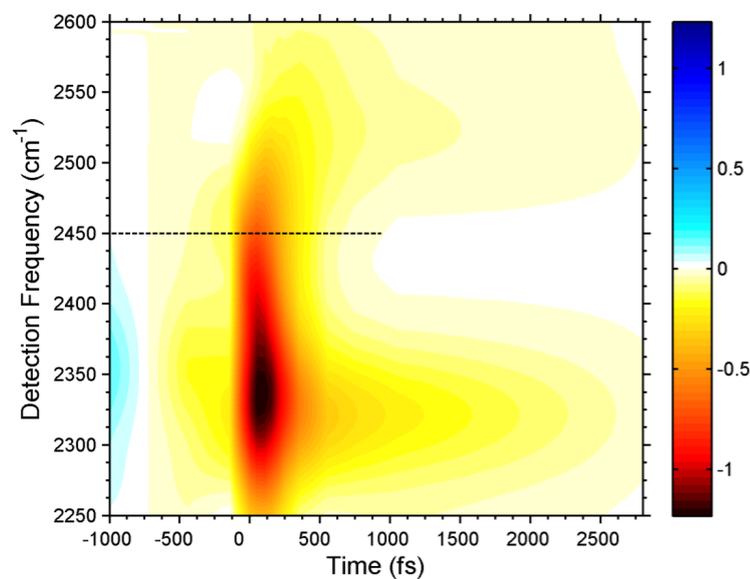
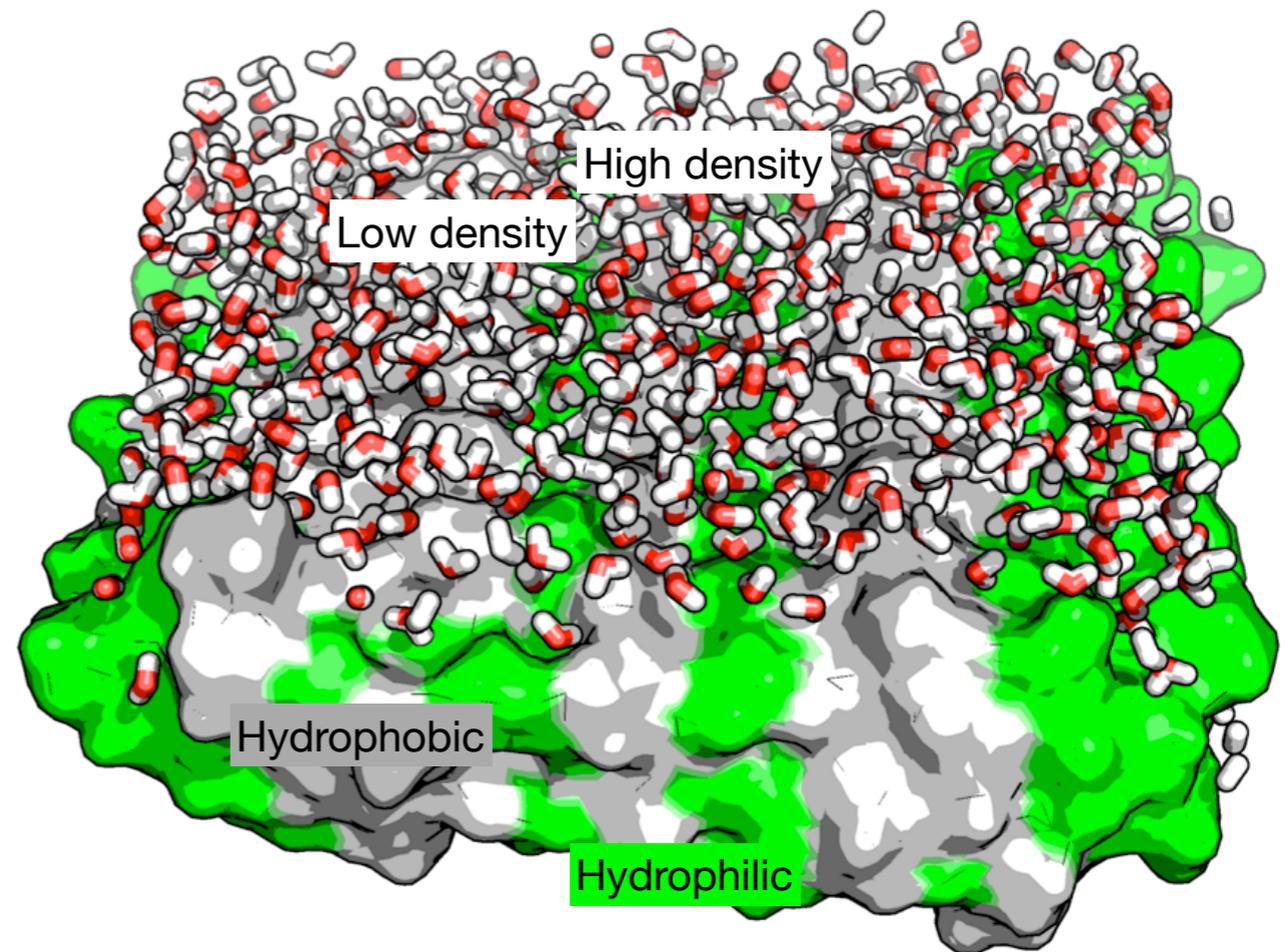
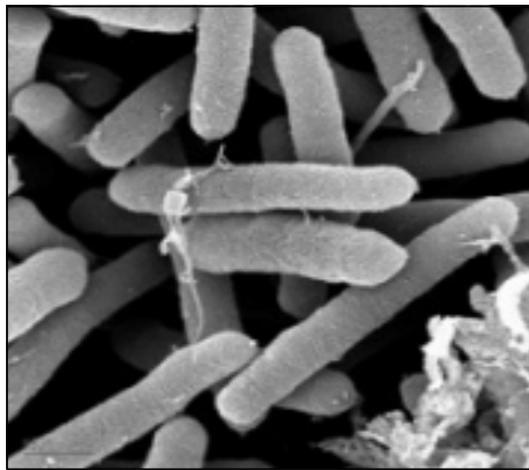




Sum frequency spectroscopy laser setup

Ice bacteria can control water at their surface

P. syringae



Water ordering

Energy transfer

Applications for freeze bacteria

Clouds seeding: Can we genetically engineer the ice bacteria to adjust the rainfall needed?

Food preservation: Can we freeze food more gently with less energy?

Cryobiology: Can we learn how to avoid ice nucleation for gentle freezing of organs?

Freeze surfaces: Can we make biomimetic freeze and antifreeze surfaces?

Idea for teaching ice nucleation

educationinchemistry

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Kit

- 125 g sodium ethanoate-3-water (sodium acetate-3-water) (irritant)
- Watch glass
- 250 ml beaker
- Stirring rod
- Bunsen burner
- Tripod
- Gauze

Preparation

Weigh 125 g of the sodium ethanoate into the beaker and add 12.5 cm³ of water.

Place the beaker onto a tripod and gauze over a Bunsen burner until the solid has completely dissolved.

Place the watch glass over the top of the beaker to prevent dust particles getting

Allow the solution to cool to room temperature.

<https://eic.rsc.org/exhibition-chemistry/hot-ice/>

Movie about ice nucleation bacteria:

<http://www.sciencemag.org/news/2016/04/video-these-microbes-are-key-making-artificial-snow>

Article by AU researcher about ice proteins

<http://advances.sciencemag.org/content/2/4/e1501630.full>