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New Sustainable Technology for Pure Water - an essential ingredient for food

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Acknowledgements

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Team

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Facilities

Institut Laue Langevin, D17, D22

NIST BT5

Help at Experiments

- Rob Barker
- Giovana Fragneto
- Andrew Jackson
- Bob Cubitt
- Anders Olsson
- Carl-Johan Englund
- Ida Berts
- Matthew Wasbrough
- Lionel Porcar
- Paul Butler

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Water is valuable & Important

Dune 7, near Swarkopmund, Namibia

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Water is valuable & Important

Kalahari, Botswana – semi-desert region

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River water may not be clean

Zambesi, near Livingstone, Zambia/Zimbabwe Border

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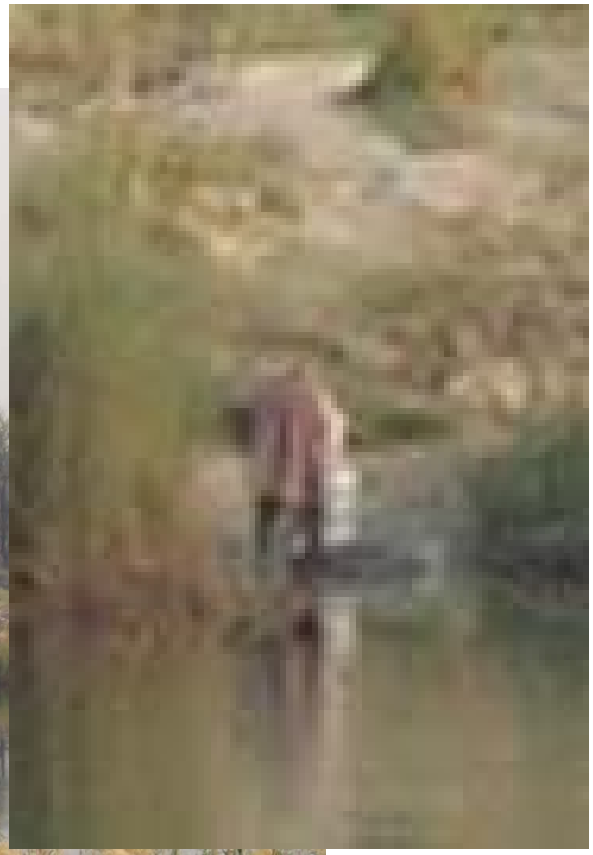
Water Sources

Okawango, East of Rundu



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Supply Technology

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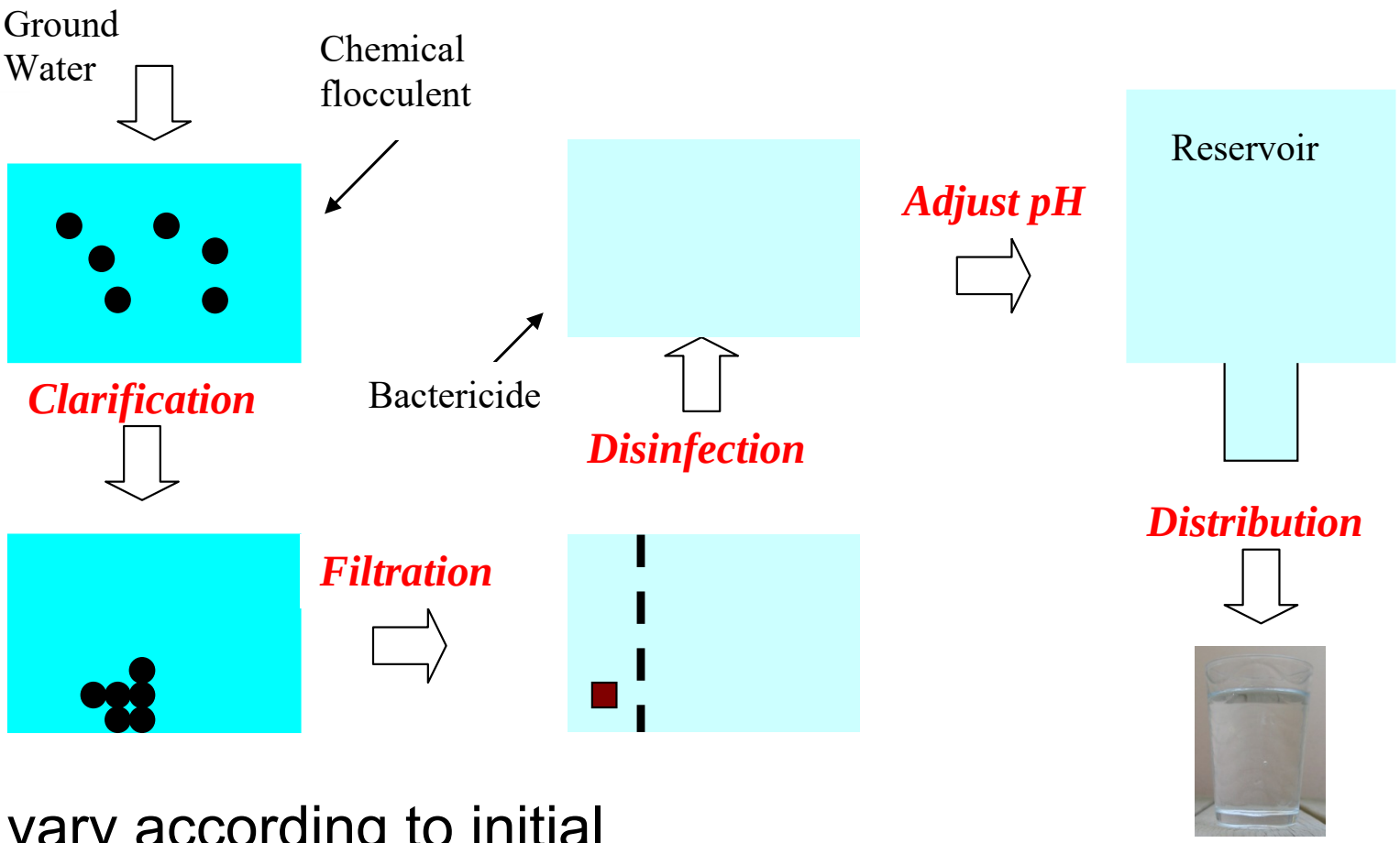
Major Steps in Purification



Details vary according to initial water source and requirements

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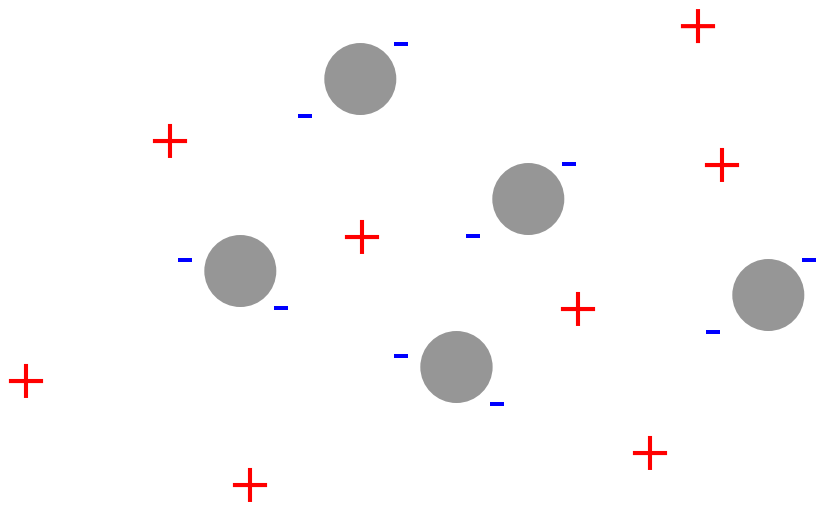
Why are dirt particles dispersed in water?

Colloidal particles

Mostly charge repulsion



Long range repulsion – larger than short range van der Waals attraction

How do we get aggregates?

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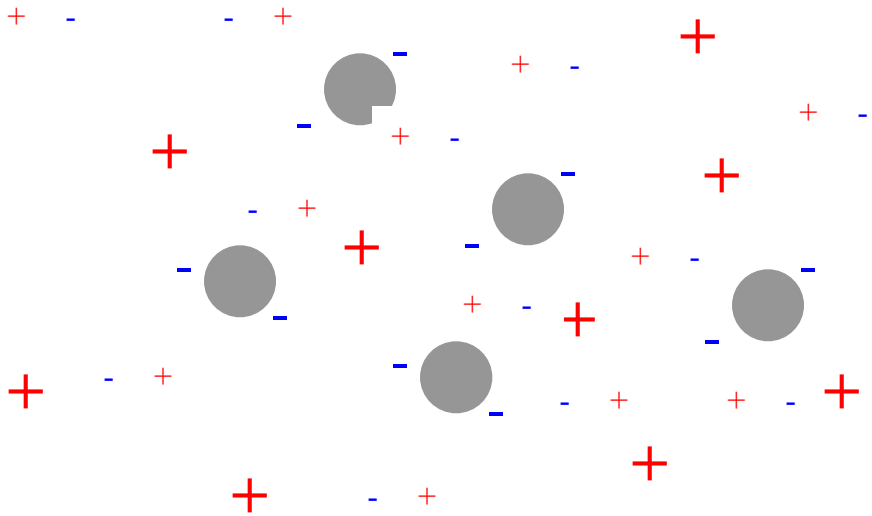
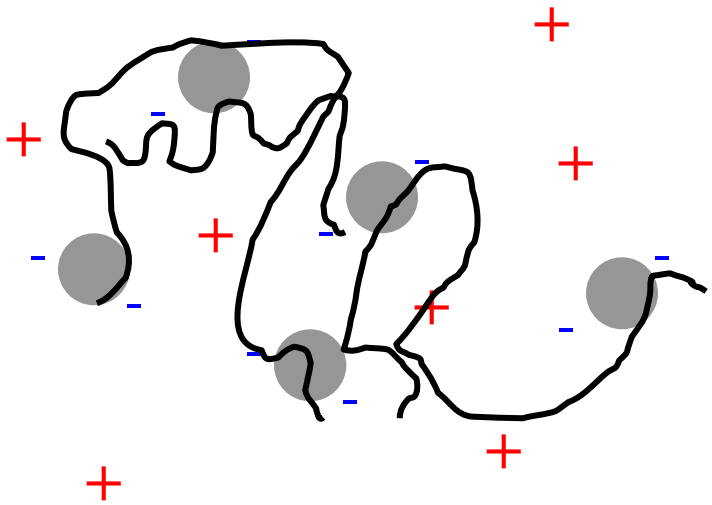
Flocculating Particles – the usual approach



Add salt – screen charge repulsion



Add adsorbing polymer – link particles together

Scaling, Floc structure, Economics

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Adding salts – leaves soluble material in solution

Polymers – if the right amount will be removed with particles

Chemicals – price is increasing

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Muddy Water treated with crushed *Moringa oleifera* seeds

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Comparative tests

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Village Scale

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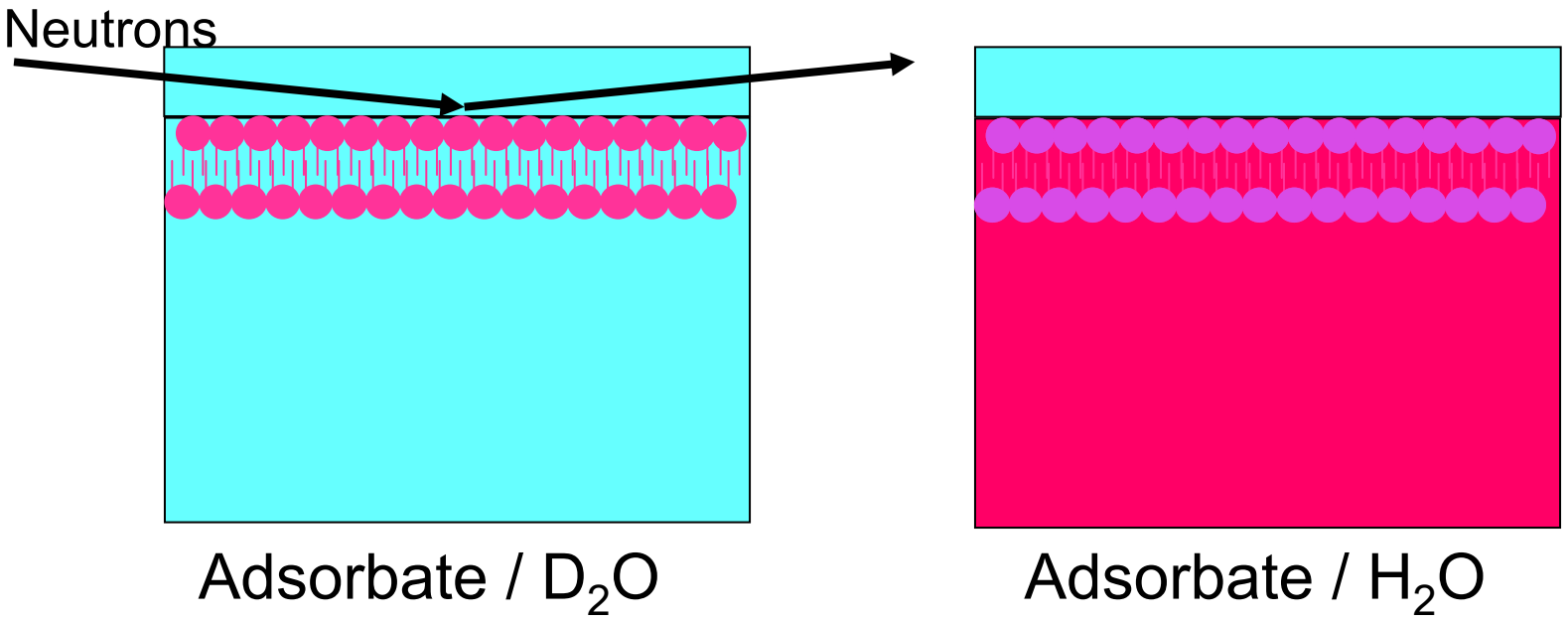
Neutron reflection

Contrast matching

Solvent hydrogen/deuterium composition

Sapphire
D_2O
Adsorbate
H_2O



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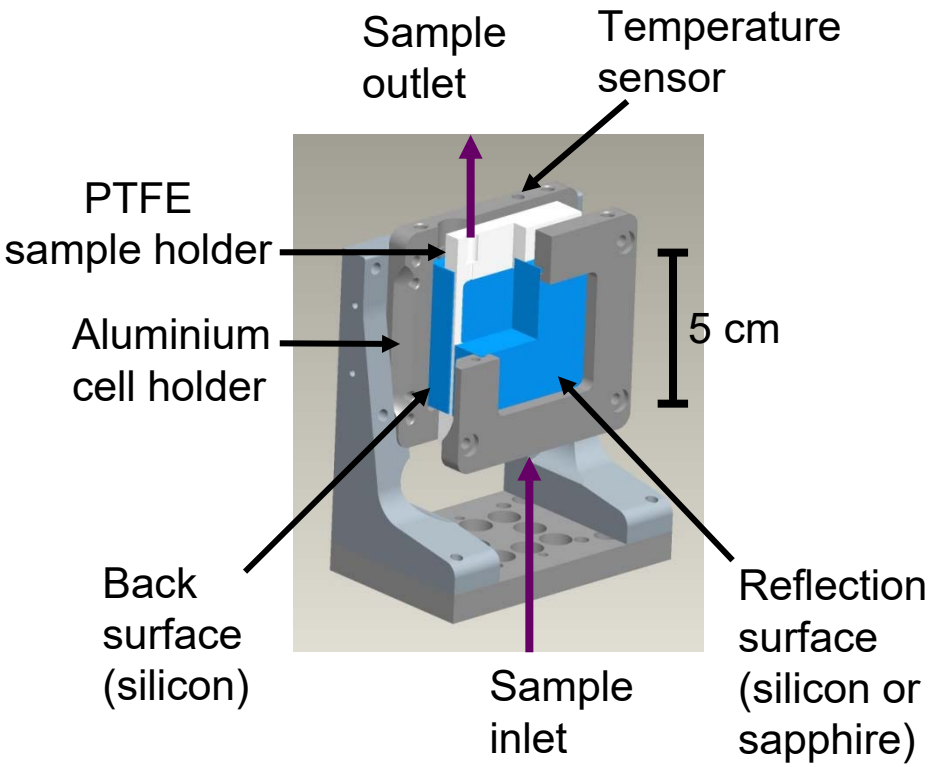
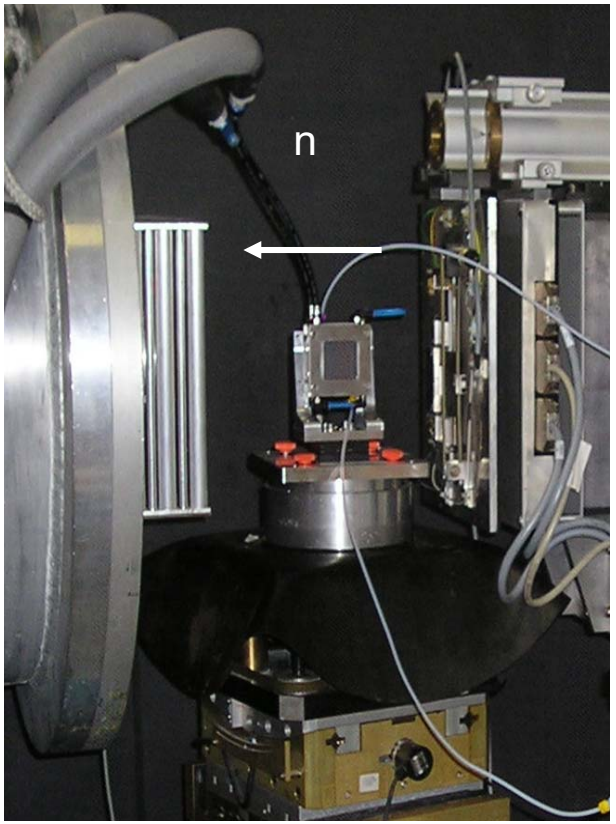
Sample Holder



D17 reflectometer
ILL, France



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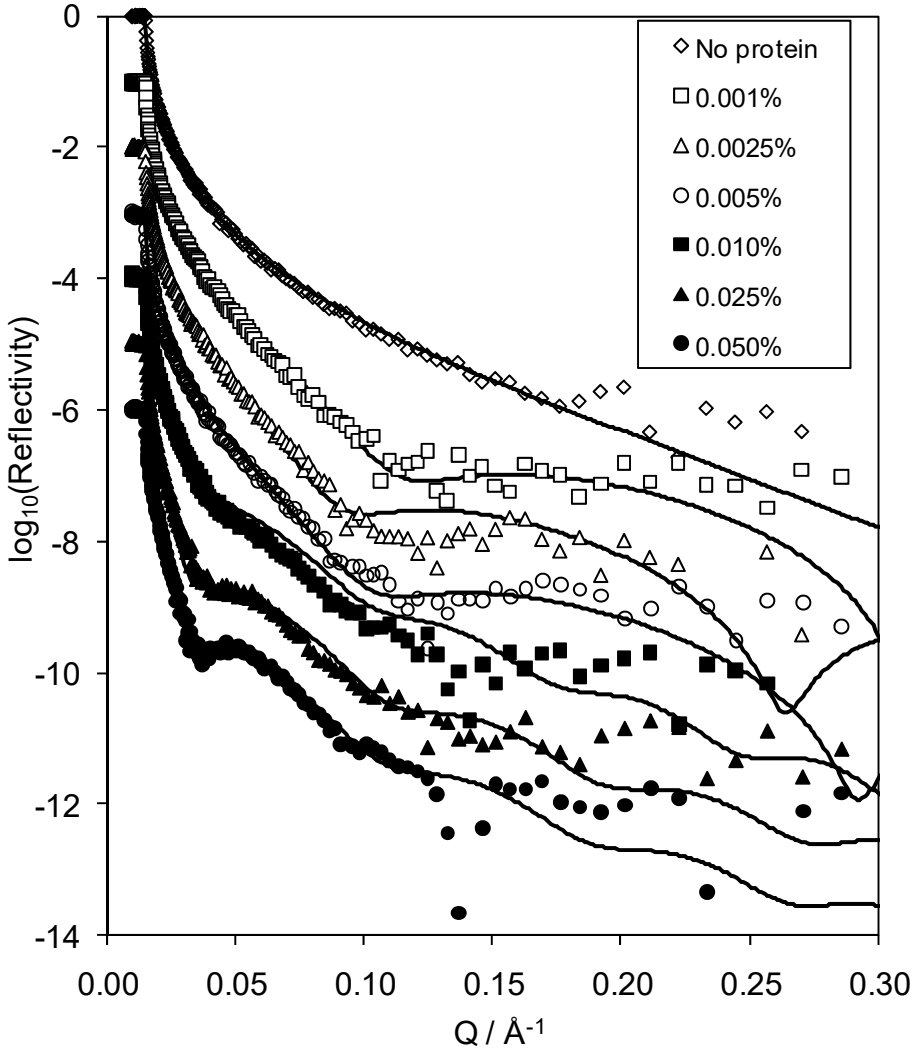
Effect of concentration

Moringa oleifera protein in D_2O at silica surface as model for mineral



MO Protein Adsorbed Layer on SiO_2

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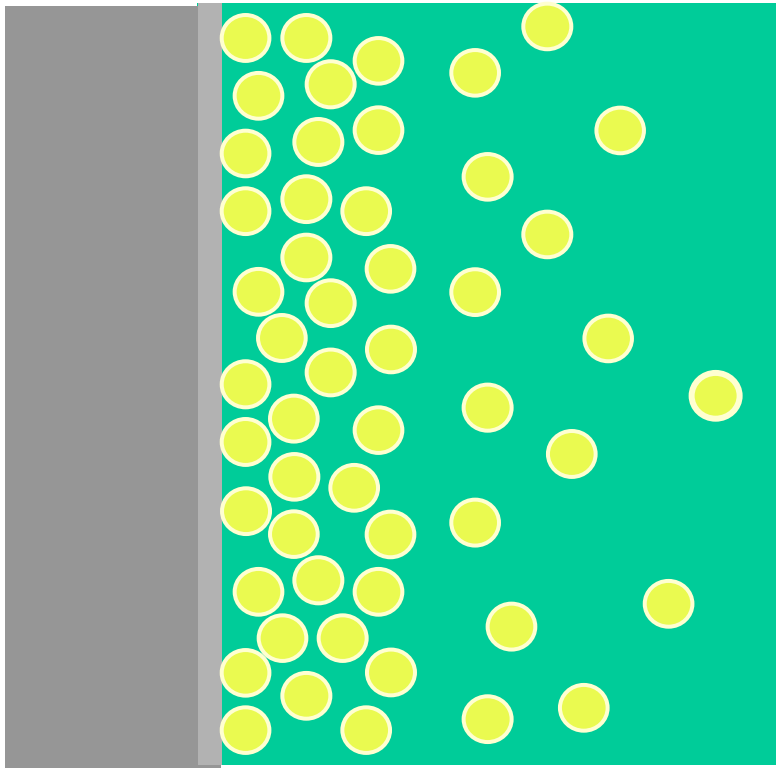
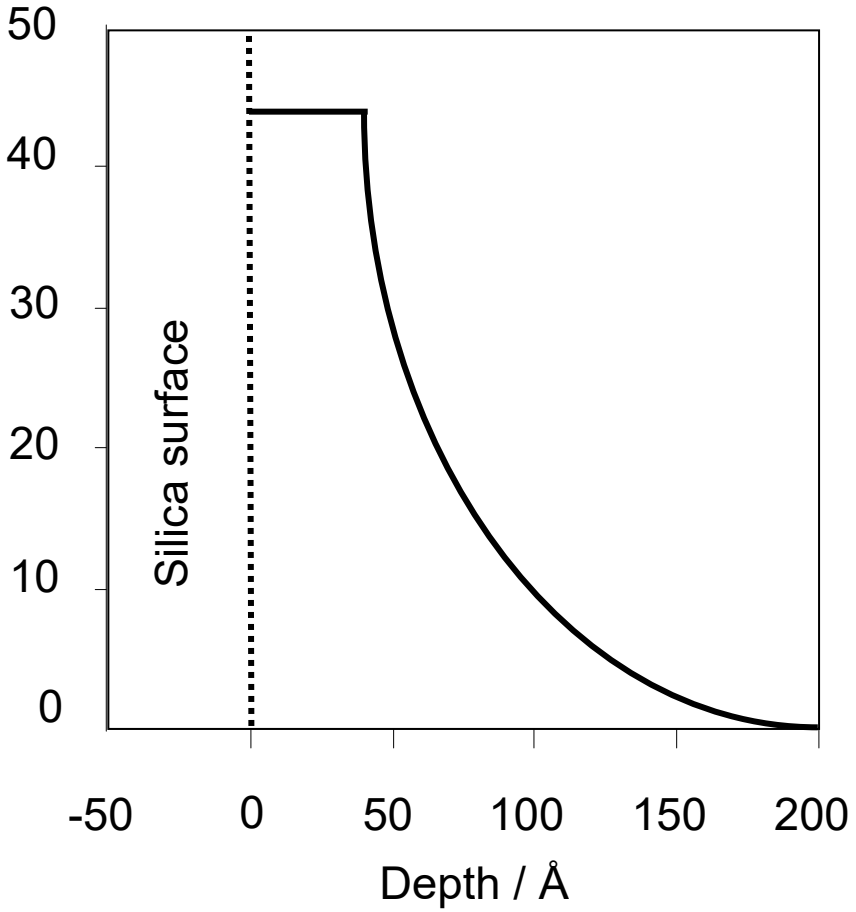
0.05 % Protein



Protein %



H. M. Kwaambwa *et al.*, *Langmuir* **26**, 3902-3910 (2010).

Adsorption to PS Latex Particles

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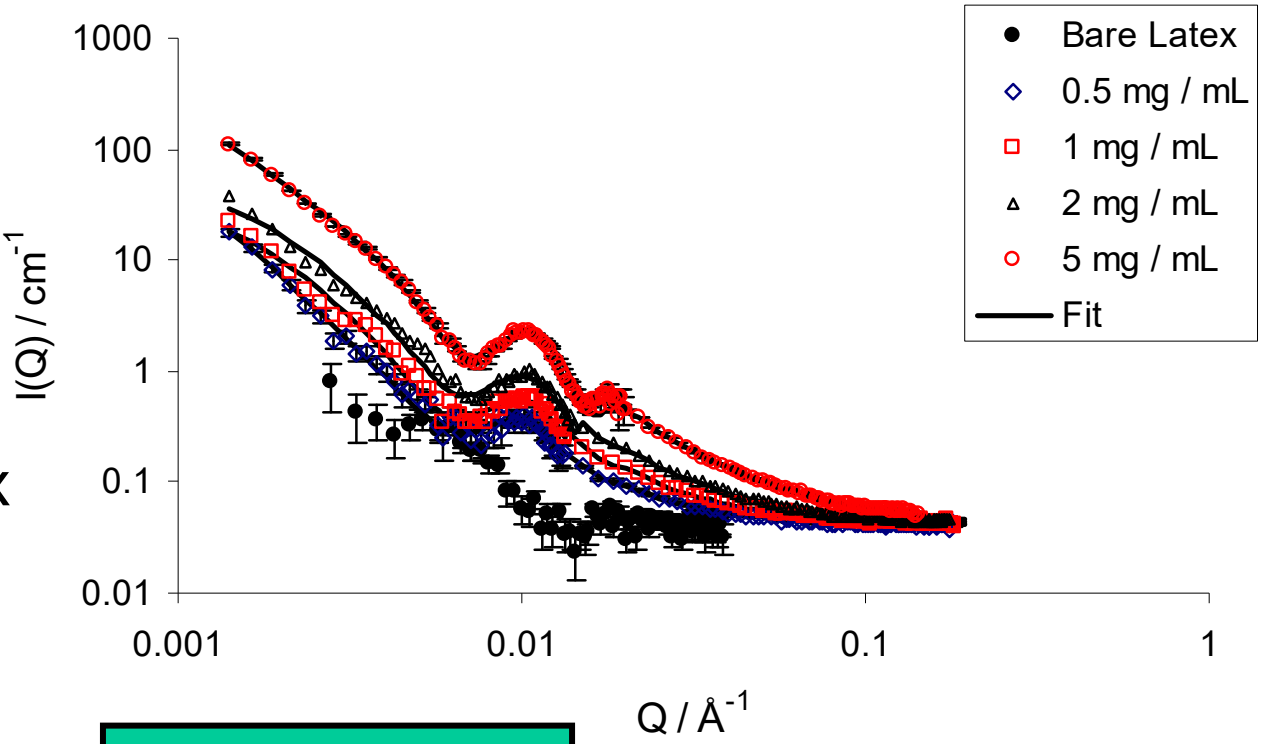
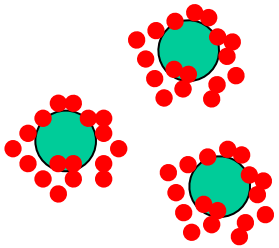
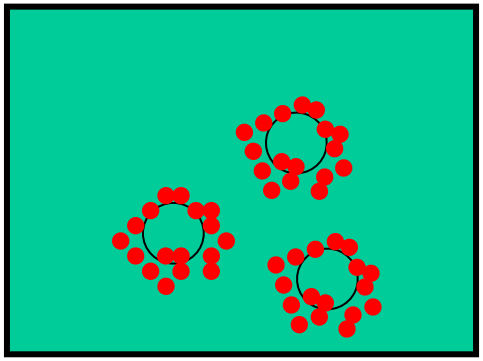
Moringa oleifera protein.

Deuterated latex in D_2O







SANS Data – D22 ILL

Use ‘contrast matching’ with D_2O

Hellsing et al *Coll. Surf. A*, **460**, (2014), 460–467.

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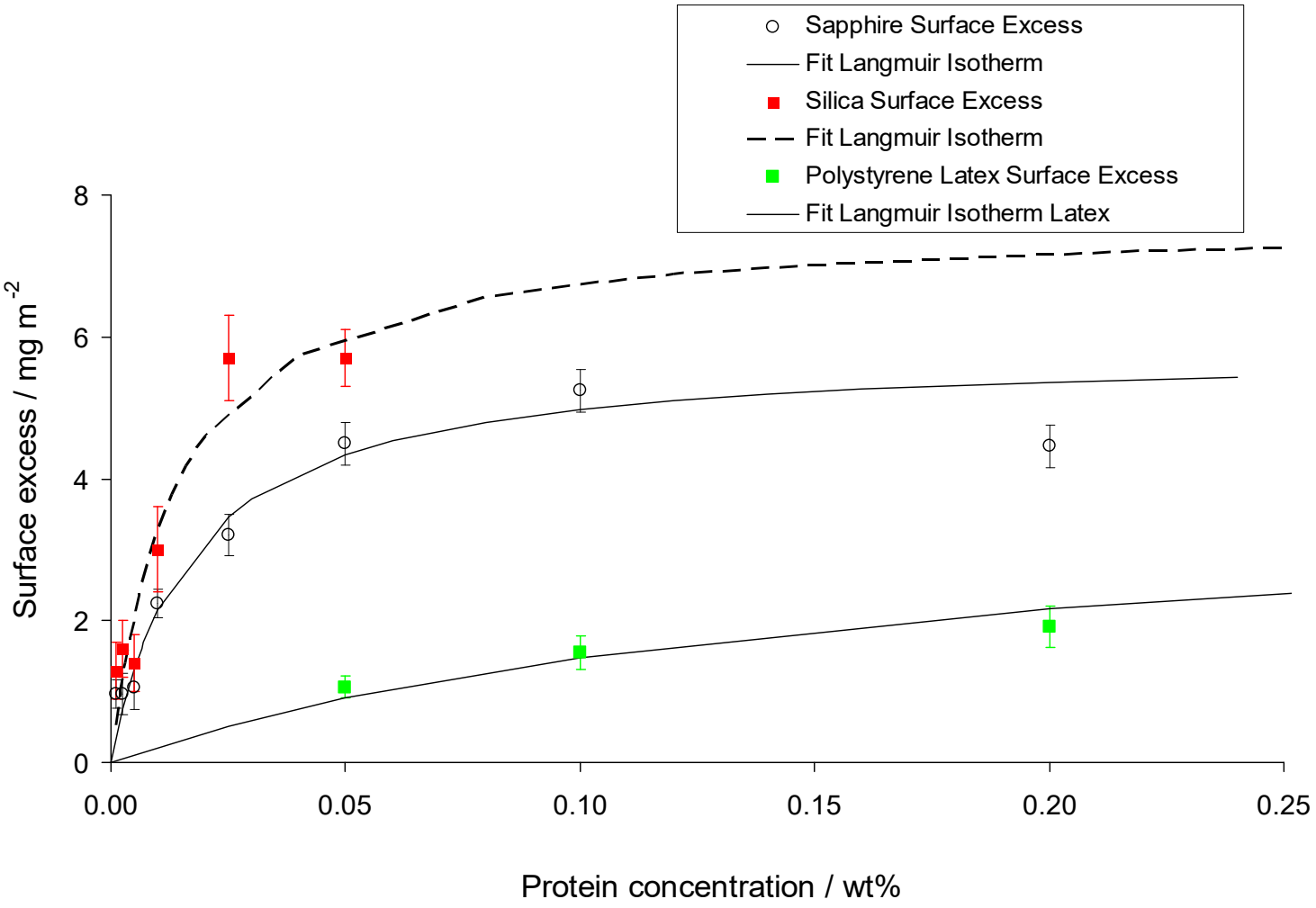
Adsorption Different Surfaces



Describing Flocs - Fractal Aggregates

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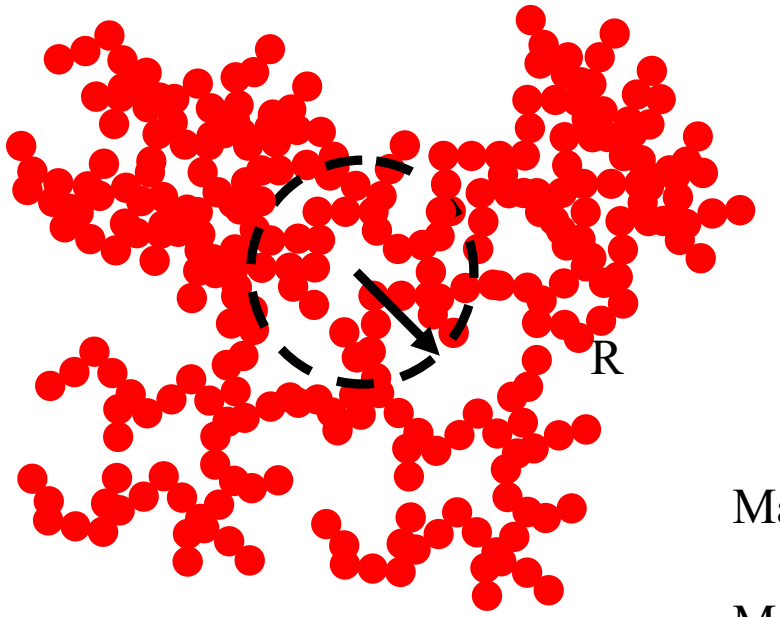
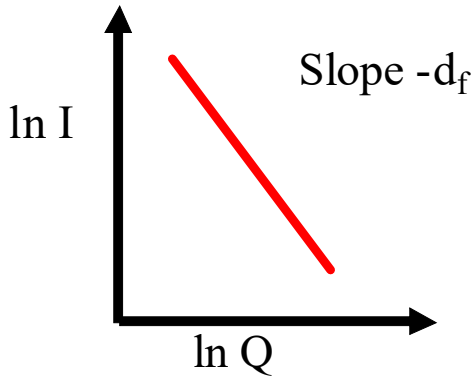




Mass fractal

$M \sim R^d$

Scattered Intensity

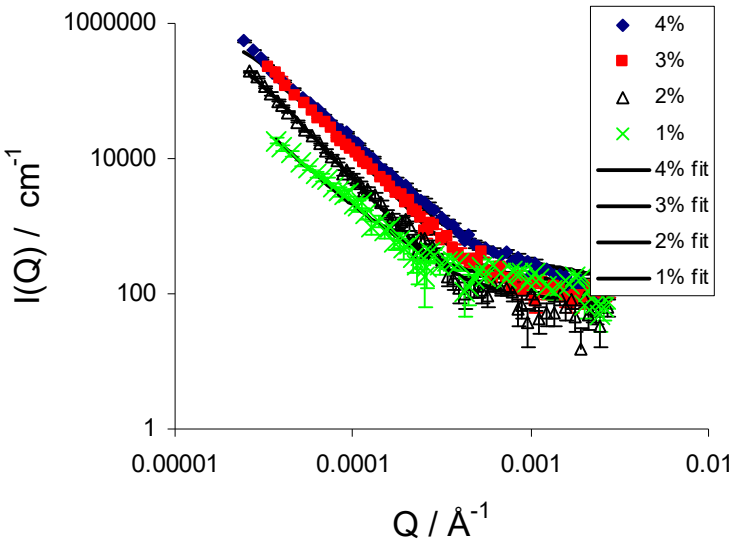
$Q = (4\pi/\lambda) \sin(\theta/2)$

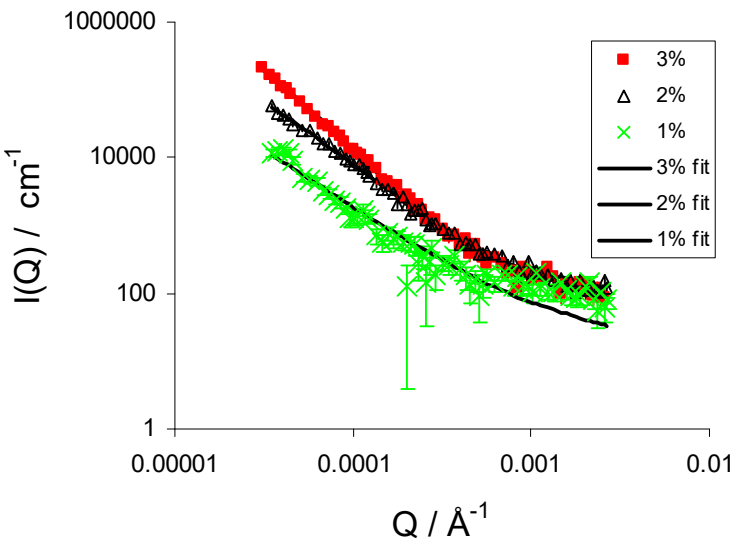
Diffusion limited $d_f \sim 1.75$

Reaction limited $d_f \sim 2.3$

Weitz, Meakin et al.

USANS – hydrogenous latex





0.2% *Moringa Oleifera* protein

0.2% *Moringa Stenopetala* protein

Flocs – change with particle concentration

Model: J. Teixeira (1988) 'Small-Angle Scattering by Fractal Systems' *J. Appl. Cryst*. **21**, 781-785.

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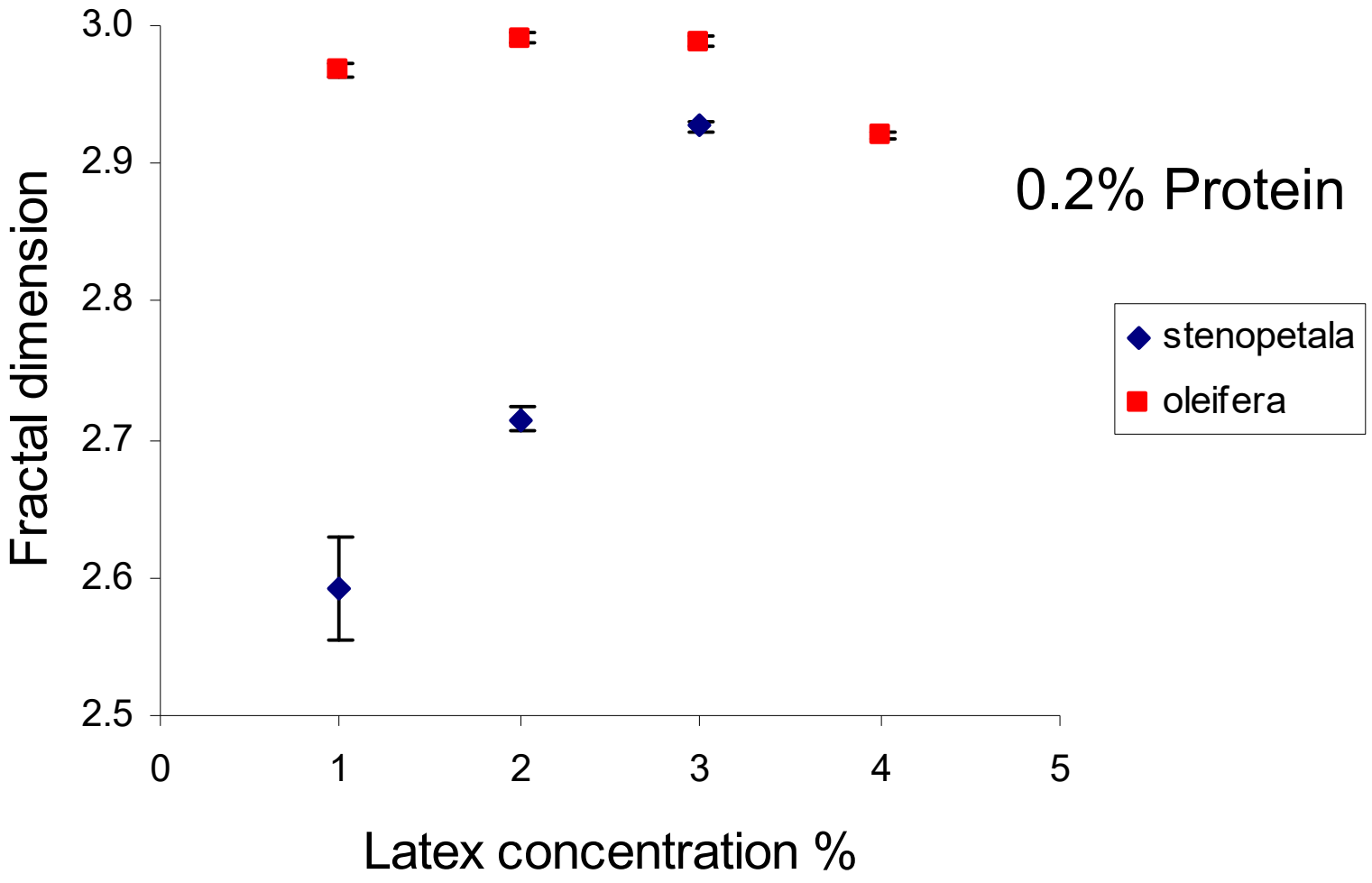
Fractal Dimensions



Understanding Aggregates

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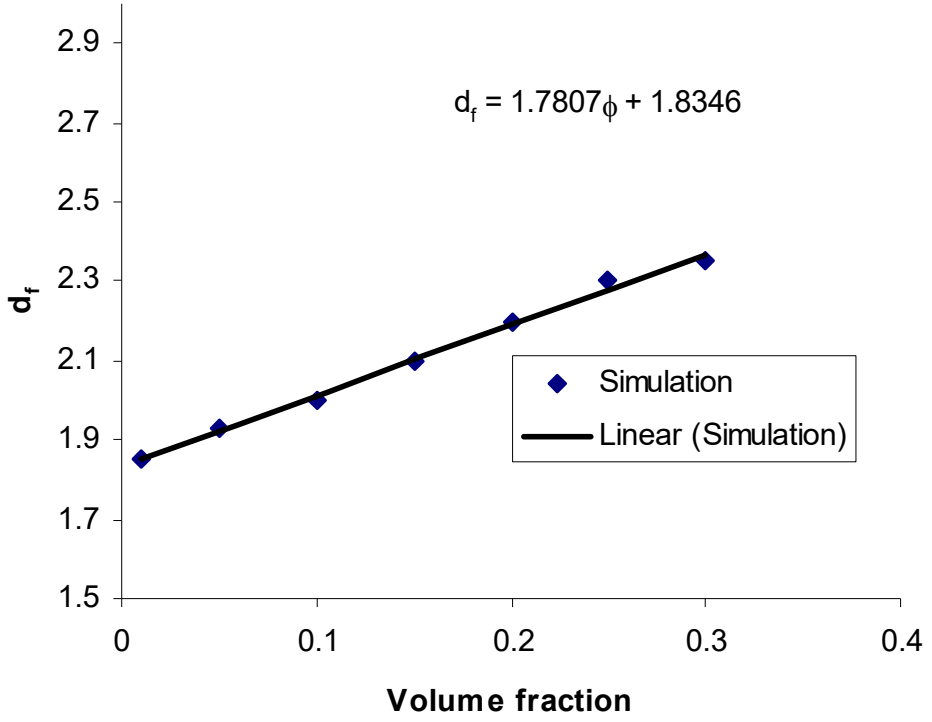
d_f is larger than expected

3 is maximum possible!

Moringa oleifera gave denser flocs

Brownian dynamics has predicted d_f varying with concentration



M. Lattuada *J. Phys. Chem. B*, **116**, 120-129.

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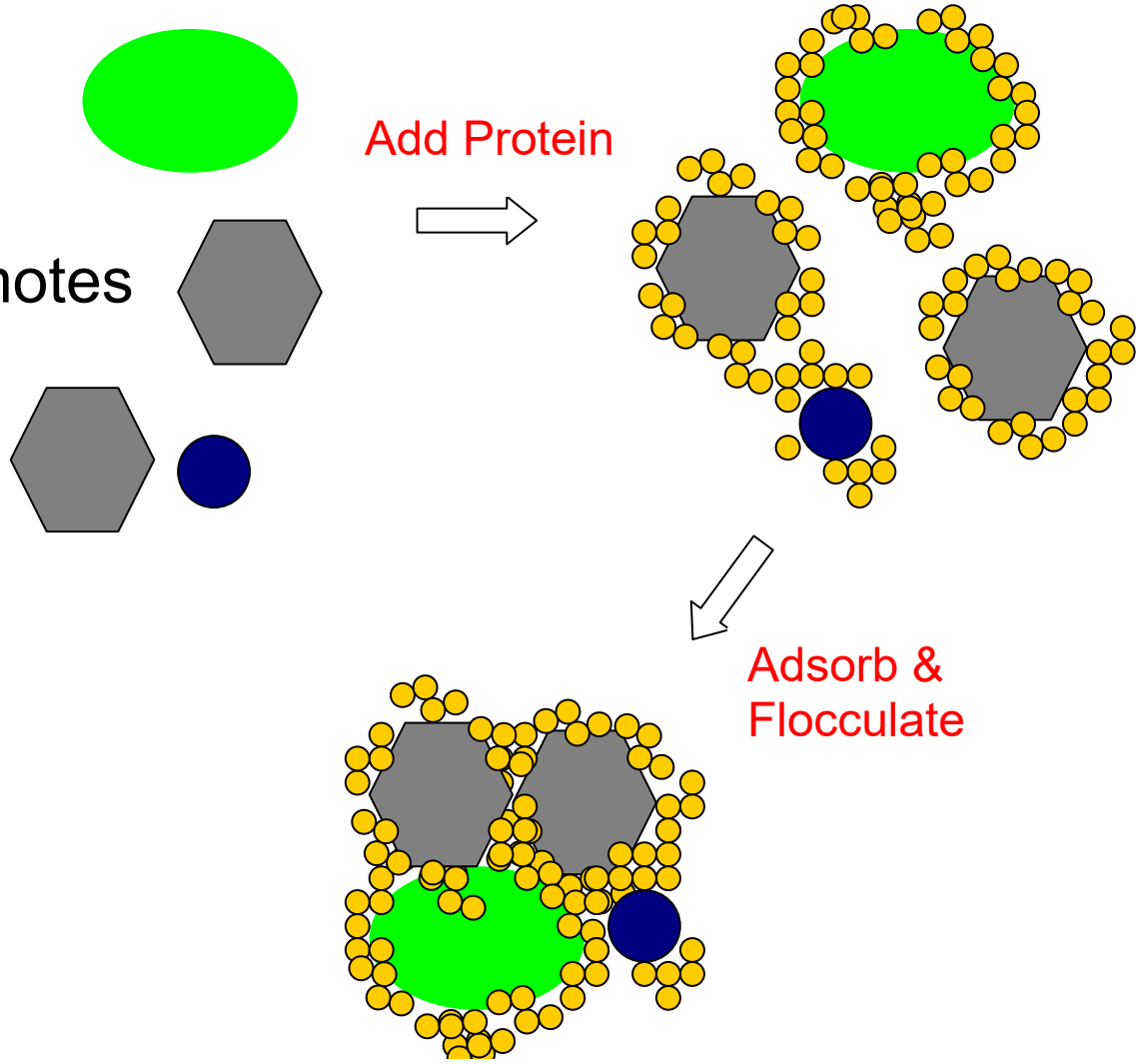
How does MO protein work?

Adsorption to range of different particles promotes heterocoagulation



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Challenges and Oppotunities

- Disinfection and Oxygen Demand in water
- Engineered systems for small communities

- Use of Moringa for waste water treatment
- Mineral separations – selective binding in the presence of surfactants
- Treatment of drilling muds and oil well wastes

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Thank you for your attention

Questions?