

Some Current Issues in Dairy Technology Where Neutrons Could Play a Role

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What I Imagine Neutrons can do for Me

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Agenda

- My world – i.e. a brief description of the work we currently do in our group
- What we need to know
- Some current issues in Dairy Technology – as I see them
- and how neutrons could help us



My world

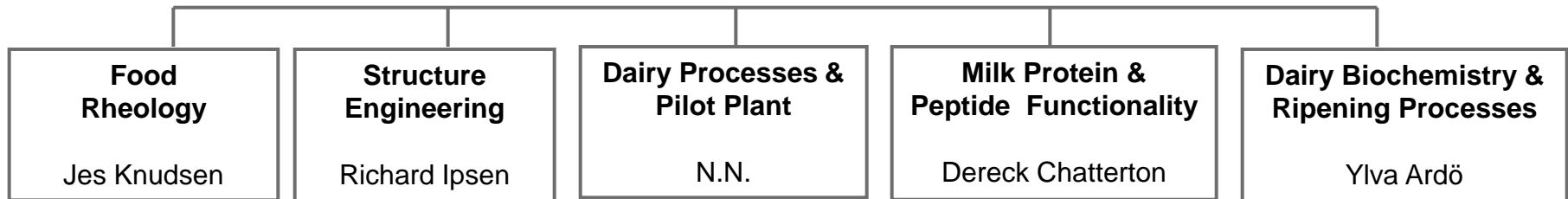
Research and education with focus on dairy products, milk based ingredients and dairy processes

Our research is:

- Applied – but from a mechanistic viewpoint
- Multi-disciplinary
- Pre-competitive
- Usually financed 50-50 by government and industry
- Based on a thorough understanding of the matrix (milk and its products)



My world



The direct coupling of:

- Product technology
- Microbiology
- Enzymes
- Biochemistry
- Rheology
- etc

to final product quality (e.g. texture, sensory properties)



My world



My world

Understanding ingredient functionality in dairy products



Achieving clean labelling by use of milks own components



My world – current research focus (1)

Milk protein concentrates for cheese:

- Use of membrane-filtered milk in cheese production
- Microfiltration makes it possible to concentrate the casein fraction – but the structure of MF cheese is not well understood
- To design a process for production of MF cheese it is crucial to understand the interactions between protein, water and calcium in the concentrate as well as in the cheese.

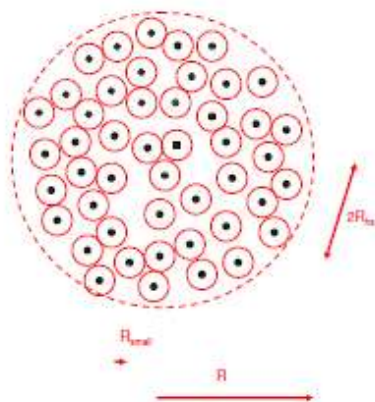


Figure 1: Model of casein micelle

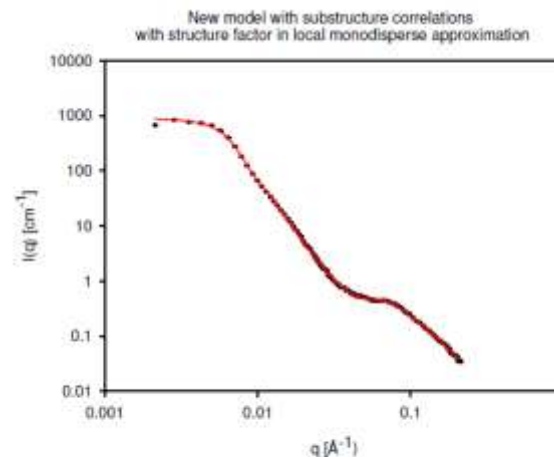


Figure 3: SAXS scattering data of concentrated milk casein isolate with the corresponding fit to data.

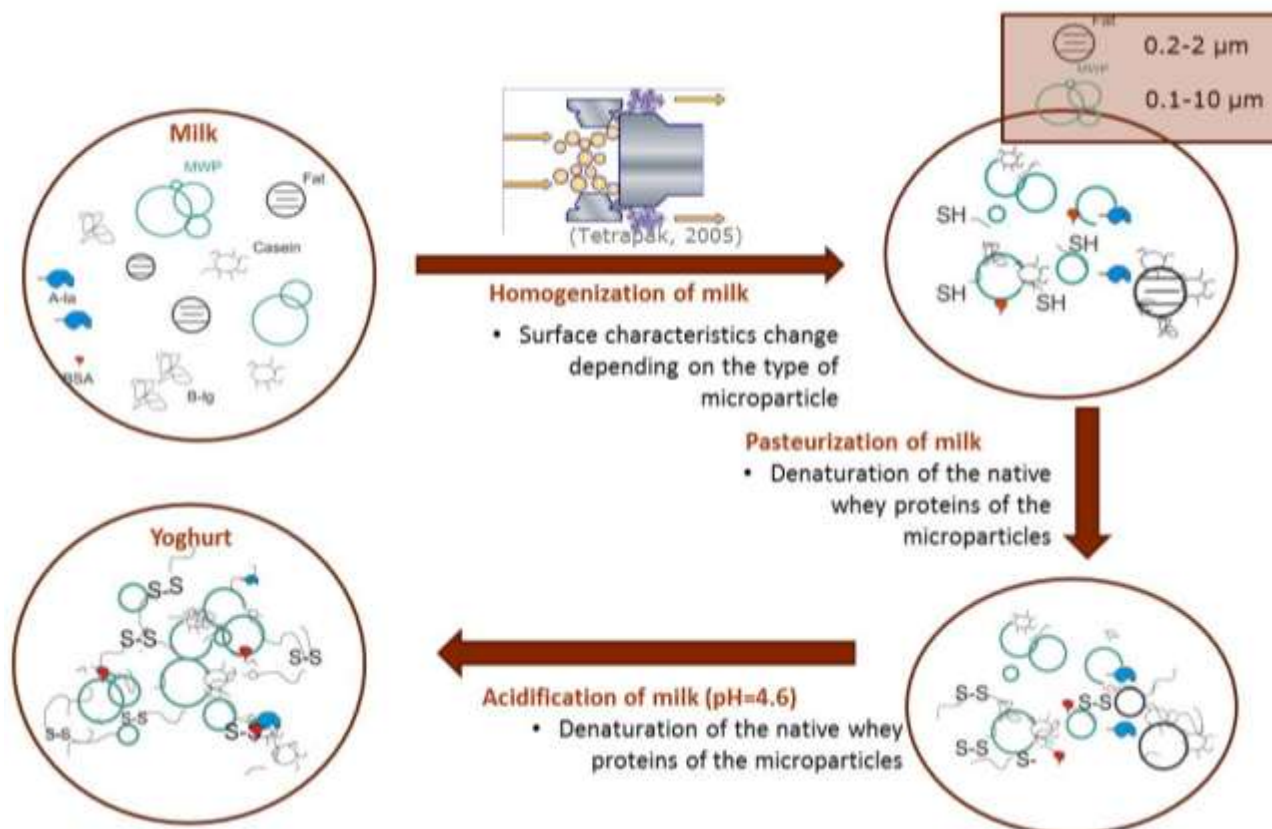




My world – current research focus (2)

Milk protein aggregation (microparticulates):

- How it affects structure of acidified milk products – and how we can optimize it by understanding the



My world – current research focus (3)

Interactions between milk proteins and polysaccharides (e.g. exopolysaccharides, EPS)

- How it affects structure of acidified milk products – and how we can optimize it by understanding the mechanism

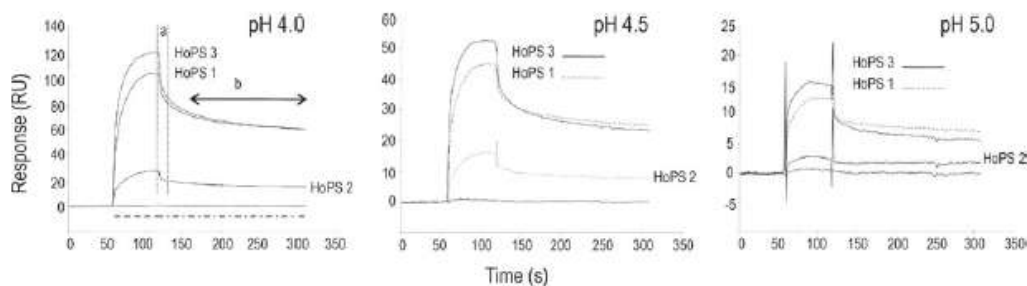
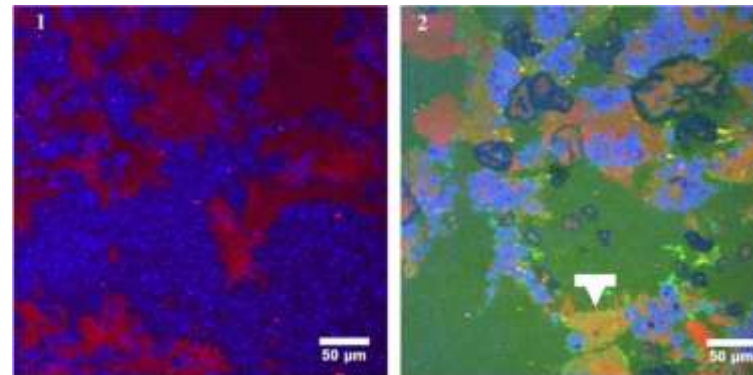


Figure 1 Binding of EPS to β -casein studied by surface plasmon resonance. Three different EPS samples were screened for binding to immobilized β -casein at different pH as a function of time. All HoPS interacted with β -casein at pH 4.0, 4.5, and 5.0, but the binding

decreased with the pH. HoPS 3 showed the highest binding and HoPS 2 the lowest. Association is indicated by the *dashed line at the bottom of the figure* and dissociation as the *dashed-dotted line*

Babol et al, 2011



Arltoft et al, 2008

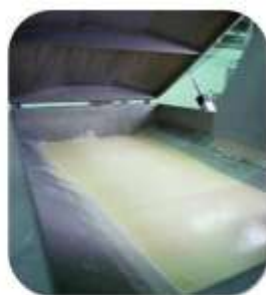
My world – current research focus (4)

Cheese powder without melting salts

- Achieving a stable feed and proper melting of a highly variable raw material – without addition of phosphates. Understanding the mechanism.



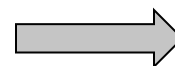
Chopping and mincing



Melting, mixing, emulsification



Pasteurization



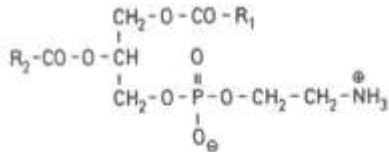
Melting salts)are usually citrates or Na-phosphates. They chelate calcium and have an important role in the three-dimensional structure of processed cheese or cheese analogues – as well as in the feed for cheese powder manufacture



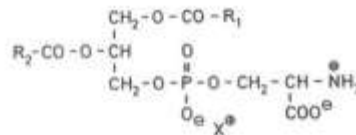
My world – current research focus (5)

Stable low fat butter through use of buttermilk powder

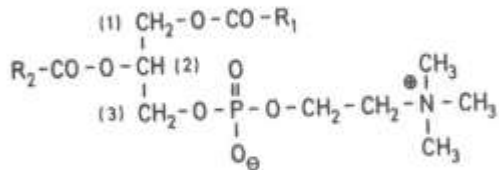
- Improving the efficacy of phospholipids from buttermilk to ensure a stable w/o emulsion. Understanding the mechanism.



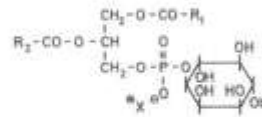
PC: Phosphatidyl choline



PS: Phosphatidyl serine



PE: Phosphatidyl ethanolamine



PI: Phosphatidyl inositol



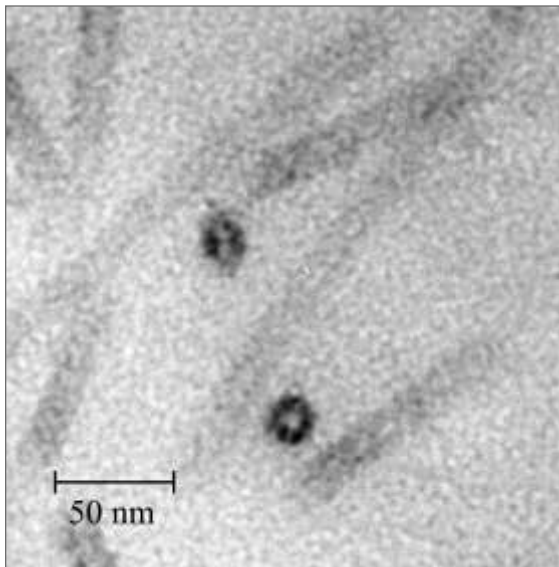
PS: Sphingomyelin



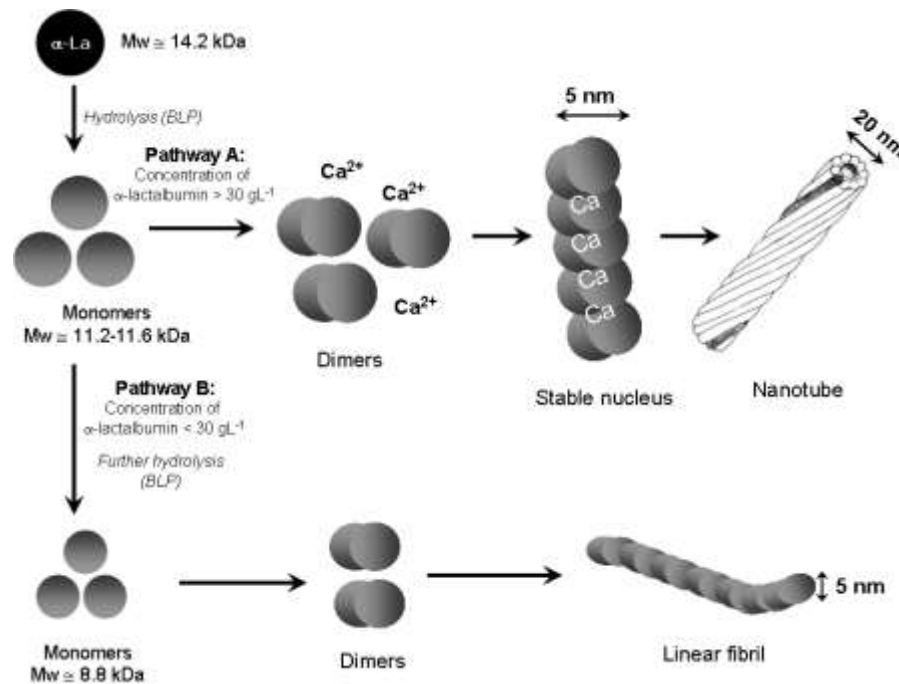
My world – current research focus (6)

Nanotubular structures from limited hydrolysis of α -lactalbumin

- Stabilizing structure and understanding the mechanism



Ipsen et al, 2001



Ipsen and Otte, 2007

What we need to know – to resolve relevant mechanisms

- Structure of the casein micelle – especially it's calcium – under a very wide range of conditions. Preferably in 4D
- The calcium balance in milk under a similar wide range of conditions
- Interfacial properties of milk proteins/peptides (incl. structural rearrangements at interfaces). Interactions with small molecular weight surfactants
- The occurrence/concentration of the natural emulsifiers in milk (e.g. phospholipids) during processing. Including self-assembly.
- The extent of casein-whey protein and whey protein-whey protein interactions during processing – plus the nature of the aggregates (e.g. surface properties)



What we need to know – to resolve relevant mechanisms

- How, precisely, calcium is involved in the self-assembly of partially hydrolyzed α -lactalbumin – and similar naturally occurring self-assembling protein systems.
- How the protein phase in cheese melts – and the role of calcium as well as phosphates in this process
- Strength and precise nature of protein-PS interactions in complex food systems – and how they are affected by processing and other ingredients

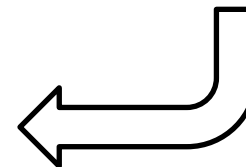
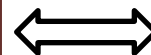
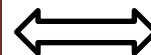
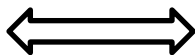
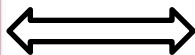
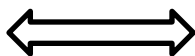
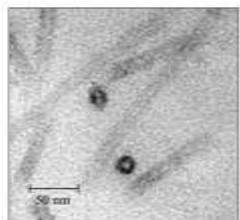
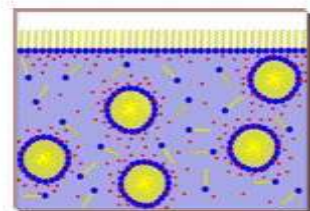
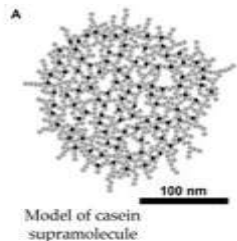


What everybody working with dairy technology would like to know – according to me

- Structure of the casein micelle and how it is influenced by processing
- Changes in the calcium balance in milk as a consequence of processing
- Interactions between milk proteins and:
 - Small molecular weight surfactants
 - Polysaccharides
 - Other food proteins
- How to control and design milk protein aggregation in complex dairy/food matrices.



How neutrons can help




Since you can't bring neutrons to the dairy plants – let's bring the dairy plants to the neutrons




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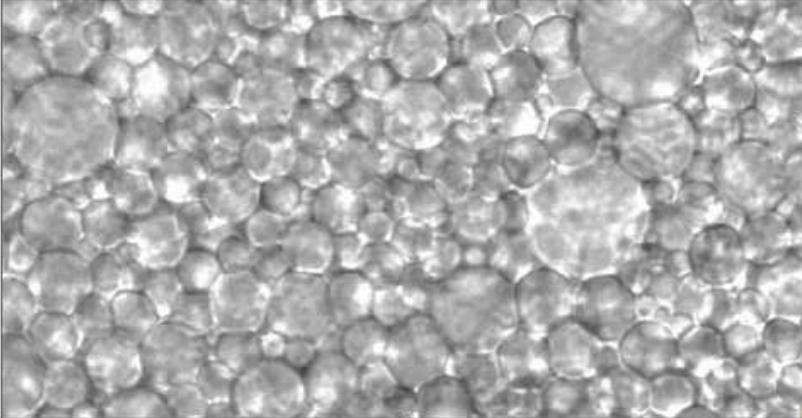
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Thank you for your attention !

