

de Gennes

Kopelman

Kretzschmar

Glotzer

Kegel

Velev

Muller

Doyle

Velogel

Paunov

Lahann

Vanderlick

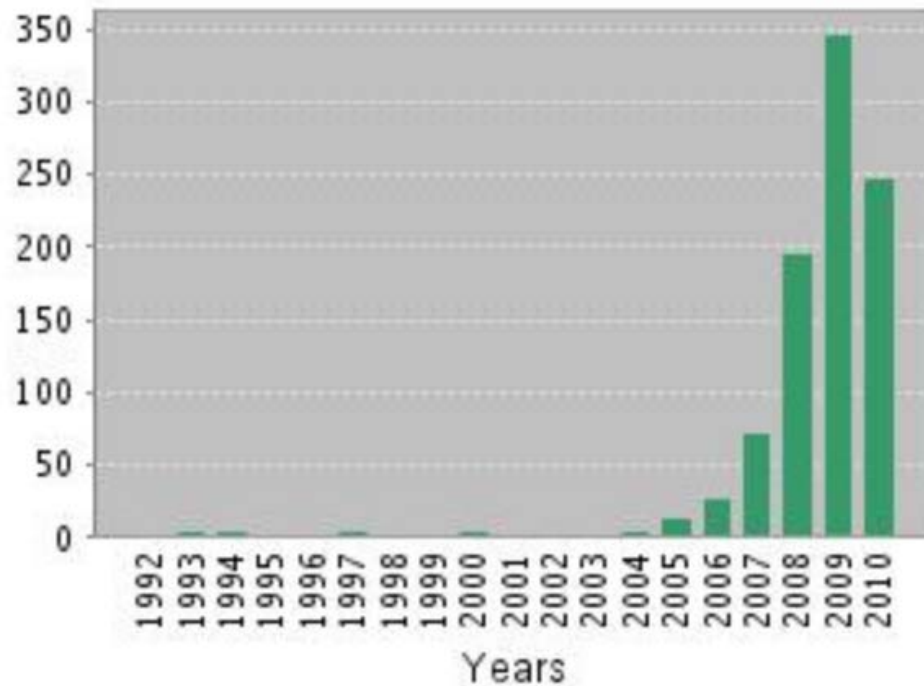
van

Blaaderen

And more

The patchy particle problem

Citations in Each Year



20 years later

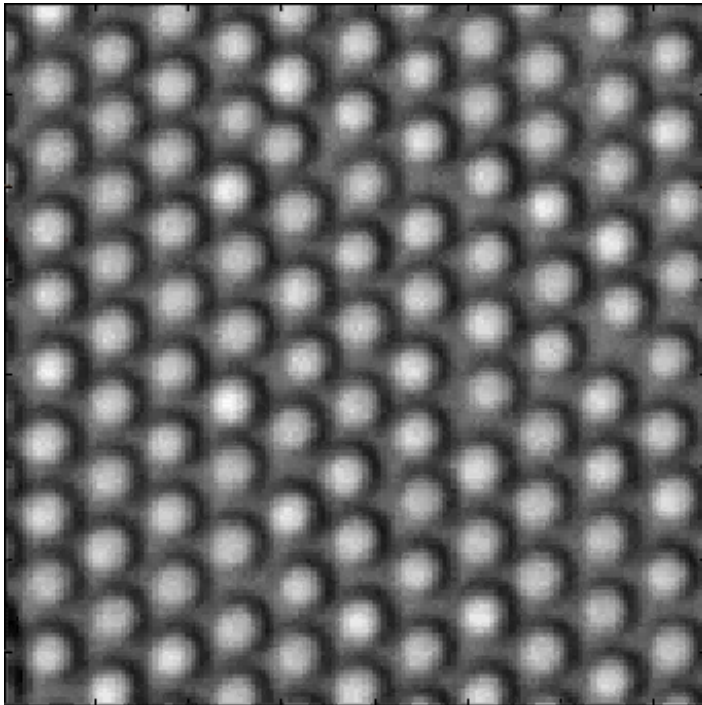


de Gennes

“Janus”

The world is round yet not symmetric

Colloid as Proxy for Atom



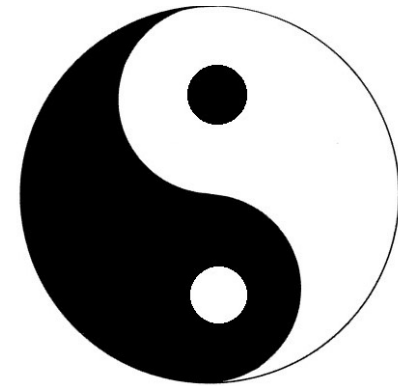
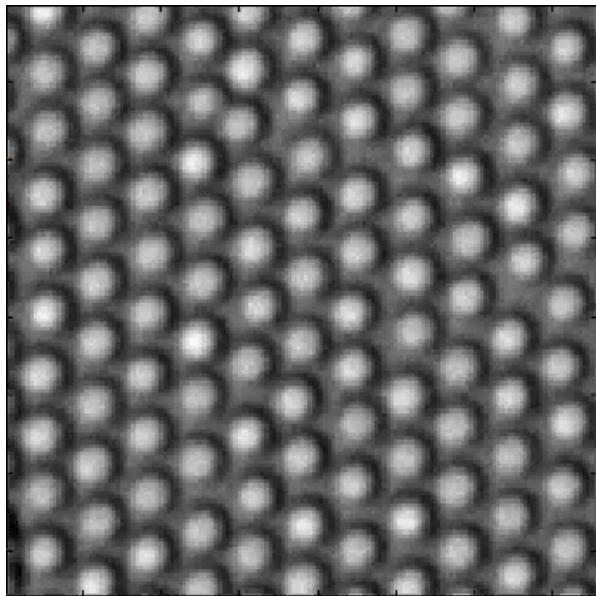
Hard spheres, etc.



Q: how would such spheres self-assemble?

Janus spheres with chemical shape

Colloid as Proxy for Atom



Molecular colloids

Desired:

Directional bonding

The synthesis problem

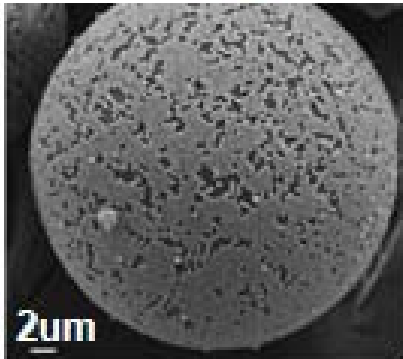
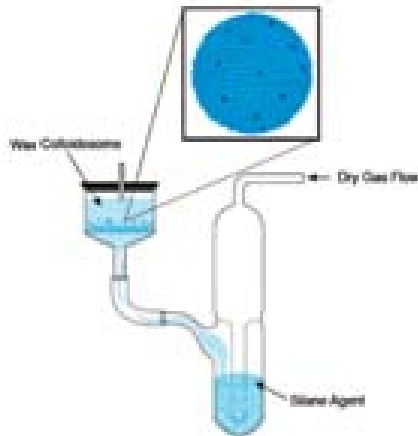
Pathways of chemical reactivity

The detection problem

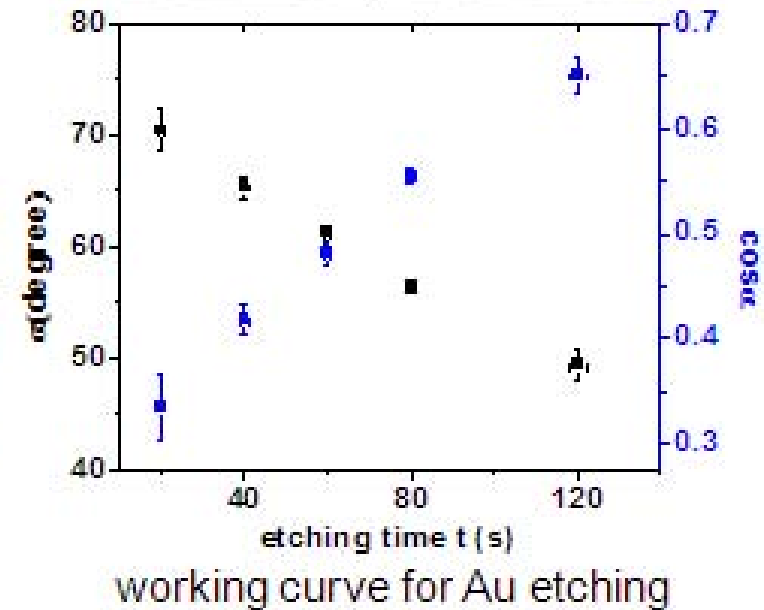
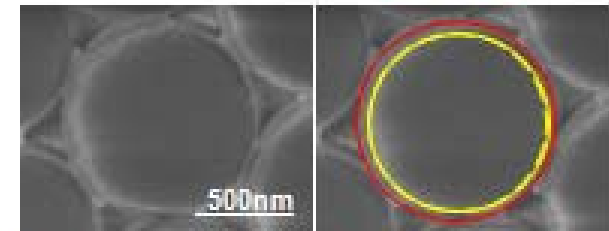
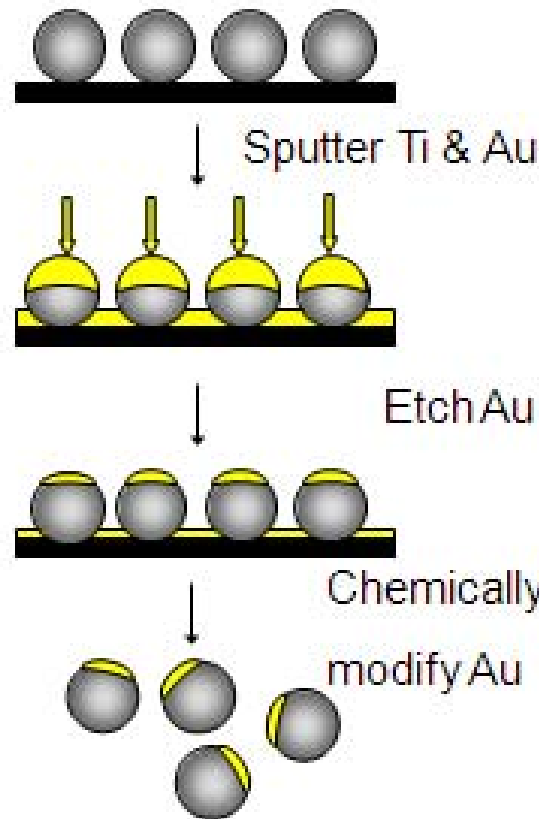
Avogadro's number

The scaleup problem

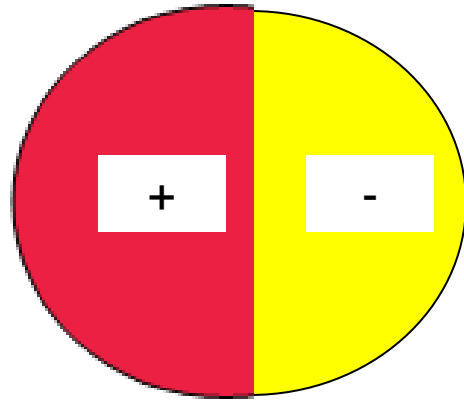
Janus particle fabrication



**Scaled up
To large amounts**



**The most precise method
Disadvantage: Limited quantity**



Cationic, anionic

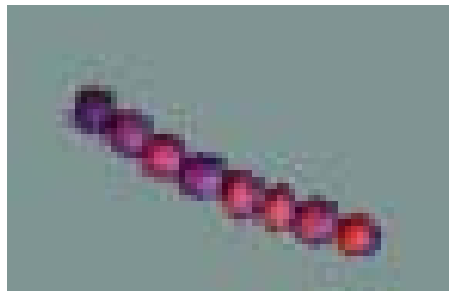
Zwitterionic.

Hemispheres of
matched electric
charge



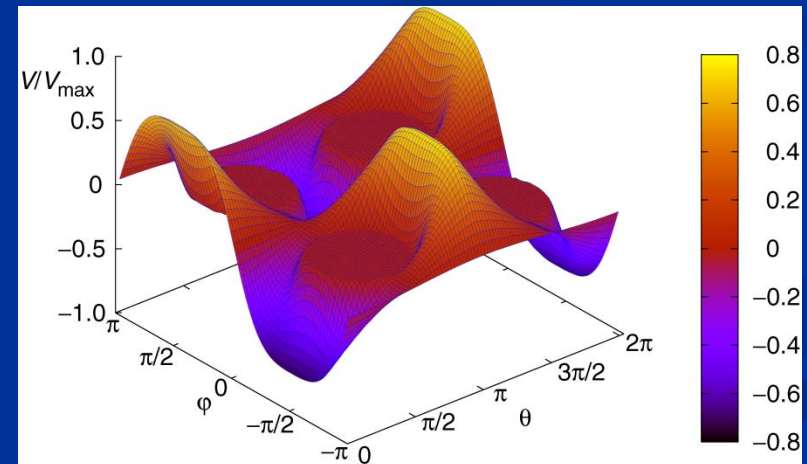
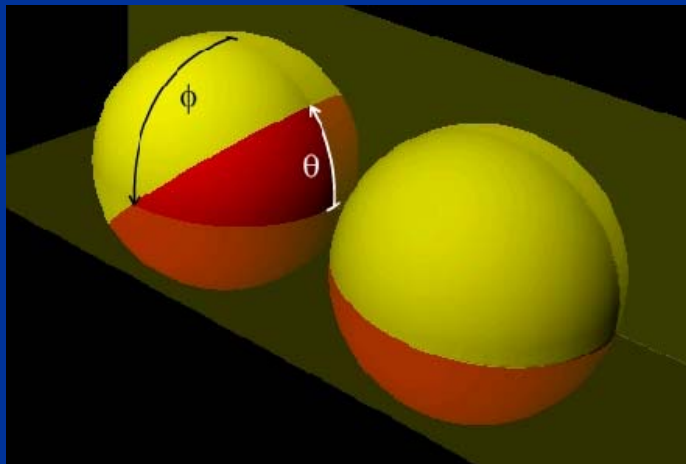
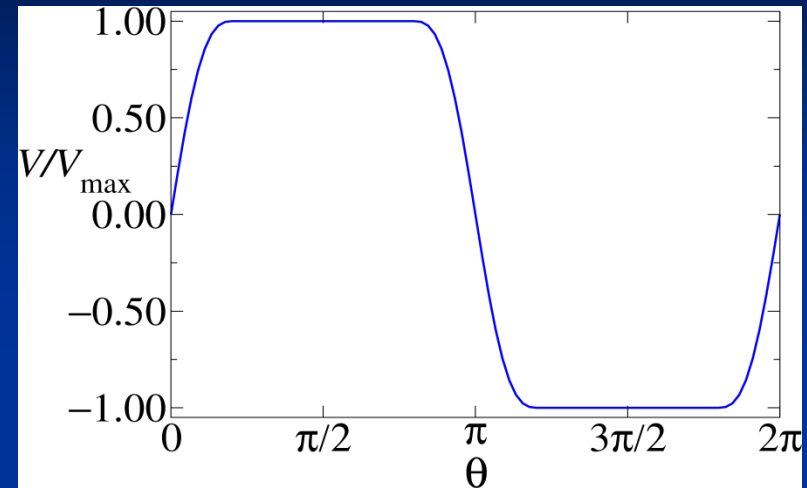
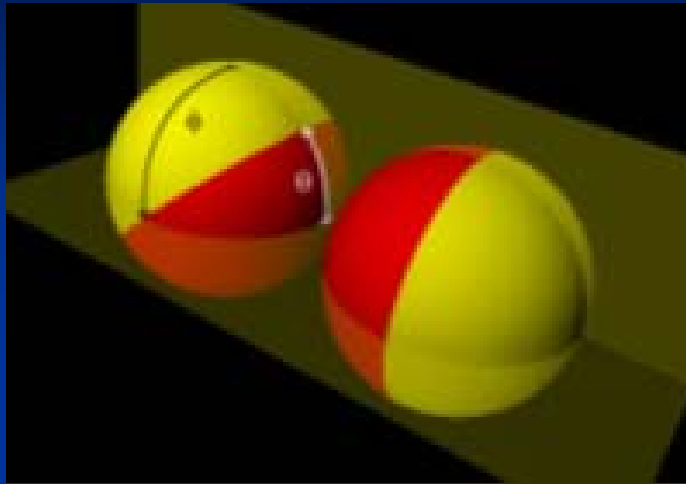
Erik Luijten,
Northwestern

First guess: dipolar strings?



*No.
Debye length < colloid size.*

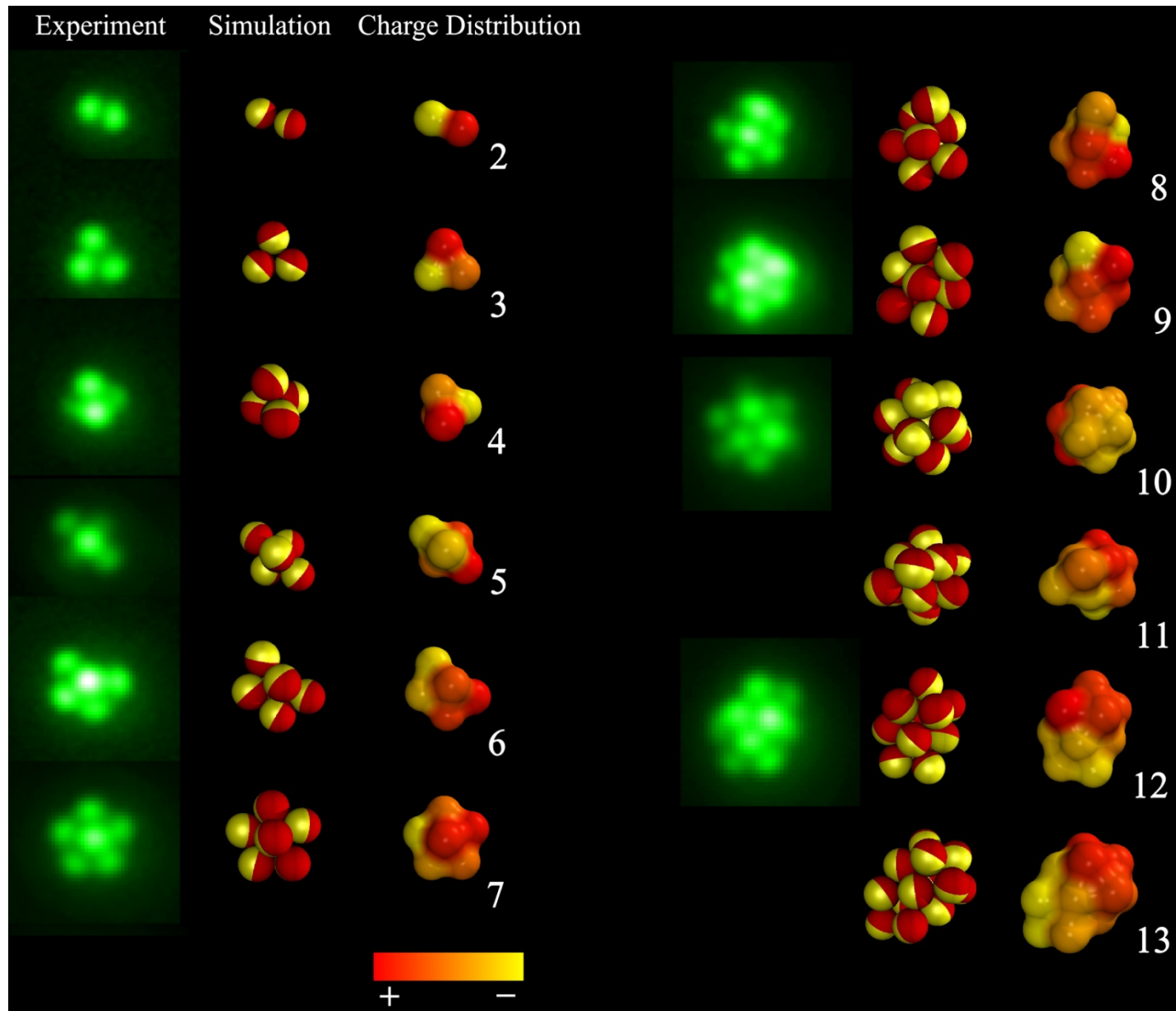
Energy Landscape at fixed separation:



Directional and short range

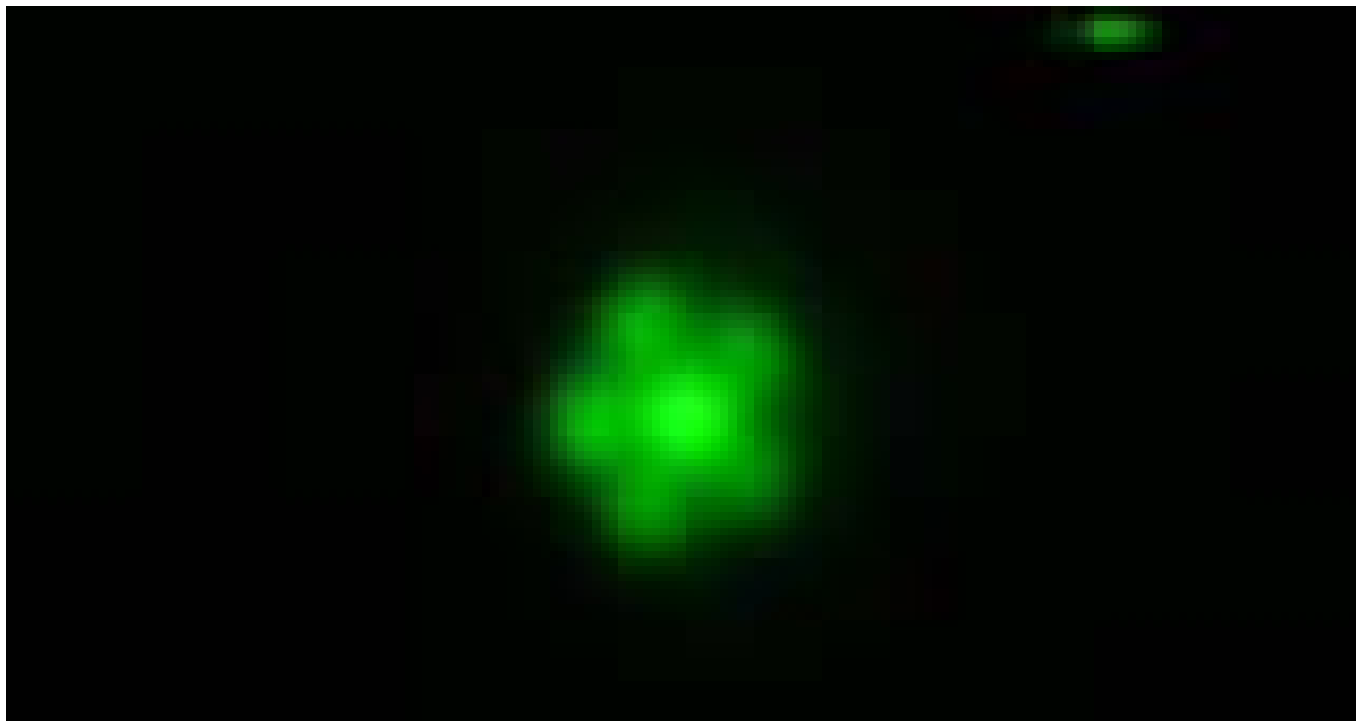
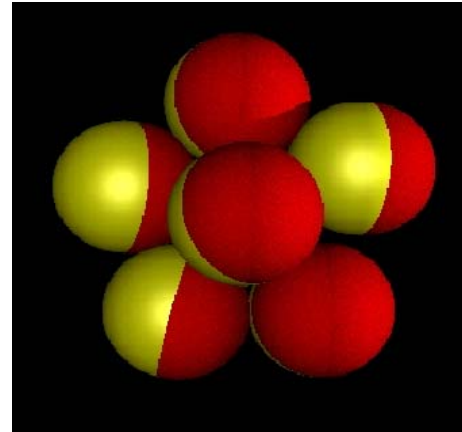
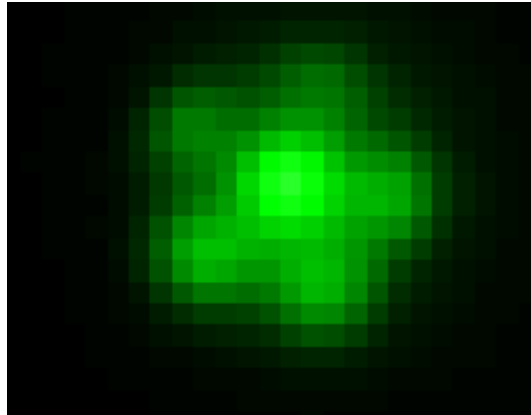
All clusters preserve charge asymmetry

MC simulations
by
Erik Luijten
and
Angelo
Cacciuto



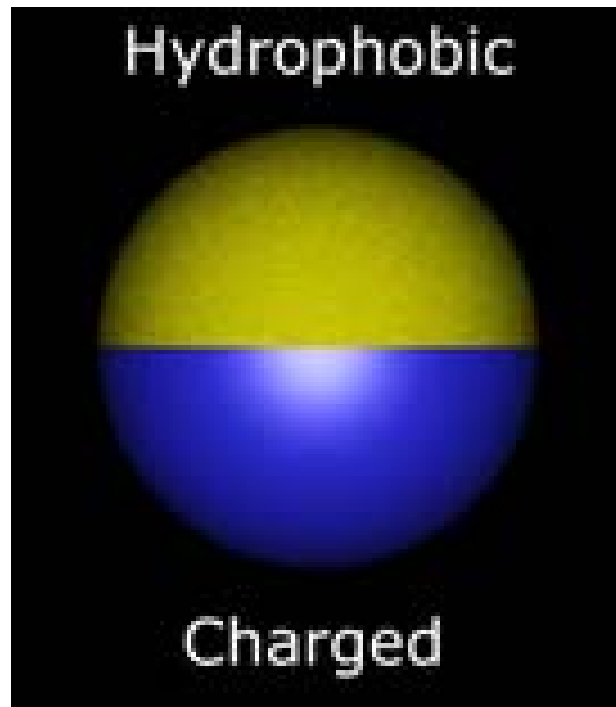
Dynamic !

Heptamer cluster (n=7)

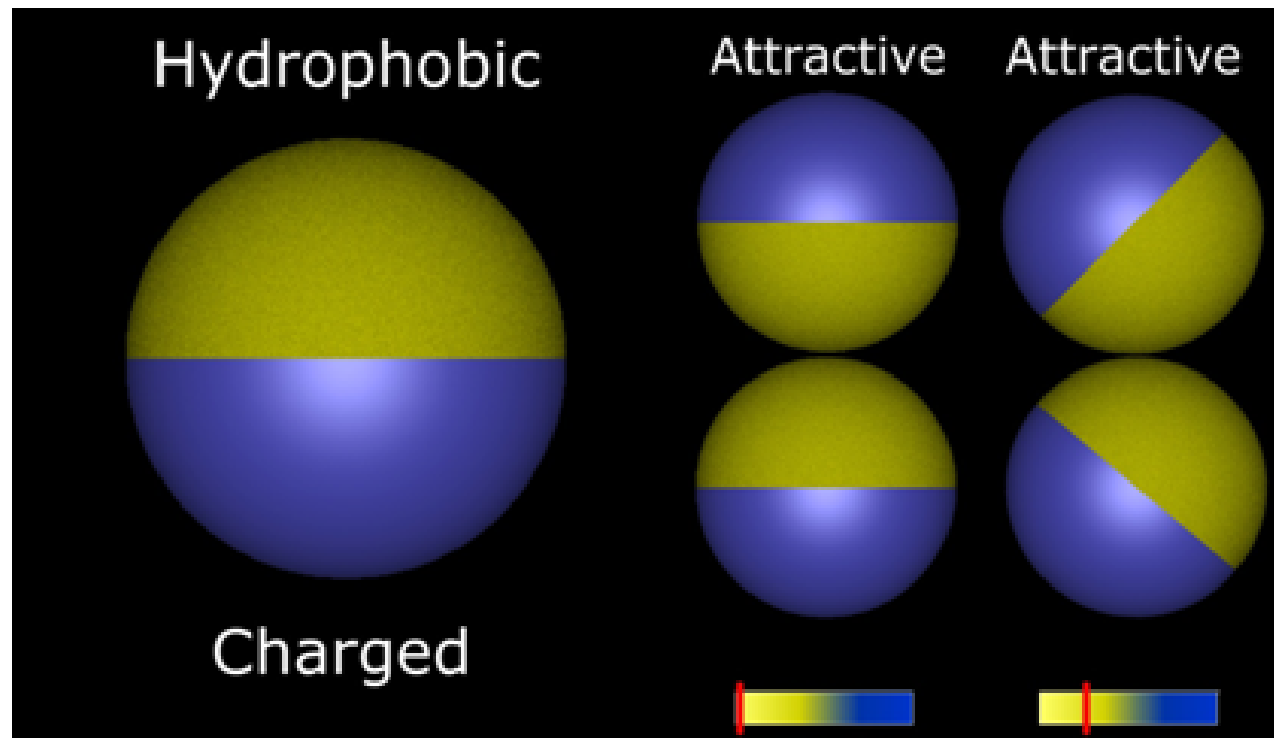


*a surface-
bound
cluster*

Areas of the same size

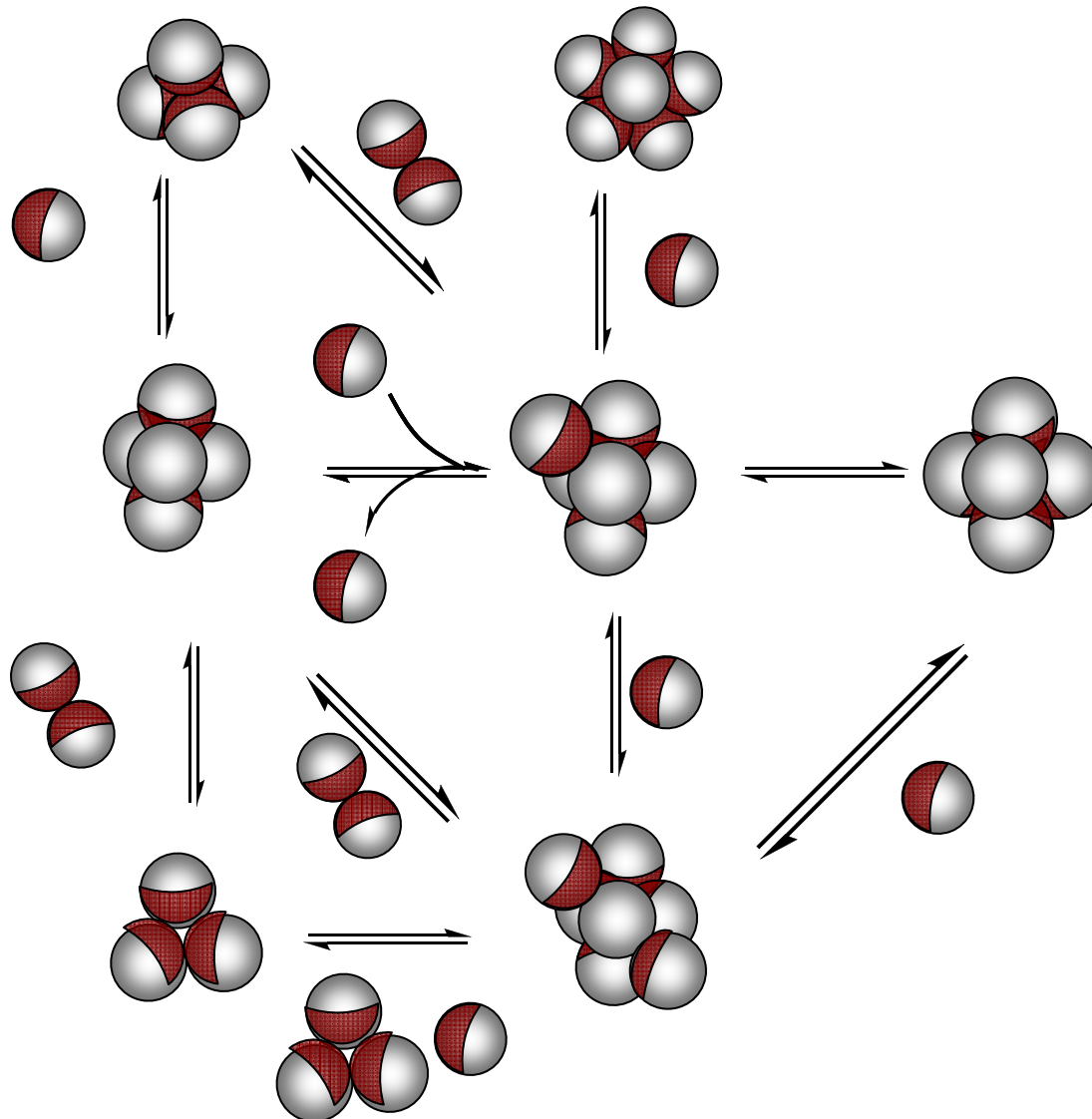


Possibilities are modulated by salt

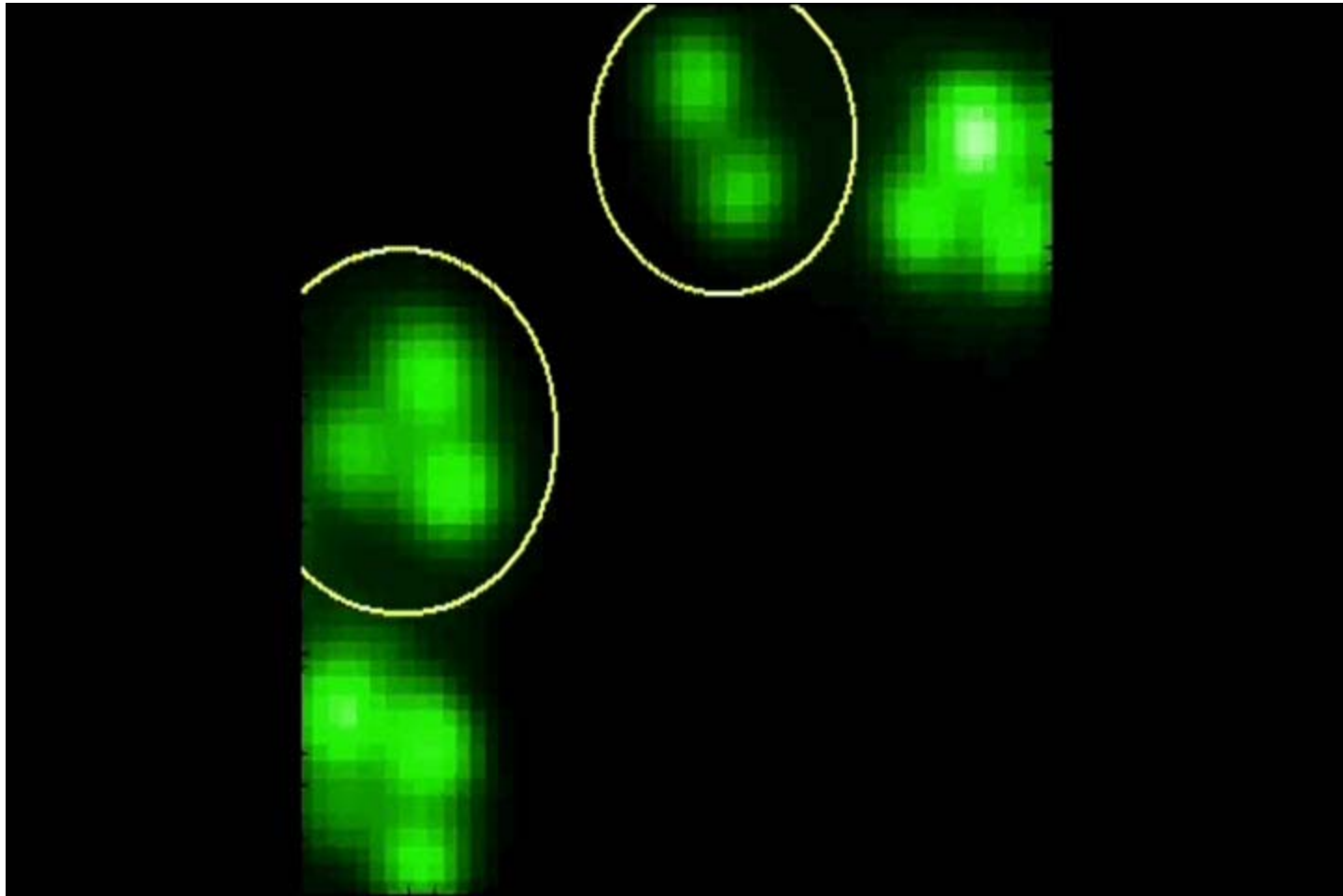


Only at higher salt

Clusters are born and die, reversibly



Heptamer from fusion of smaller clusters



Status report

Same # of particles

**

Energetically the same

**

Entropically -- different

Status report:

Chiral colloids – not unusual

Their structure is selected by kinetics

What we learn

Colloids with directional bonding
and chemical-type reactivity
(yes, probably)

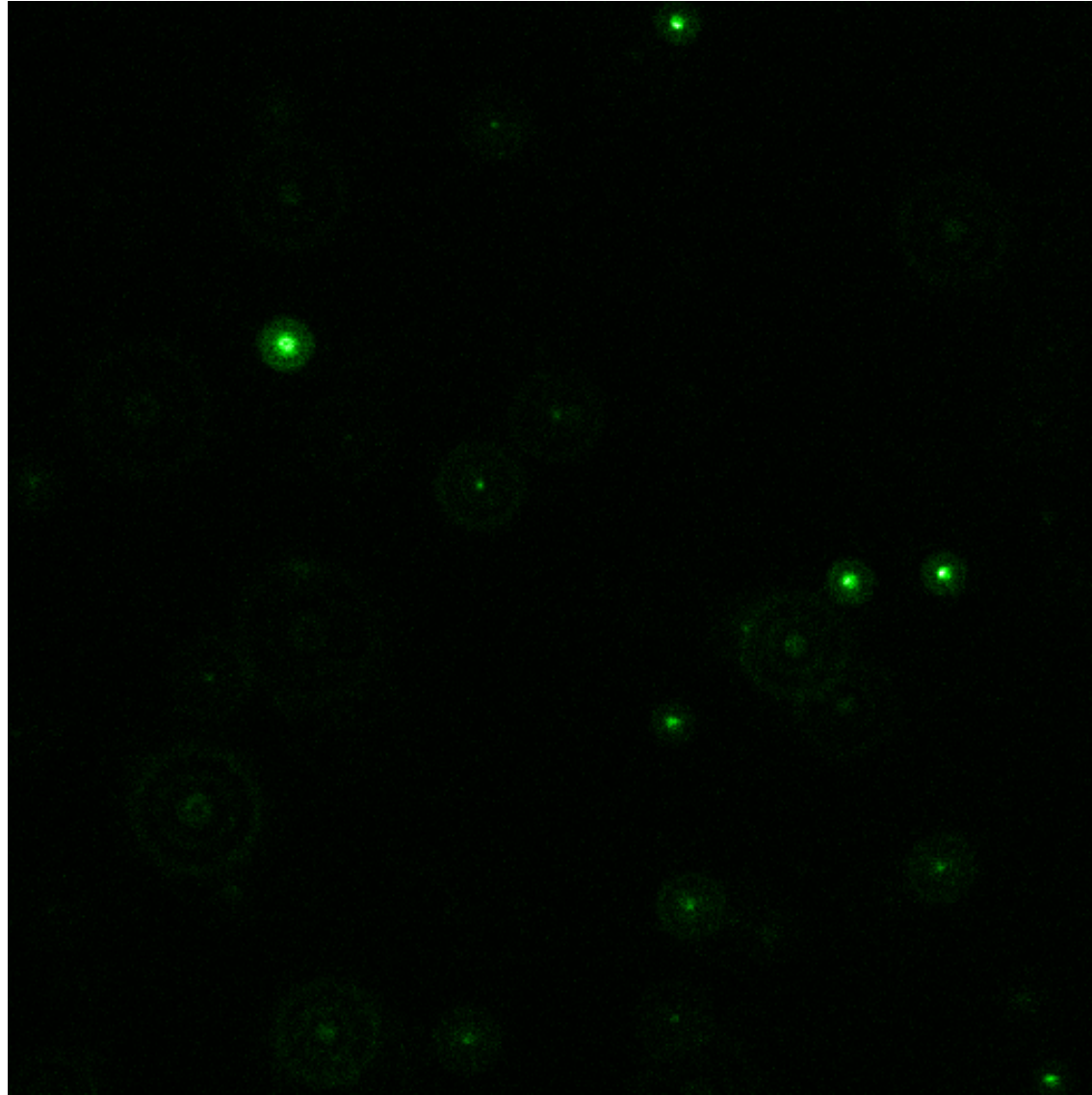
“aggregation”; “crystallization”
(too simple)

Self-limiting structures

Vignette 2

Exploiting optical anisotropy

The Sky in a Microscope

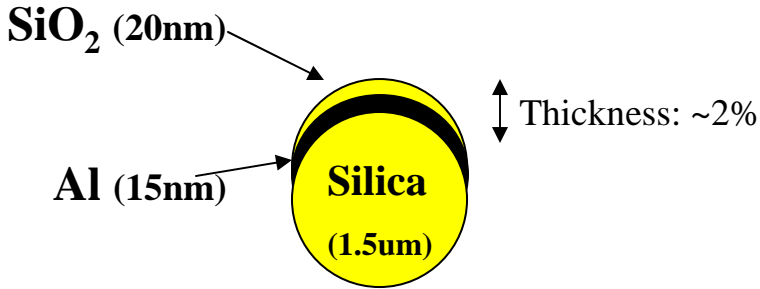
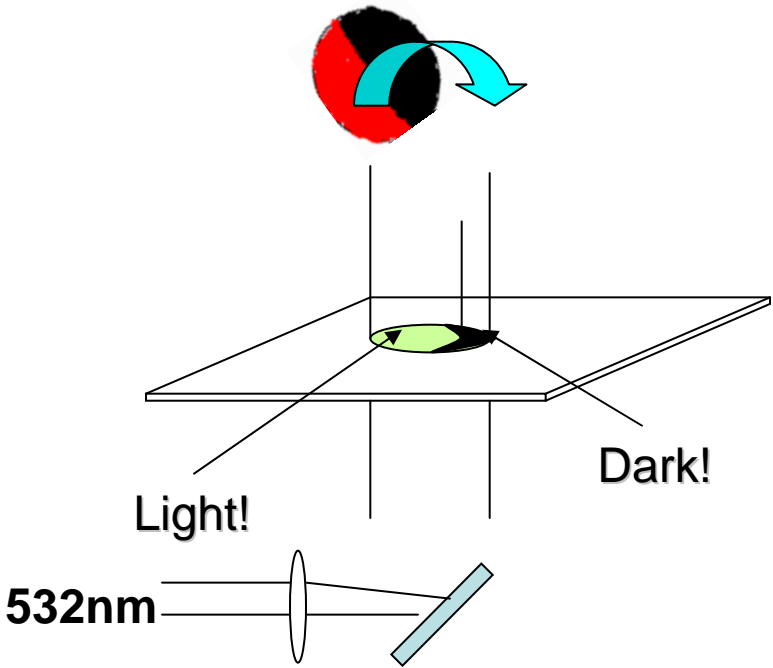


MOONs

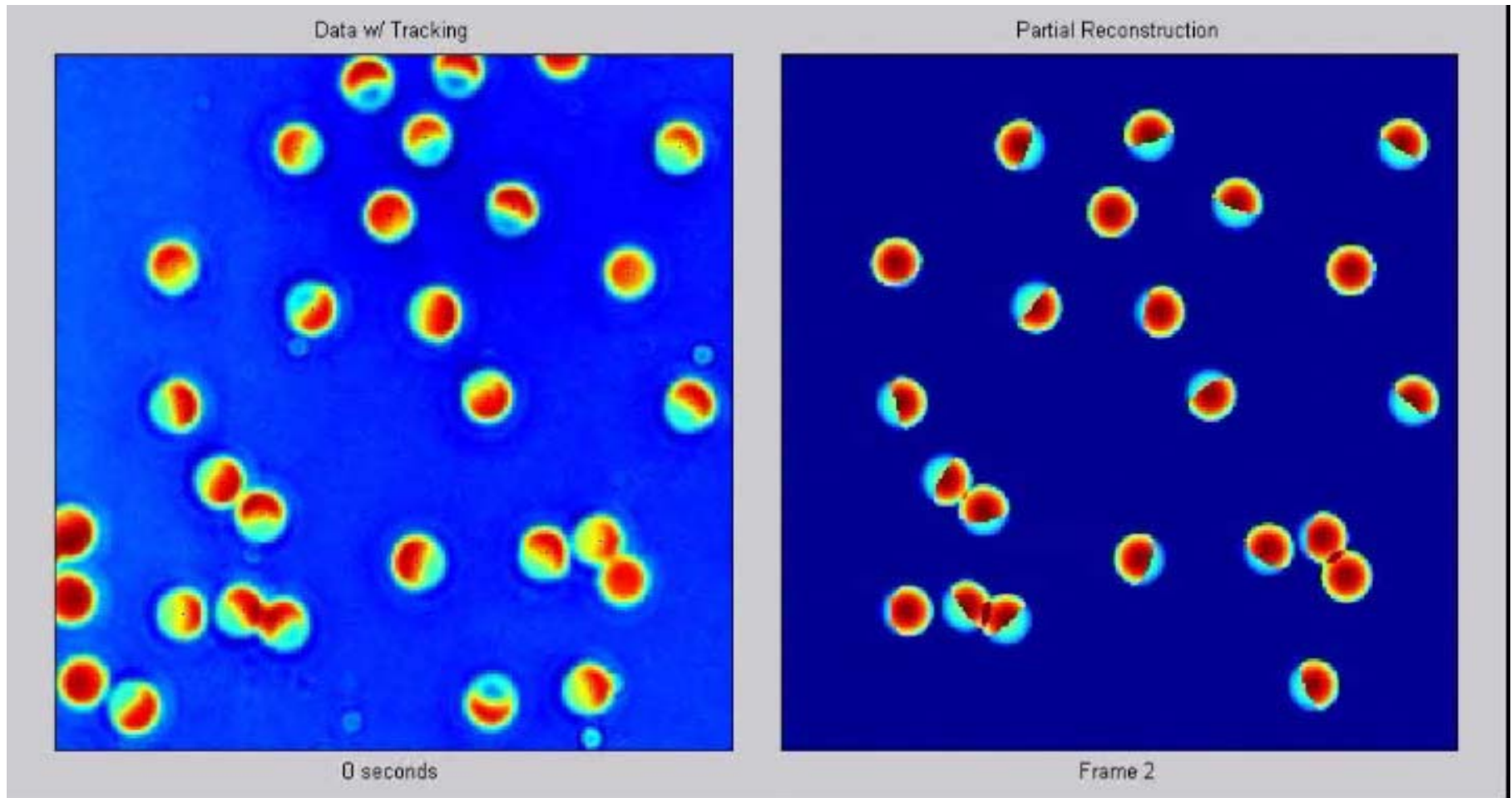


Raoul Kopelman

Different optically
Same chemically



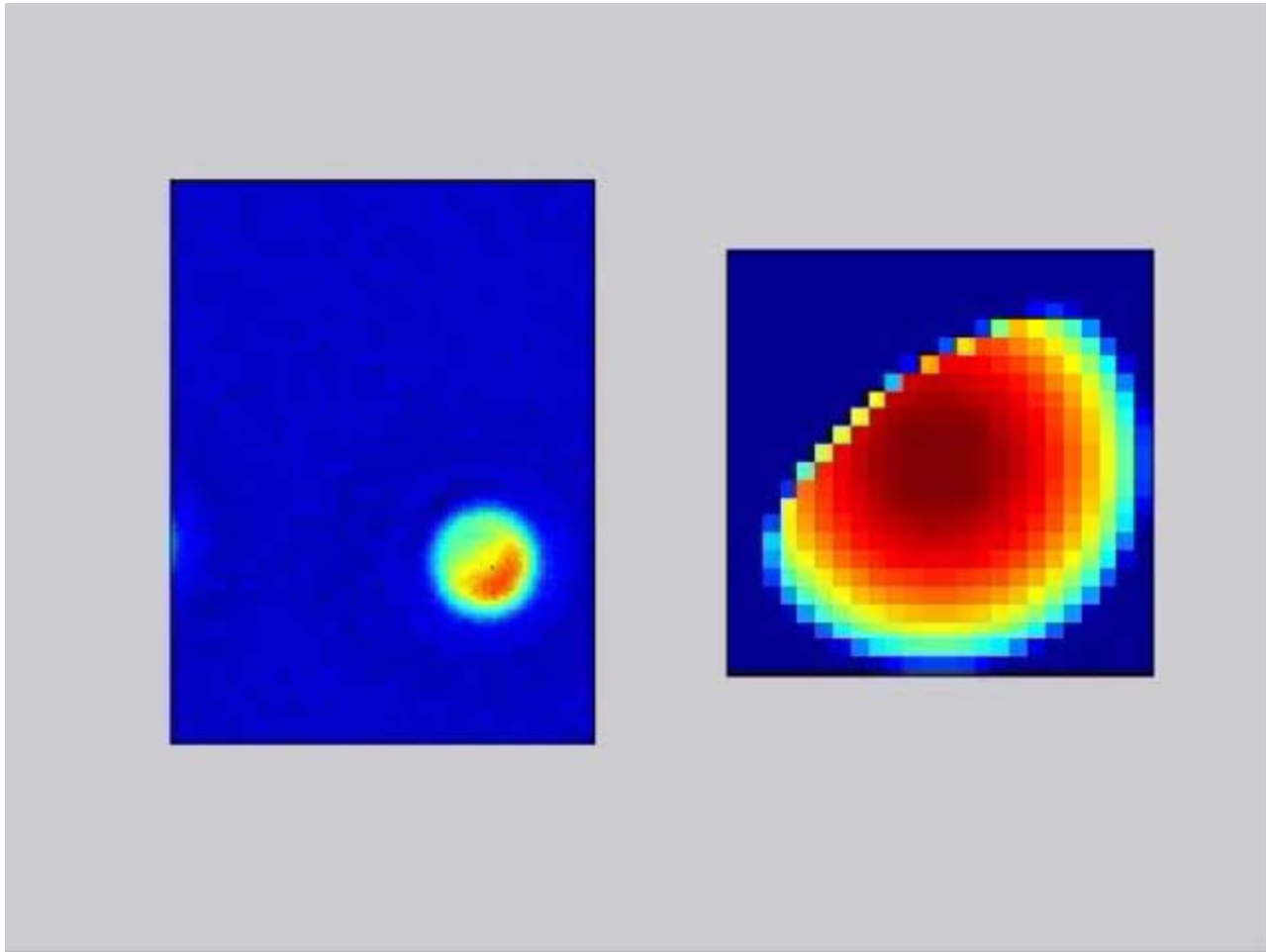
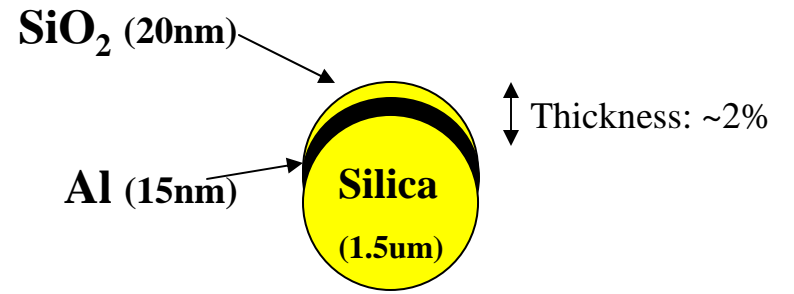
Quantifying the rotation of spinning spheres



Data

Calculated angle

4-dimensional particle tracking



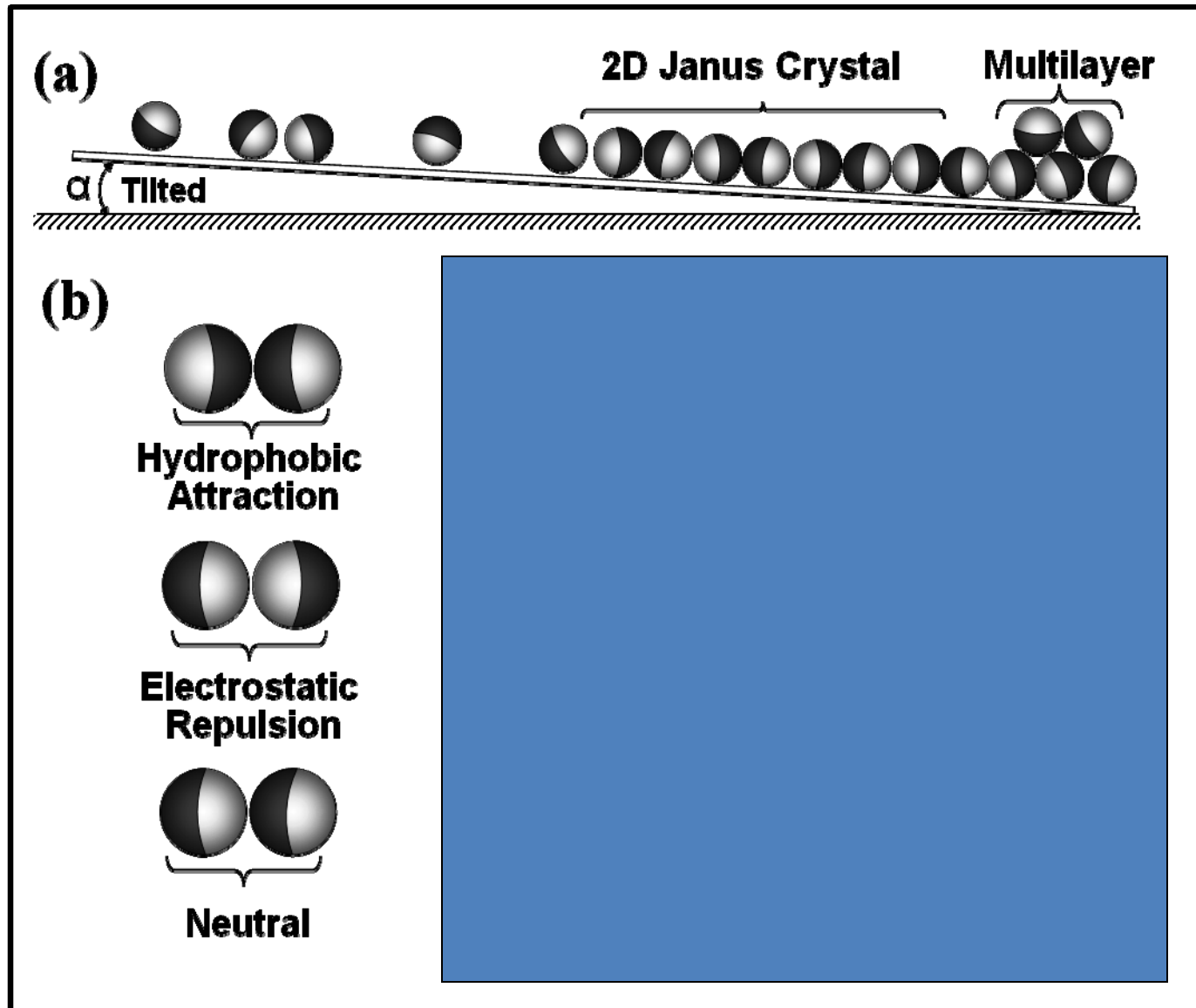
Data

Calculated angle

Vignette 3

Crystals, patterns of long range





Summary, opportunities, outlook

Janus colloids - the molecular colloid problem.

MOONS - spheres rotate, too.

2D crystals - static patterns, dynamic patterns.

A playground for new applications and science.