Key Concepts for section IV (Electrokinetics and Forces)

1: Debye layer, Zeta potential, Electrokinetics

2: Electrophoresis, Electroosmosis

3: Dielectrophoresis

4: **Inter-Debye layer force, Van-Der Waals force**

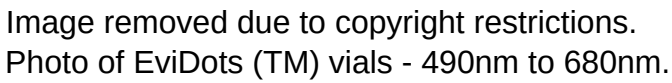
5: Coupled systems, Scaling, Dimensionless Numbers

Goals of Part IV:

(1) Understand electrokinetic phenomena and apply them in (natural or artificial) biosystems

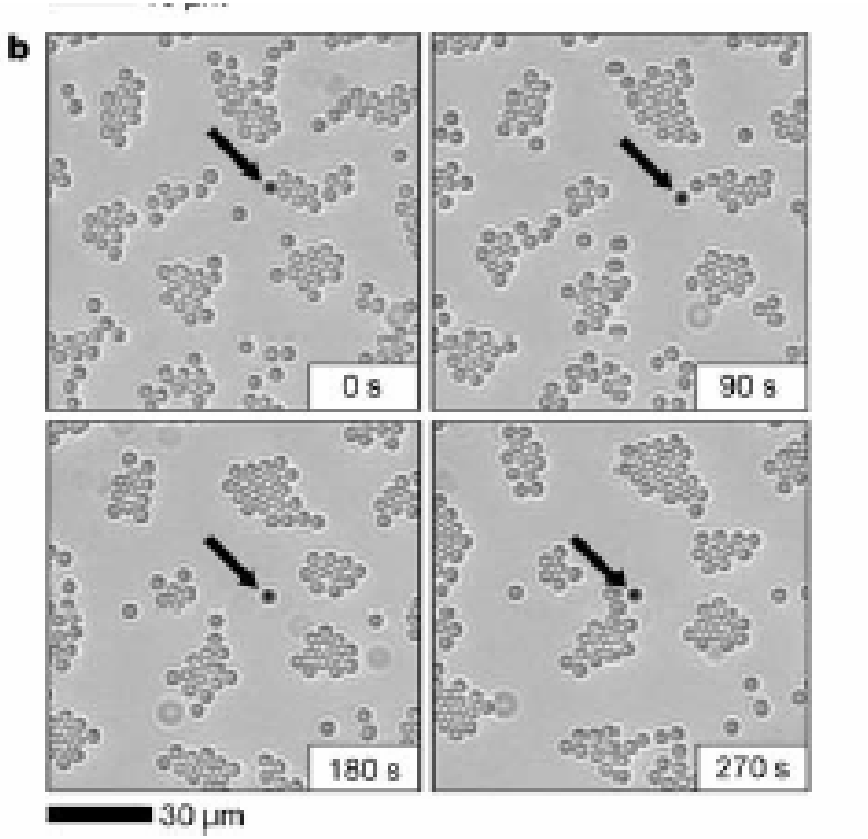
(2) Understand various driving forces and be able to identify dominating forces in coupled systems

Nanoparticles : Emerging tools for Bioengineering



From www.evidenttech.com (Evident Technology)

The problem of colloid (nanoparticle) stability



M. M. Baksh, M. Jaros, J. T. Groves, *Nature* **427**, 139 (2004)

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Figure 4 in A. Yethiraj and A. van Blaaderen. *Nature* **421**, 513 (2003)

Coagulation / Flocculation

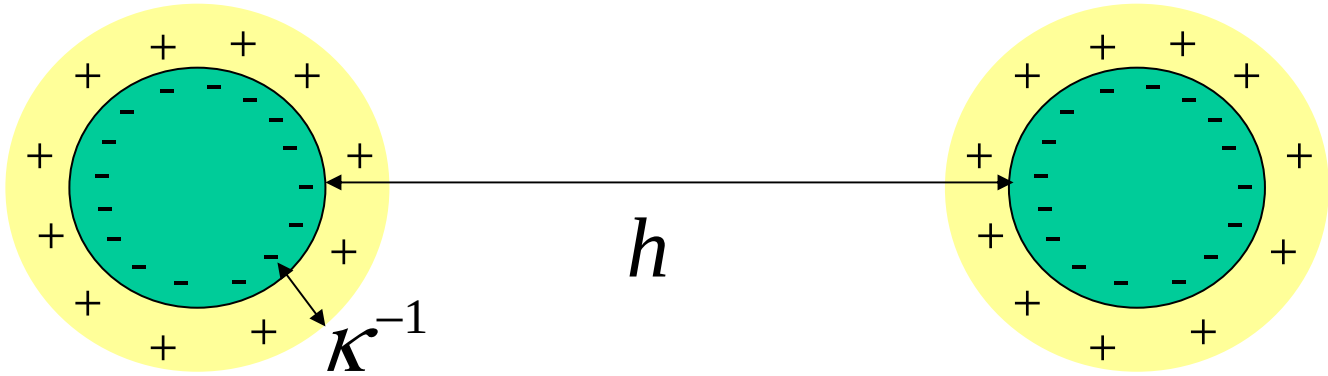
Schulze-Hardy Rule

Critical coagulation concentrations for hydrophobic solutions (millimoles per dm^3)					
As_2S_3 (-ve sol)		*AgI (-ve sol)*		*Al_2O_3 (+ve sol)*	
LiCl	58	$LiNO_3$	165	NaCl	43.5
NaCl	51	$NaNO_3$	140	KCl	46
KCl	49.5	KNO_3	136	KNO_3	60
KNO_3	50	$RbNO_3$	126		
K acetate	110	$AgNO_3$	0.01		
$CaCl_2$	0.65	$Ca(NO_3)_2$	2.40	K_2SO_4	0.30
$MgCl_2$	0.72	$Mg(NO_3)_2$	2.60	$K_2Cr_2O_7$	0.63
$MgSO_4$	0.81	$Pb(NO_3)_2$	2.43	K_2 oxalate	0.69
$AlCl_3$	0.093	$Al(NO_3)_3$	0.067	$K_3[Fe(CN)_6]$	0.08
$1/2\ Al_2(SO_4)_3$	0.096	$La(NO_3)_3$	0.069		
$Al(NO_3)_3$	0.095	$Ce(NO_3)_3$	0.69		

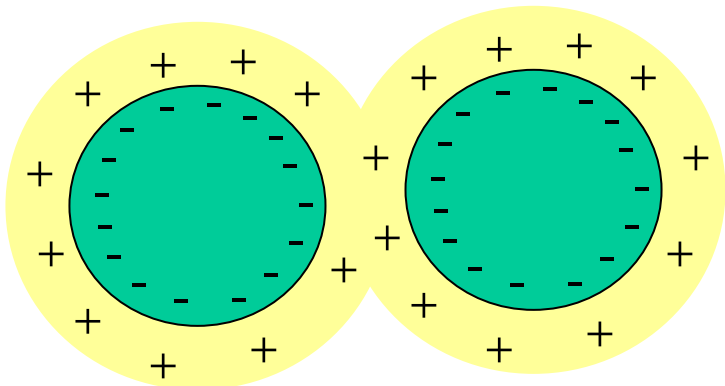
Figure by MIT OCW.

Source: “Introduction to Colloid and Surface Chemistry”
By Duncan J. Shaw (Butterworth Heinemann)

Electrostatic interaction within electrolyte solution

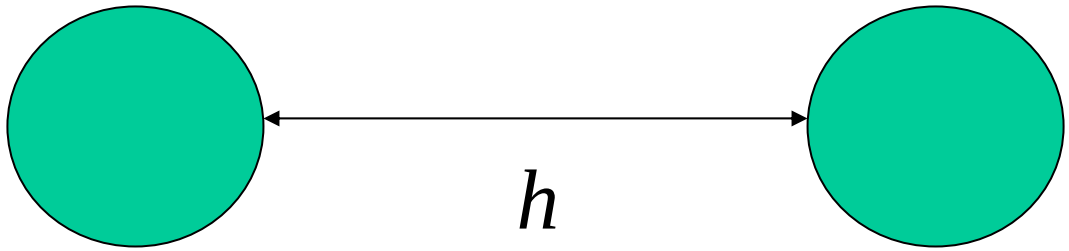


weak or no interaction



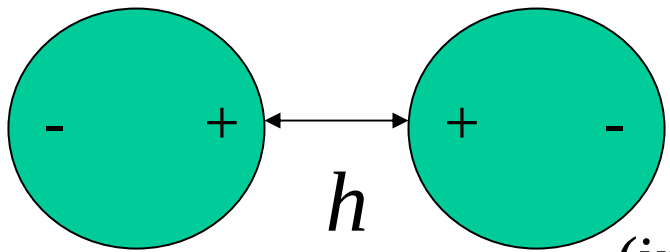
significant repulsive interaction
(inter-Debye layer repulsion)

Van der Waals Forces (attractive forces)
London Dispersion Forces (F. London, 1930)



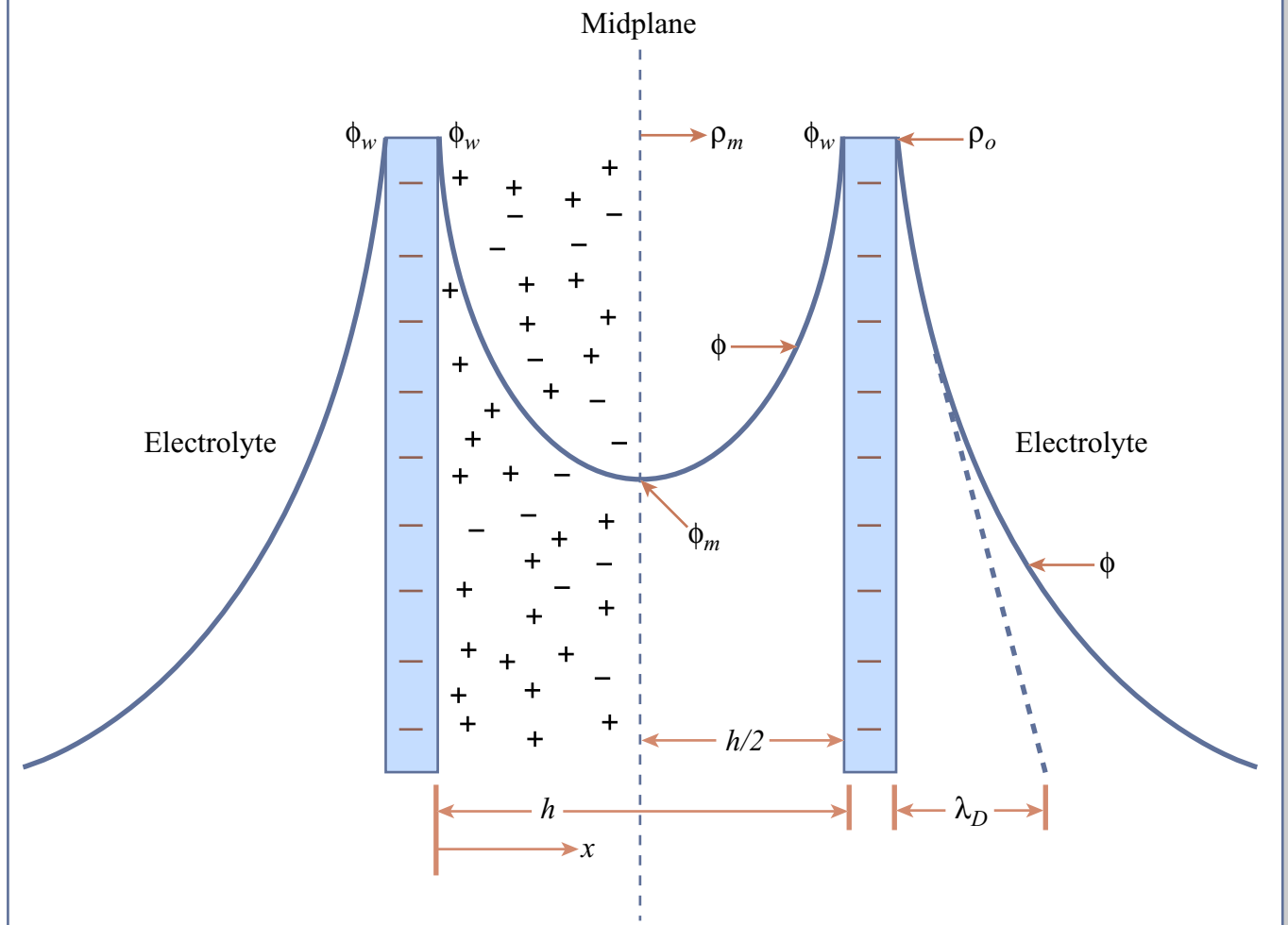
Non-polar molecules

weak or no interaction



(induced dipole)

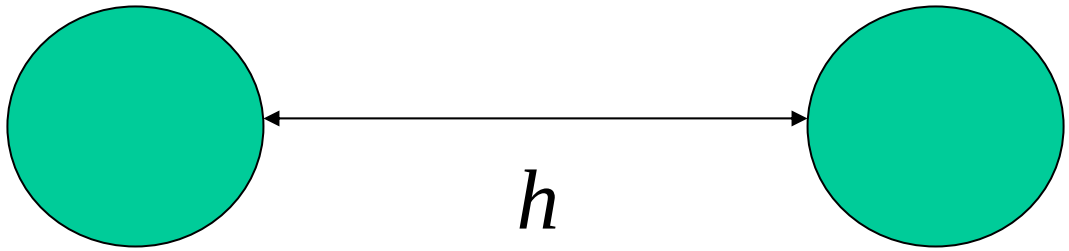
Attractive interaction



Potential distribution resulting from the overlap of double layers from opposing plates.

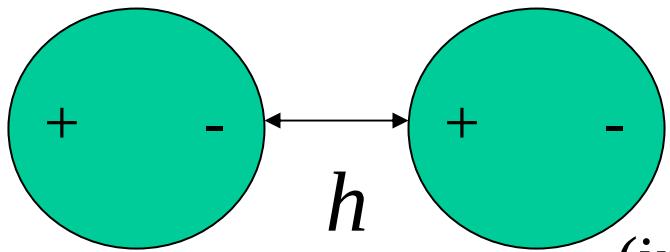
Figure by MIT OCW.

Van der Waals Forces (attractive forces)
London Dispersion Forces (F. London, 1930)



Non-polar molecules

weak or no interaction



(induced dipole)

Attractive interaction

Values of Hamaker Constants		
Material	$\frac{A_{11}\ (microscopic)}{10^{-20}\ J}$	$\frac{A_{11}\ (macroscopic)}{10^{-20}\ J}$
Water	3.3 - 6.4	3.0 - 6.1
Ionic Crystals	15.8 - 41.8	5.8 - 11.8
Metals	7.6 - 15.9	22.1
Silica	50	8.6
Quartz	11.0 - 18.6	8.0 - 8.8
Hydrocarbons	4.6 - 10	6.3
Polystyrene	6.2 - 16.8	5.6 - 6.4

Figure by MIT OCW.

Source: “Introduction to Colloid and Surface Chemistry”

By Duncan J. Shaw (Butterworth Heinemann)

Tokay Gecko (*Gekko gecko*)

Photo courtesy of ‘elbisreverri’.
http://www.flickr.com/photos/elbisreverri/53226345/

Photo courtesy of David Clements.