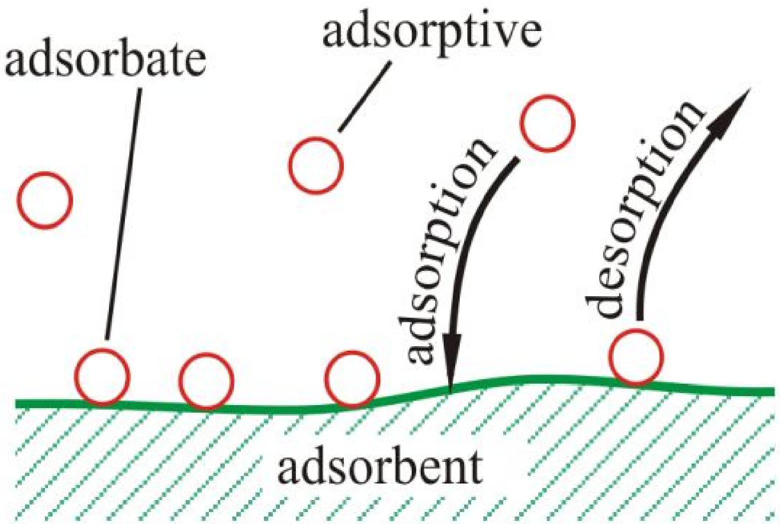
4. Adsorption: enrichment on the surface (binding on „active” sites)

Desorption: removal of the adsorbed species



$$A + S \rightleftharpoons AS$$

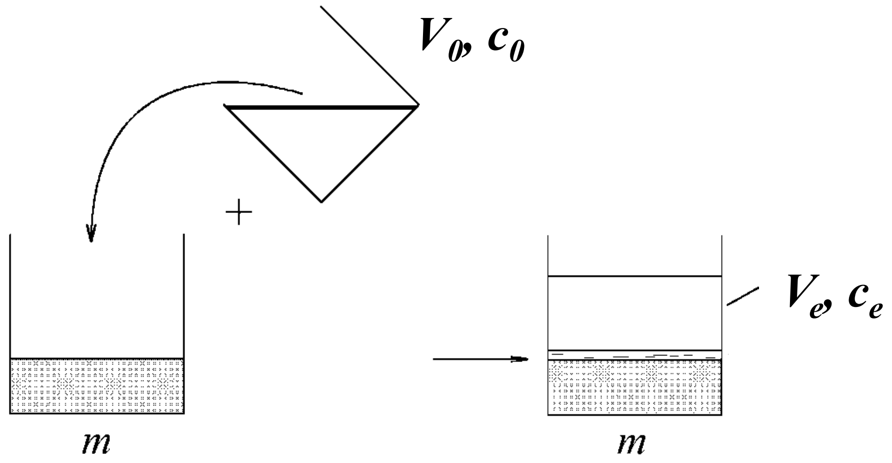
Equilibrium process

$$\Delta G = \Delta H - T\Delta S$$

Adsorption is brought by the forces acting between the solid and the molecules of the gas. These forces are of two kinds: physical (physisorption) and chemical (chemisorption).

Example: Adsorption phenomena at S/L interfaces from dilute binary liquids:

From the mass balance:



$$n^a = \frac{(c_0 - c_e)V_0}{m}$$

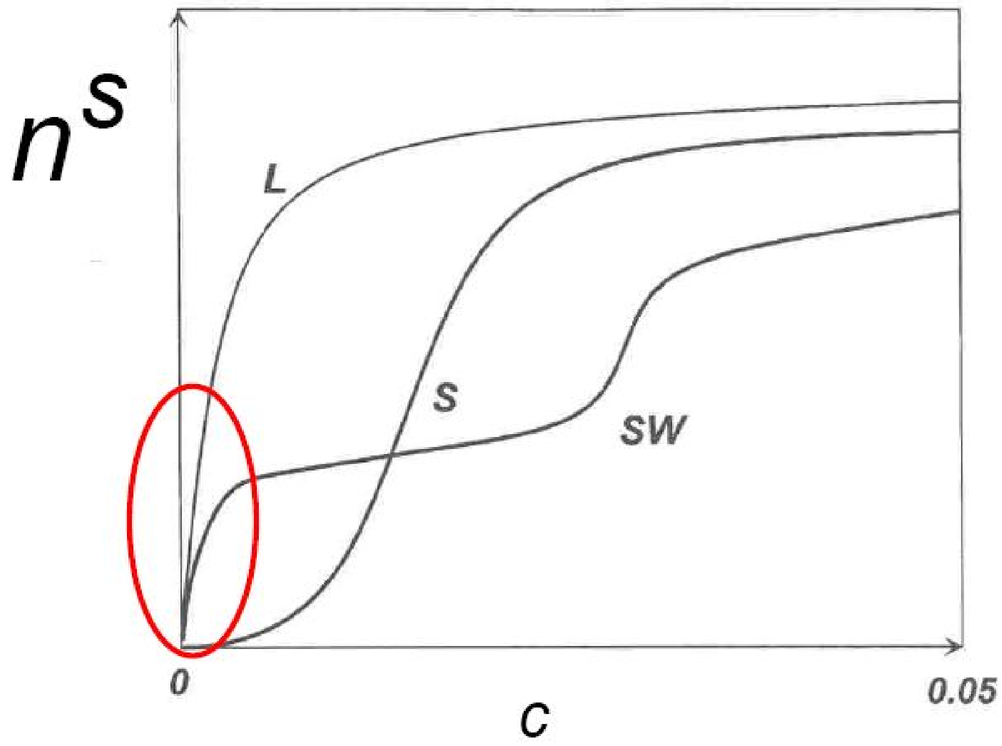
T=const. (isotherm)

In case of nonionic systems the typical interactions are:

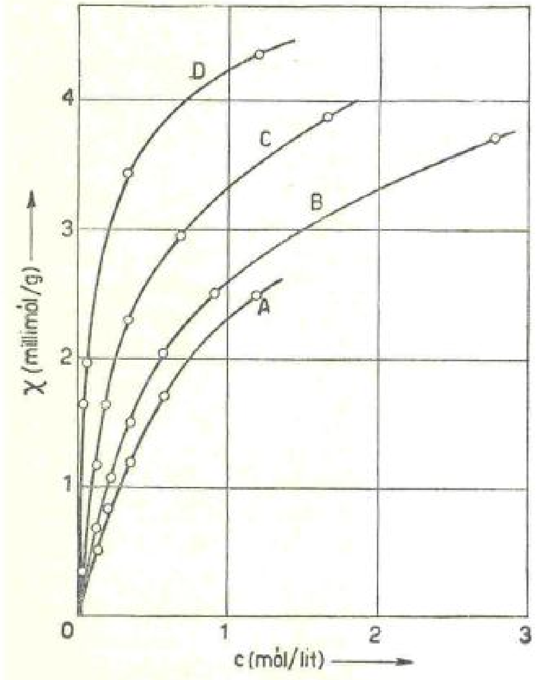
van der Waals and dispersion
(secondary interactions)

Surface/dissolved material
Surface/ solvent
Solvent/dissolved material

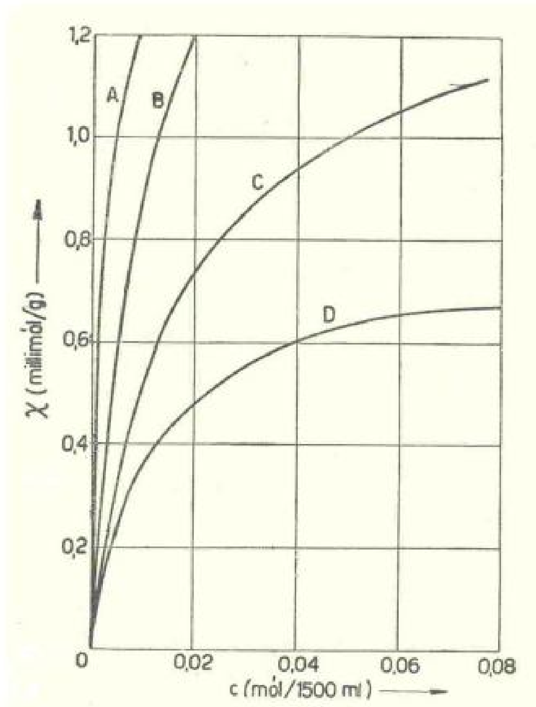
TYPICAL SHAPES OF THE ISOTHERMS:



A: formic acid
B: acetic acid
C: propionic acid
D: butyric acid



From water on activated carbon



From toluene on silica

Oriented adsorption

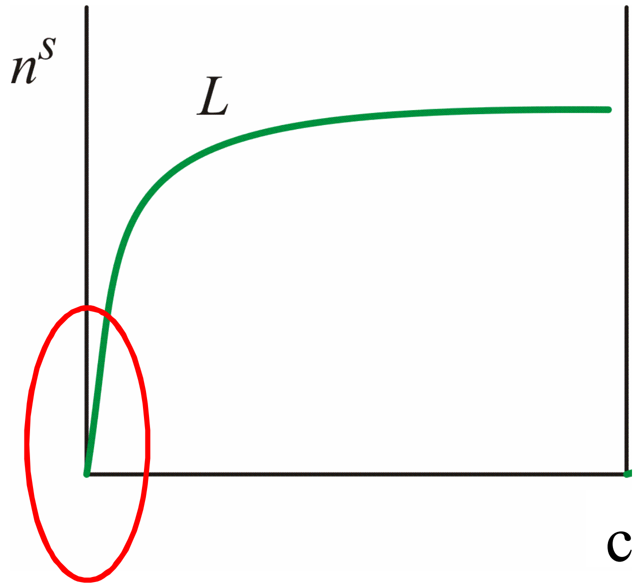
INTERPRETATION OF DATA

1. Shape of the isotherm

2. Models

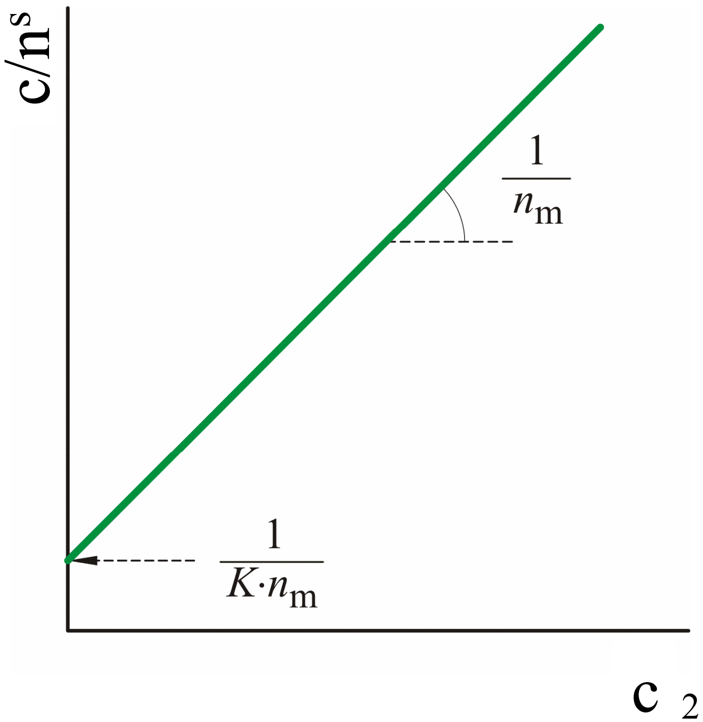
a) Langmuir

$$n^s = n^s_m \frac{Kc}{1+Kc}$$



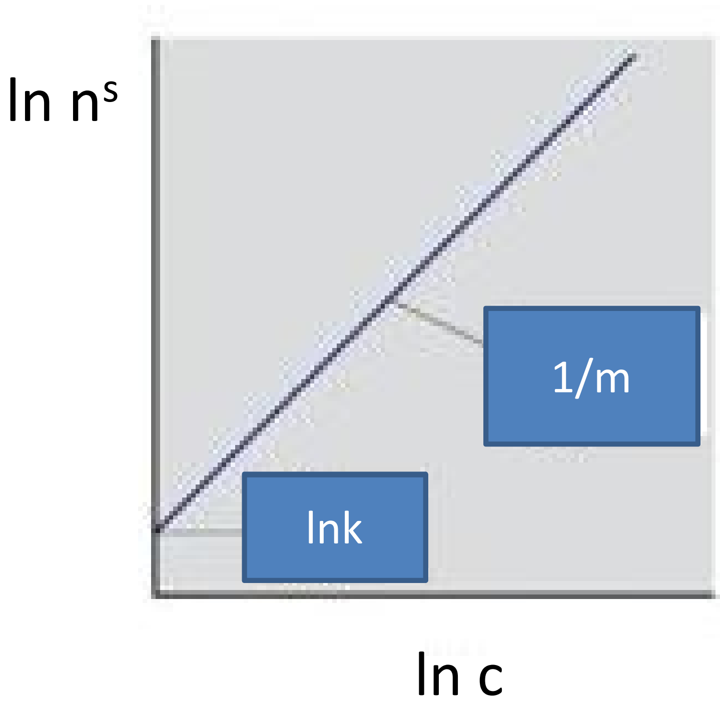
Henry $c \to 0$

$$\frac{c}{n} = \frac{1}{Kn_m} + \frac{c}{n_m}$$



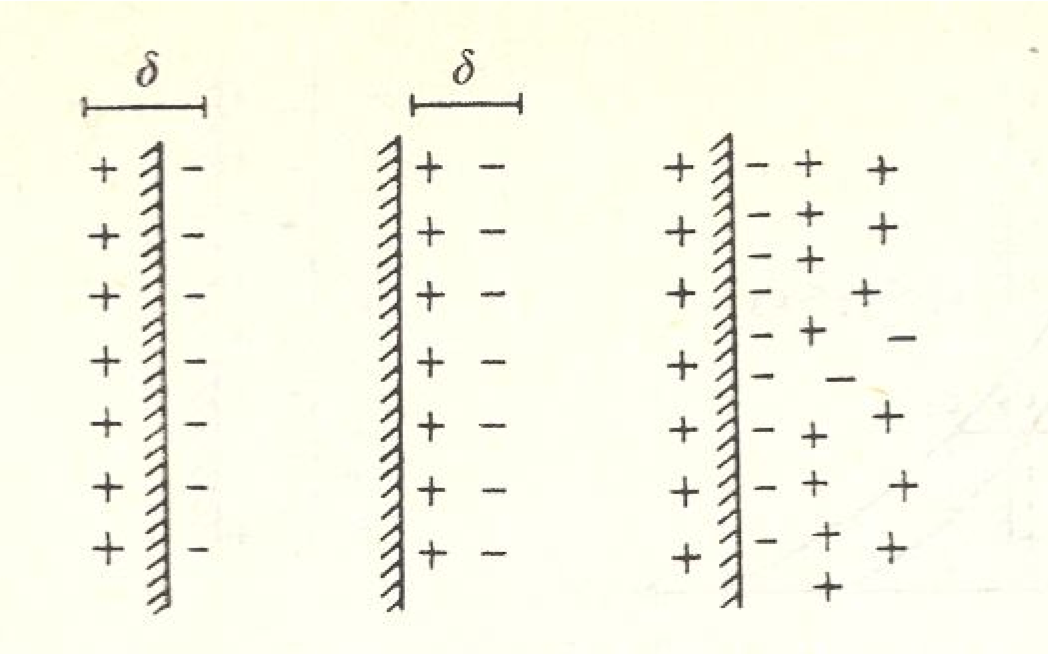
b. Freundlich

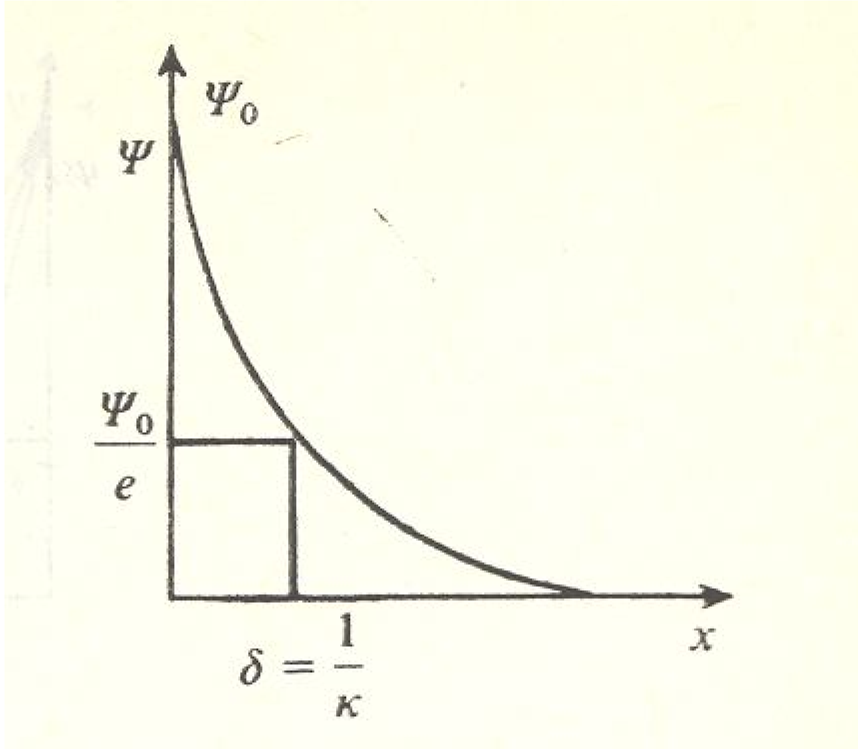
$$n^s = kc^{1/m} \qquad m > 1$$



* Ionic systems

Electrostatic interactions: attraction
repulsion





The role of the counterion

$$\Psi = \Psi_0 \, e^{-\kappa x}$$

$$\kappa = \mathrm{konst} \cdot z\sqrt{c}$$

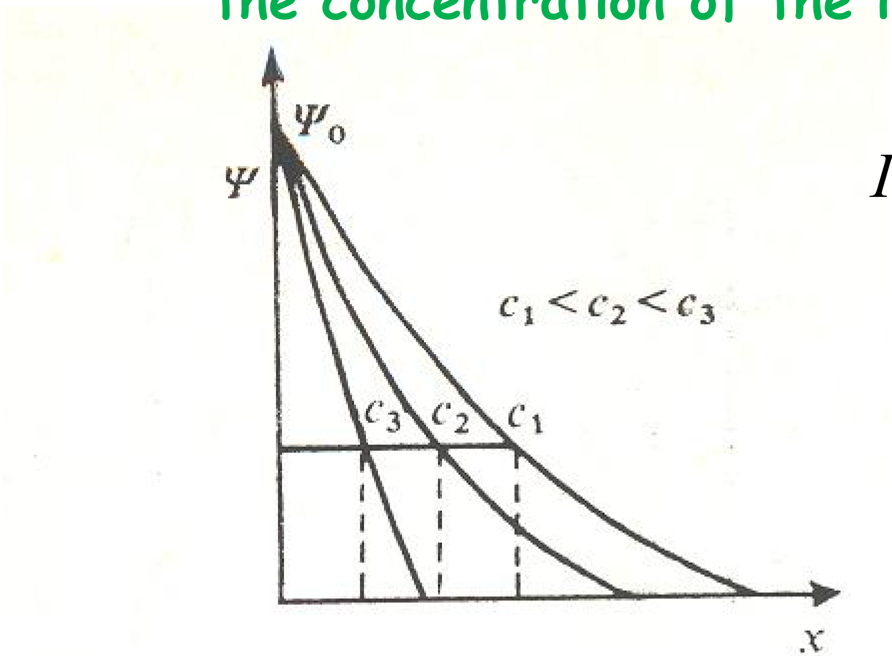
Thickness of the electric double-layer δ

z the charge of the counterion (symmetric electrolites)

$1/\kappa$: fictive thickness

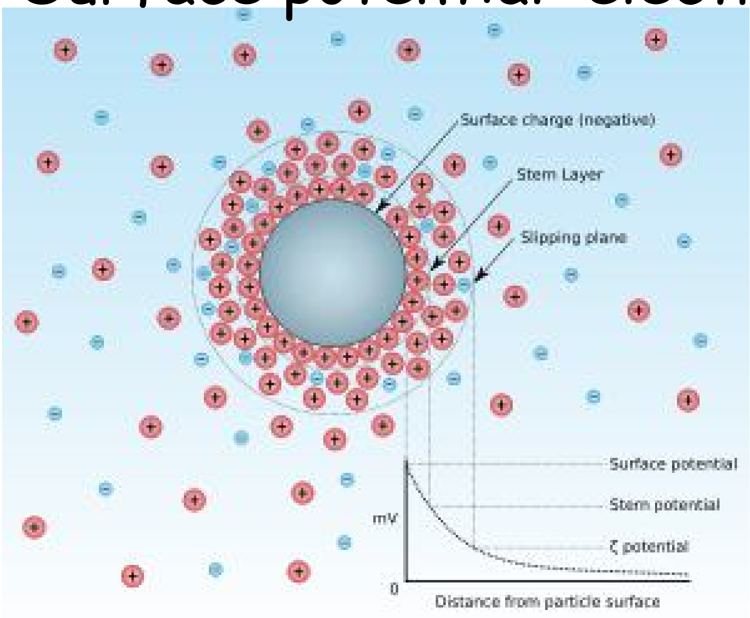
Brownian motion
Diffuse double-layer
Stern-layer

The thickness of the double-layer is influenced by the concentration of the ions



$$I = 0.5 \sum_i z_i^2 c_i$$ ionic strength

Surface potential: electrokinetic potential or *ζ - potential*



$$\zeta = \frac{4\pi\sigma\delta}{\varepsilon}$$

σ: surface charge density
ε: permittivity of the medium

Zeta potential [mV]	Stability behavior of the colloid
from 0 to ±5,	Rapid coagulation or flocculation
from ±10 to ±30	Incipient instability
from ±30 to ±40	Moderate stability
from ±40 to ±60	Good stability
more than ±61	Excellent stability