Supplementary Material (ESI) for Soft Matter


# Recovery Model (example of calculation of diffusion coefficient)

$z := 1$

$r := 10.5 \cdot 10^{-6}$

r....particle radius (µm)

$punkt := 1$

$:=$

C:\..\mobility.xls

data.....input data file (excel)
<u>format:</u>
column A: starting from A2: time (s)
row 1: A1 free, B1-...1: angles of circular regions from FRAP data
column B2-....2: respective grey values

$Zeiten := 100$

zeiten....specifies fraction of data (time in %) which should be taken into account for calculation

zeilen ...rows; spalten ....columns; winkel ....angles

$zeilen := ceil\left(rows(Data) \cdot \frac{Zeiten}{100}\right)$

$spalten := cols(Data)$

$Data1 := submatrix(Data, 1, zeilen - 1, 0, spalten - 1)$

$Data2 := submatrix(Data, 0, zeilen - 1, 1, spalten - 1)$

$Data3 := submatrix(Data, 1, zeilen - 1, 1, spalten - 1)$

$zeit := Data1^{\langle 0 \rangle}$

$Data4 := Data2^{T}$

$vdat := Data3^{T}$

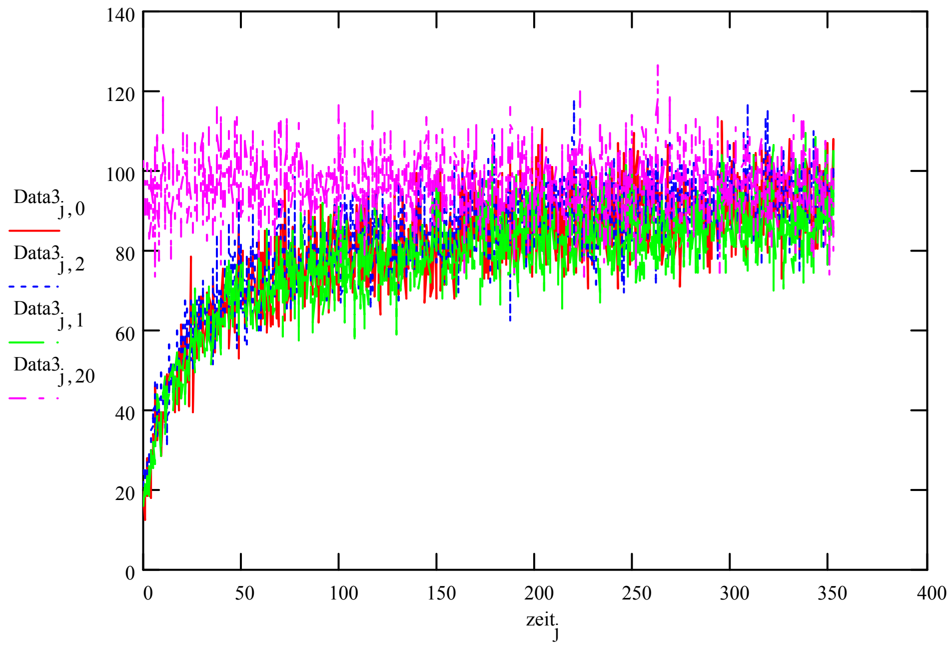
$winkel := Data4^{\langle 0 \rangle}$

<u>Comments:</u>
in Data3 intensity data are present. The rows are assigned to the times in the "zeit"-vector. The columns represent the cosine of the angle from the "winkel"-vector.

$i := 0 .. spalten - 2$

$j := 0 .. zeilen - 2$

$winkel_i := \cos\left(winkel_i \cdot \frac{\pi}{180}\right)$




$refer := spalten - 5$

$Data3_{0,2} = 25.125$

$zeilen = 881$

$spalten = 45$

$winkel_{spalten-2} = -1$

$winkel_4 = 0.961$

$zeitmittel := 10$

$vi := Data3^{\langle refer \rangle}$

$st := 0$

$vd := Data3^T$

st...region from which the fluorescence recovery is examined (circular areas)

$vdat0 := submatrix(vd, 0, spalten - 2, 0, zeitmittel)$

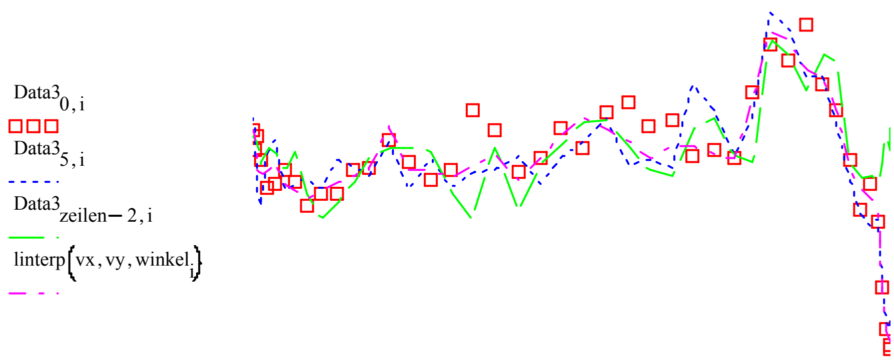
$i := 0 .. spalten - 2$

$vdat := vdat0^{\langle 0 \rangle}$

$$vdat_i := \frac{\sum_{j=0}^{zeitmittel} vdat0_{i,j}}{zeitmittel + 1}$$

$vx_i := winkel_{spalten-2-i}$

$vy_i := vdat_{spalten-2-i}$




$$Trend := \frac{\displaystyle\sum_{j=zeilen-2-100}^{zeilen-2} vi_j}{\displaystyle\sum_{j=0}^{100} vi_j}$$

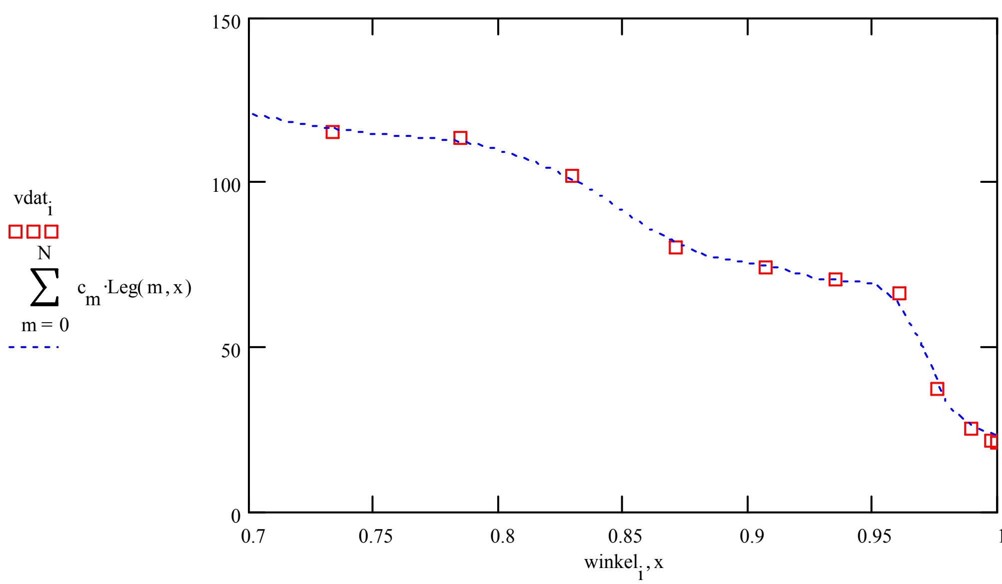
$Trend = 1.03$

$N := 50$

$m := 0..N$

$$c_m := \frac{2\cdot m+1}{2}\cdot\int_{-1}^{1}(linterp(vx, vy, x))\cdot Leg(m, x)\,dx$$

$x := -1, -0.99..1$



$$\sum_{m=0}^{N} c_m \, Leg\left(m, winkel_{st}\right) = 23.746$$

$$vdat_{st} = 21.017$$

$$vg := 1 \cdot 10^{-14}$$

$$vt := zeit$$

$$vi := Data3^{\langle st \rangle}$$

$$punkt := winkel_{st}$$

$$saett := 500$$

$$Rec := \frac{\dfrac{\displaystyle\sum_{m=saett}^{zeilen-2} vi_m}{zeilen - saett - 1}}{c_0}$$

$$mitt := \frac{\displaystyle\sum_{m=0}^{zeilen-2} vi_m}{zeilen - 1}$$

$$Rec := 1$$

here (Rec): insert % recovery if necessary

$$F(t,u,Rec) := (1 - Rec) \cdot \sum_{k=0}^{N} c_k \cdot Leg(k, punkt) + Rec \cdot \sum_{k=0}^{N} c_k \cdot Leg(k, punkt) \cdot \exp\left[\frac{-u \cdot k \cdot (k+1) \cdot t}{r^2}\right]$$

$$Rec = 1$$

$$S(u,Rec) \qquad \overset{zeilen-2}{\underset{m \quad 0}{}} \left(vi_m - F\left(vt_m, u, Rec\right)\right)$$

$$Var \qquad \overset{zeilen-2}{\underset{m \quad 0}{}} \left(vi_m - mitt\right)$$

$$Sol(u,Rec) := \left[\sum_{m=0}^{zeilen-2} \left[\left(vi_m - F\left(vt_m, u, Rec\right)\right) \cdot \left[\sum_{=} \right]\right]\right]$$

$$Sol1(Rec,u) := \left[\sum_{m=0}^{zeilen-2} \left[\left(vi_m - F\left(vt_m, u, Rec\right)\right) \cdot \left[\sum_{=} \right]\right]\right]$$

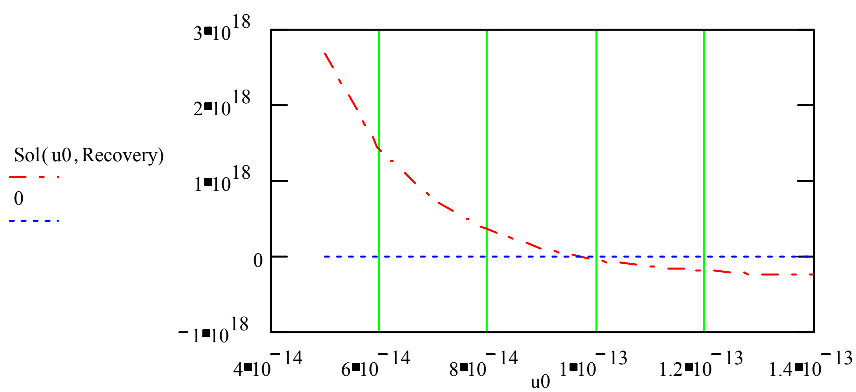
$Anf := 0.5\cdot10^{-13}$

$End := 1.5\cdot10^{-13}$

$$u0 := Anf, Anf + \frac{(End - Anf)}{10} .. End$$

$$Deter(u, Rec) := \frac{Var - S(u, Rec)}{Var}$$

$Recovery := 1$



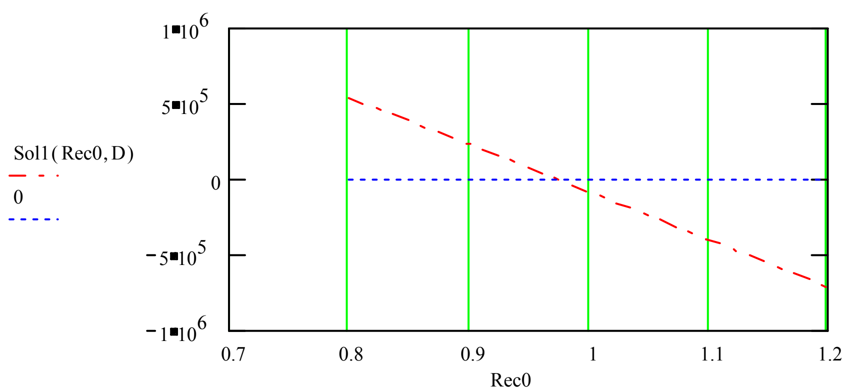

$D := 1\cdot10^{-13}$

insert diffusion constant for overlay in last graph below

$Anf1 := 0.8$

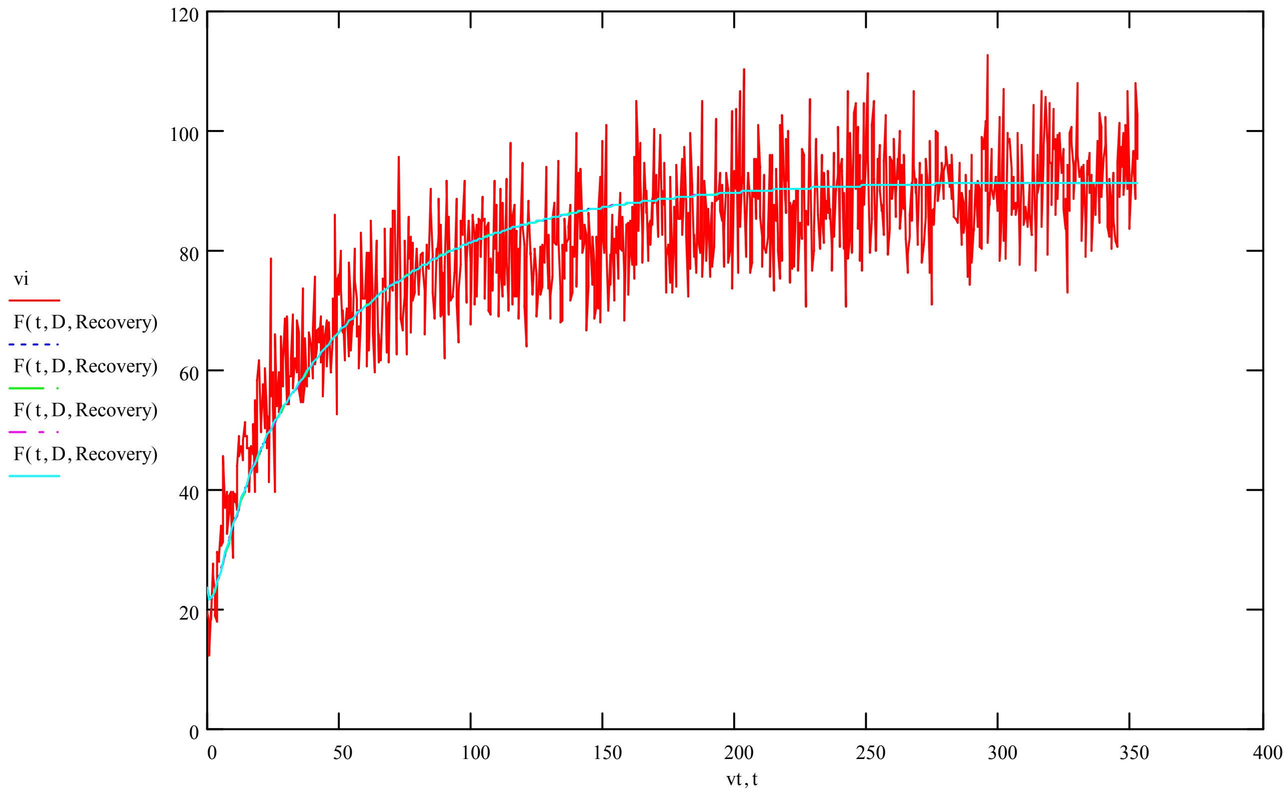
$End1 := 1.2$

$$Rec0 := Anf1, Anf1 + \frac{(End1 - Anf1)}{4} .. End1$$




$Deter(D, Recovery)\cdot100 = 73.755$

$t := 0 .. zeit_{zeilen-2}$




$$Recover := \frac{Recovery \cdot 100}{Trend}$$

$Recover = 97.042$

$F(0, D, Recovery) = 23.746$

$Export^{\langle 1 \rangle} := F(vt, D, Recovery)$

$Export^{\langle 0 \rangle} := vt$

$Export^{\langle 2 \rangle} := vi$

$Export_{0,3} := winkel_{st}$

$$Export_{0,4} := \frac{D}{10^{-14}}$$

$Export_{0,5} := Recovery$

$Export_{0,6} := Deter(D, Recovery) \cdot 100$

export data to corresponding output file

# Lipid coverage on colloidal particles:

Let us compare the total amount of lipid per colloidal particle in case of adsorbed vesicles vs. an adsorbed lipid bilayer. It is obvious that vesicles closely adsorbed next to another on the surface of the colloid together would have a much larger membrane surface than a flat membrane enwrapping the colloidal support. In order to have an upper estimate of the excess lipid in the case of vesicles decorating the colloidal core, let us make the following assumptions.

1) The radius of the adsorbed vesicles is much smaller than the particle radius.
2) All vesicles have the same radius.
3) The adsorbed vesicles assume a hexagonal packing.

The area of the hexagon, $A_{Hex}$ circumscribing the adsorbed vesicle is given by

$$A_{Hex} = \sqrt{12}^{\,r} \cdot r^2$$

The area of the particle, $A_{par}$, is given by

$$A_{par} = 4\pi R^2$$

r and R are the radius of the vesicle and the particle, respectively.
Hence, the number of adsorbed vesicles, n, becomes

$$n = \frac{4\pi R^2}{\sqrt{12} r^2}$$

Their total surface area divided by the area of the colloidal particle provides an upper estimate of the lipid excess, f, in case of adsorbed vesicles vs. an adsorbed flat membrane.

$$f = \frac{4\pi R^2 \cdot 4\pi r^2}{\sqrt{12} r^2 \cdot 4\pi R^2} = \frac{4\pi}{\sqrt{12}} \approx 3.6$$