# Physics with Neutrons I

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**Exercise sheet 3**

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**Due on 08.12.2017**

wiki.mlz-garching.de/n-lecture05:index

## 1. Coherent and incoherent cross-sections

- Calculate and plot the coherent and incoherent differential scattering cross-section from scattering at two nuclei with scattering lengths $b_1$ and $b_2$ and a distance of $R$.

- How does the coherent cross-section evolve with an increasing number of nuclei with equal distances placed along a line? You should probably compute this using something like Matlab or Python (or any other scientific programming application).

## 2. Scattering cross-section of $SiO_2$

Calculate the total coherent and incoherent scattering cross sections of $SiO_2$. Hint: You can look up neutron scattering lengths and cross sections at
`http://www.ncnr.nist.gov/resources/n-lengths/`.

## 3. Practical neutron scattering

Sample holders for diffraction experiments are often made of materials that do not scatter coherently (why?). A possible choice is a *zero-scattering alloy* which can be a mixture of natural titanium and zirconium. What is the composition of this alloy? Why is the term *zero-scattering* misleading?

## 4. Correlation functions

Derive the van Hove function

$$G(\mathbf{r},t) = \frac{1}{N}\sum_{j,j'}\int\left\langle \delta\Big(\mathbf{R}-\mathbf{r}_{j'}(0)\Big)\delta\Big(\mathbf{R}+\mathbf{r}-\mathbf{r}_j(t)\Big)\right\rangle dR$$

from the expression for the intermediate scattering function

$$I(\mathbf{Q},t) = \frac{1}{N}\sum_{j,j'}\langle e^{-i\mathbf{Q}\cdot\mathbf{r}_{j'}(0)}e^{i\mathbf{Q}\cdot\mathbf{r}_j(t)}\rangle$$

using the substitution

$$e^{-i\mathbf{Q}\cdot\mathbf{r}_{j'}(0)} = \int e^{-i\mathbf{Q}\cdot\mathbf{r}'}\delta\Big(\mathbf{r}'-\mathbf{r}_{j'}(0)\Big)d\mathbf{r}'.$$