Interaction of solutes (sugars) with membranes by neutron diffraction

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Small solute molecules, particularly di- and mono- saccharides, are associated with a cryoprotective effect. The concentration of sugars between bilayers is correlated with changes in phase transition temperatures, and may be explained by a theory where the sugar molecules mediate the interactions between bilayers brought in proximity by dehydration, and reduce the compressive stresses within the bilayer\cite{1}. An alternate mechanism is based on a very specific short range interaction between specific sugars, and has been examined by molecular dynamics simulations\cite{2}. The two mechanisms of cryoprotection imply quite different concentration profiles of sugar molecules between bilayers.

In this work we turn to highly orientated samples, effectively one dimensional crystals, using Fourier methods to reconstruct the scattering length density profile of the unit cell from neutron diffraction measurements. The bilayer profile remains unchanged, while there are significant differences are in the scattering length density in the aqueous layer. These indicate that the deuterated trehalose molecules are concentrated in the centre of the aqueous layer. The implications of these results for our understanding of the effects of sugars on membrane phases will be discussed.

\begin{figure}[h]
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\includegraphics[width=\textwidth]{figure1.png}
\caption{Scattering length density reconstruction of DOPC bilayer/ trehalose/water from neutron diffraction data.}
\end{figure}