An excerpt from Section 2.2.

\[ S \equiv \left\langle \frac{3}{2} \cos^2 \vartheta - \frac{1}{2} \right\rangle \equiv \langle P_2(\cos \vartheta) \rangle \tag{1} \]

\[ \langle \Delta T' \rangle = \left[ T_{zz} - \frac{1}{2}(T_{xx} + T_{yy}) \right] S + \frac{1}{2} (T_{yy} - T_{xx}) D. \tag{2} \]

It is not obvious how to measure the order parameter \( S \) from its definition, Eq. (1). We will find that Eq. (2) leads to an equation for \( S \) such that \( S \) can be measured optically. Consider the case where the tensor \( T \) is the imaginary part of the electric susceptibility of the liquid crystal,

\[ \chi = nA, \tag{3} \]

where \( n \) is the index of refraction and \( A \) is the absorption.\(^1\) Note that \( A \) depends on the orientation of light to the liquid crystal and \( n \) depends on the polarization of the light relative to the director of the liquid crystal. We assume that the only absorbing bonds in the molecule are along the \( z \)-axis.

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\(^1\)I probably need to derive Eq. (3). On the other hand, if I never mentioned that it is the susceptibility, I could probably get away with it. The only property of \( \chi \) that I use is that \( \chi = nA \). But that can’t be right because then we would just define \( \chi \) to be the absorption tensor and derive an equation for the order parameter that depends only on \( A_\perp \) and \( A_\parallel \)—I can do it mathematically, so why isn’t it an ok way to measure \( S \)? Another question: should I write the un-subscripted \( n \) and \( A \) in bold font to indicate that they are tensors? Is there a difference between a tensor and a value that depends on the direction in which it is measured? I suppose I’m not quite clear on what a tensor is. Arfken and Weber (page 126) says scalars are tensors—ones which do not change under rotations of the coordinate system. So \( n \) and \( A \) are clearly not scalars, and Eq. (3) might be better as \( \chi = n \cdot A \).