The Effect of Reference Frames on Diffusion Controlled Experiments

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Diffusion is a molecular transport of mass in mixtures, that occurs in the presence of a concentration gradient and tends to reduce concentration variations. Mass transport caused by a thermal gradient is known as thermal diffusion, or the Soret effect. The mass transport in liquid mixtures is generally described by Fick's law, which relates the diffusive flux of the mixture components to the gradient of its driving force. This diffusive flux can be defined within several distinct systems of reference, notably the three commonly-used reference frames for Fick's law: volume-, mass- and molar-averaged. In ternary mixtures, however, the different types of diffusion coefficients do not show identical values anymore when examined in different reference frames. The only elements that remain invariant regardless of the reference system are the eigenvalues of the diffusion matrix. We have performed mass-diffusion measurements on several ternary systems using the Taylor dispersion technique [1]. Traditionally, a volume-fixed frame of reference is used for this type of measurement. The same ternary mixtures were then utilised to conduct Soret measurements, where the governing equations are typically written in a mass-fixed reference frame [2]. These experiments have allowed to obtain two distinct measurements of diffusion coefficients, as well as a measurement of the Soret coefficients. Previously, it has never been properly investigated what the actual difference between the diffusion coefficients measured in two different types of experiments is. The central question thus, to be discussed during the presentations, is how the diffusion coefficients measured by the Taylor dispersion technique and the ones deducted from the Soret experiment compare to one another.

References

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