

Measurement of Diffusion in Ternary Liquid Mixtures by a Light Scattering Technique and a Comparison with Data Obtained by Taylor Dispersion

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Dynamic light scattering (DLS) measurements have proven to be a powerful technique for studying the behavior of transport properties of liquid and liquid mixtures both in the vicinity of a liquid-liquid critical point and also far from it. Therefore it seems superior to classical the methods of Fick's diffusion coefficient determination, such as Taylor dispersion (TD), using macroscopic concentration gradients. We report results of diffusion coefficient measurements in the ternary liquid system Glycerol-Acetone-Water (GAW), obtained by DLS technique and then compared with data found using the TD method.

In DLS experiments we obtain the time-dependent intensity autocorrelation function (ACF). Fitting the experimental ACF, we could predict the values and the physical characters of diffusion coefficients. Far from the critical solution point in our system a coupling between two modes results in two characteristic relaxation times, which may be associated either with mass diffusion or thermal diffusion. In the vicinity of the critical solution point the dynamic light scattering measurements in our system reveal two or more hydrodynamic relaxation modes with well-separated characteristic relaxation times. From the autocorrelation functions we can experimentally determine at least two effective diffusivities D_1 and D_2 . From the theoretical prediction presented here, these values may result from pure mass diffusion and pure thermal diffusion transport processes. Both the slow and fast modes have been measured as a function of temperature for all of the different compositions investigated in our system. A possible physical meaning of the main modes D_1 and D_2 in our ternary liquid mixture is discussed.

When we compare the transport modes from DLS with the Taylor dispersion measurements we find that only the slowest mode represents mass diffusion and this mode agrees very well with one of the eigenvalues of Fick's diffusion matrix obtained from our TD measurements, whereas the faster thermodiffusion mode shows a different physical behavior.