The Soret Effect in Ternary Liquid Mixtures: Ground and Space Experiments

Werner Köhler [C, S]
Physics Department, University of Bayreuth, Bayreuth, Germany
werner.koehler@uni-bayreuth.de

Diffusive flows in isobaric, non-isothermal liquid mixtures are driven both by composition and temperature gradients. Since the number of independent diffusion and thermodiffusion coefficients and, hence, the complexity, rapidly grows with the number of constituents, ternary mixtures play an important role as model systems for truly multicomponent mixtures. Besides thermogravitational columns, different two-color optical techniques have recently been developed for the investigation of the Soret effect in ternary liquid mixtures: optical digital interferometry (2-ODI), optical beam deflection (2-OBD), and thermal diffusion forced Rayleigh scattering (2-TDFRS). The DCMIX project of ESA aims to establish reliable reference data for the Soret effect in ternary liquids and serves as a nucleus for ample ground based work. Until now, three DCMIX campaigns have been carried out aboard the International Space Station ISS. The investigated ternary mixtures are dodecane/isobutylbenzene/tetralin (DCMIX1), methanol/toluene/cyclohexane (DCMIX2) and water/ethanol/triethylene glycol (DCMIX3). DCMIX4 is scheduled for 2018. In order to fully characterize ternary mixture, it is necessary to extract six independent parameters from the measured data, which is particularly difficult in case of similar diffusion eigenvalues. A detailed analysis shows that, nevertheless, stable values for the thermodiffusion and the Soret coefficients can be obtained. Additional errors arise from the inversion of the contrast factor matrix, which is frequently ill-conditioned. Besides first results from microgravity experiments, a complete data set for the DCMIX1 system measured on the ground will be presented. We have found that the sign for the Soret coefficient of tetralin is always positive and the one of dodecane always negative. The Soret coefficient of isobutylbenzene changes sign depending on the composition of the mixture. This finding can be rationalized on the basis of a recently introduced phenomenological thermophobicity concept. A similar sign change of one of the components has also theoretically been predicted in molecular simulations of isotopic ternary mixtures.