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Optical investigation of the sign and behavior of the Soret coefficient in magnetic colloids

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The Soret effect, or thermodiffusion, is one of the most interesting phenomenon observed in the Condensed Matter field of research [1]. This effect is measured by the *Soret* (or *thermodiffusion*) *coefficient* (S_T)[2], which is proportional to the ratio of the volume-fraction-current density and of the temperature gradient. Lenglet and co-workers [3] reported values of S_T (from $10^{-3}K^{-1}$ up to $10^{-1}K^{-1}$) measured in some magnetic colloidal systems (ferrofluids), which can be positive or negative, depending on the particular ferrofluid studied. Recently, we proposed a generalization of the thermal lens model formalism to introduce and characterize the thermodiffusion phenomenon [4]. The theory treats the case where a local heating generates a temperature gradient in a single phase binary sample (a colloid for instance) that yields, through a thermodiffusion process, concentration gradients in an initially homogeneous sample. The treatment generalizes the concept of thermal lens to a .matter lens., due to the coupling of a concentration variation with the optical properties of the medium. This formalism allows the use of the Z-Scan (ZS) technique to determine the Soret coefficient of samples. Applying this theory to the results of a ZS experiment with di□erent ferro.uid samples we got values that agree with those obtained from forced Rayleigh scattering measurements on the same material. In the ZS technique the sample is moved along a single focused Gaussian laser beam (defining a z-axis) on both sides of the waist. The light intensity transmitted through a small calibrated diaphragm far away from the waist, is measured as a function of the sample position z. Actually the ZS technique can be used to study any type of variation of the index of refraction, not only that given by nonlinear processes but also those due to other causes (variations of the temperature T and of the volume fraction of magnetic grains in a ferrofoluid ϕ, in our case). The variation of the index of refraction is expressed as the sum of terms arising from the temperature change $\delta T(r, t)$, the volume-fraction change $\delta_\varphi(r, t)$, and light intensity $I(r, t)$ in the sample due to the incident laser beam. The sign and magnitude of S_T is investigated as a function of different control parameters of the ferrofluids, like pH, concentration and size of magnetic grains. A rather complete panel of ferrofluids with different chemical-physical properties is studied. Concerning the sign of S_T, *thermophobic* ($S_T > 0$) and *thermophilic* ($S_T < 0$) materials were encountered, depending on the particular coating and transportfluid of the ferrofluid [5]. At small grains concentrations, S_T/ϕ was shown to be constant *but* dependent on the particular ferrofluid. A discussion about the "thermal & matter lens" model to determine S_T will be presented as well as the values of S_T for different ferrofluids. COFECUB, FAPESP, PRONEX/CNPq, CAPES and CNRS financial support.

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