DY 6: Ferrofluids

Time: Monday 14:30–15:30 Location: A 053

DY 6.1 Mon 14:30 A 053

The Rosensweig instability in thermoreversible ferrogels — •Christian Gollwitzer[1], Marina Krekhova[2], Ingo Rehberg[1], Günter Lattermann[2], and Reinhard Richter[1] — [1]Experimentalphysik V, Universität Bayreuth — [2]Makromolekulare Chemie I, Universität Bayreuth

Ferrogels are an interesting new class of materials that enhance the properties of magnetic fluids by elastic components [1]. According to Bohlius et al. [2], the famous Rosensweig instability should also be possible in ferrogels. Compared to the pure ferrofluid, the critical magnetic field is shifted to higher values due to elastic forces, and the critical wavenumber remains the same.

We use a thermoreversible ferrogel [3] and expose it to a homogeneous magnetic field. By controlling the temperature we can easily change the elastic modulus over several orders of magnitude. The surface profile of the ferrogel is then recorded using an X-ray technique.

[1] Zrinyi, M., Barsi, L., Szabo, D. & Kilian, H.-G. 1997 *The Journal of Chemical Physics* **106** (13), 5685–5692.
[2]Bohlius, Brand & Pleiner 2006 *Z. Phys. Chem* **220**, 97
[3]Lattermann, G. & Krekhova, M. 2006 *Macromol. Rapid Commun.* **27**, 1373–1379.

DY 6.2 Mon 14:45 A 053

Ground state structures in ferrofluid monolayers: theory and simulations — •Sofia Kantorovich[1,2], Taisiya Prokop'eva[2], Victor Danilov[2], and Christian Holm[1,3] — [1]MPI-P, Ackermannweg 10, D-55128, Mainz, Germany — [2]USU, Lenin av. 51, 620083, Ekaterinburg, Russia — [3]FIAS, Ruth-Moufang-Str 1, D-60438, Frankfurt am Main, Germany

A combination of analytical calculations and Monte Carlo simulations was used to find the ground state structures in ferrofluid monolayers. Taking into account the magnetic dipole-dipole interaction between all particles in the system, and treating ferroparticles as hard spheres, we found different topological structures that were probable for low temperatures. It turned out that among the most energetically advantageous are rings, double rings and vortex structures. However, we have shown a single ideal ring to be the most probable ground state structure for a ferrofluid monolayer. We compared extensively theoretical predictions to the results of computer simulations and found them to be in a very nice agreement.

DY 6.3 Mon 15:00 A 053

Reorientation of a Ferrofluidic Torsional Pendulum Observed in an Oscillating Magnetic Field — •Harald Brendel[1], Reinhard Richter[1], Ingo Rehberg[1], and Mark Shliomis[2] — [1]Experimentalphysik V, Universität Bayreuth, D-95444 Bayreuth — [2]Ben Gurion University of the Negev, Beer Sheva, Israel

Recently a new type of torsional pendulum was proposed [1] which we realize by suspending a disc shaped container in a Helmholtz pair of coils driven by an alternating sinusoidal current. The container is suspended with its long axis in line with the fiber. In contrast to a spherical pendulum [2,3] the orientation of the disc is sensitive both to the field direction and the field frequency: It should expose its edge to the field vector of low oscillating field and its broad side to the field vector of high frequency. Unfortunately, this reorientation (FLIP) can hardly be realized for available ferrofluids because of their polydispersity. But with help of an additional constant magnetic field, which is orientated perpendicular to the oscillating one, the FLIP of the pendulum can be observed. In this case one is able to tune the FLIP frequency by varying the amplitude of the help field. This effect is a physical mechanism in principal, which should occur in electrical polarized matter, too.

[1] M.I. Shliomis, M.A. Zaks, *Phys. Rev. E*, **73**, 066208 (2006).
[2] A. Engel, H.W. Müller, P. Reimann, and A. Jung, *Phys. Rev. Lett.* **91**, 060602 (2003).
[3] M.I. Shliomis, M.A. Zaks, *Phys. Rev. Lett.*, **93**, 047202 (2004).

DY 6.4 Mon 15:15 A 053

Rolling ferrofluid drop on the surface of a liquid — •Verena Sterr[1], Konstantin Morozov[2], and Andreas Engel[1] — [1]Institut für Physik, Carl von Ossietzky Universität Oldenburg, 26111 Oldenburg — [2]Institute of Continuous Media Mechanics, 1 Korolev Street, 614013 Perm, Russia

A ferrofluid drop ($\varnothing \sim$ mm) floats on the surface of a viscous non-magnetic liquid. Due to the properties of ferrofluids, an external magnetic field, whose vector rotates in a plane orthogonal to the fluid surface, makes the drop rotate and "roll"over the surface with velocity $\mathbf{v}_{\mathrm{drop}}$. This drift velocity is determined by use of a simplifying model which treats the ferrofluid drop either as a solid sphere (a) or as a liquid half-sphere (b). The velocity fields are expanded in vector spherical harmonics and the result $\mathbf{v}(r, \vartheta, \varphi)$ for $r \to \infty$ gives $\mathbf{v}_{\mathrm{drop}}$ in terms of experimental parameters.

In case a), the usual no-slip boundary condition is employed at the sphere surface which leads to a logarithmically diverging viscous torque, so that the last boundary condition cannot be used. In order to relieve the singularity, the Navier slip condition is applied, which allows for a finite velocity at the sphere surface and leads to a result for the drop speed which, however, depends on an unknown parameter, the slip length. Calculations for case b) are more complex, but the result does not depend on any unknown parameters.

Considering the simplifications of this model, the agreement with experimental data is surprisingly accurate.