DY 35 Ferro Fluids / Liquid Chrystals

Time: Wednesday 14:30–16:30 Room: SCH 251

DY 35.1 Wed 14:30 SCH 251

Growth behaviour of solitary spikes on the surface of magnetic fluids — •Holger Knieling, Reinhard Richter, and Ingo Rehberg — University of Bayreuth, Institute for experimental physics V, 95440 Bayreuth, Germany

The Rosensweig or normal-field instability on the surface of a ferrofluid is well known. A hexagonal pattern of liquid spikes emerges in a normal magnetic field when a certain threshold of the magnetic induction is surpassed. Recently a stable solitary spike was found in the hysteretic regime of this instability [1]. It can easily be generated by a local perturbation of the surface or the magnetic induction. We now have performed time resolved measurements of its amplitude by recording it with a high-speed camera. The analysis of the pictures results in information about the shape of the structure and the growth behaviour of the amplitude and the volume. The final static shape is compared with numerical calculations.

[1] R. Richter and I.V. Barashenkov, Phys. Rev. Lett. 94, 184503 (2005)

DY 35.2 Wed 14:45 SCH 251

More precise simulations of ferrofluids' reology — •Eric Coquelle[1], Patrick Ilg[1,2], and Siegfried Hess[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin, D-10623 Berlin, Germany — [2]LPMCN, Université Lyon I, F-69662 Villeurbanne France

Ferrofluids have attracted considerable attention in the recent years, as their field-controlled physical properties has led to mumerous application, as well as in material science as in medical field [1,2]. However, acutal simulations study "perfect" magnetic suspensions, and may neglect some experimental important parameters, such as the wide size dispersion of magnetite particles. Moreover, the hydrodynamic interactions (HI) between moving particles are neglected.

Present study first infestigates the influence of these HI; the difficulty arises from the need to uncorrelate the random motion of the particles. A method inspired from the polymers simulations has been employed, reducing the computational effort to O(Nˆ2.25).For comparison, another method based on the mobility matrix is used. The results are then compared to experimental SAXS and XPCS data.

As a second step, we model real polydisperse ferrofluid, through a system containg small and large particles. It reveals a sharp modification of the state of the simulated fluid. To go further, predictions on the magnetiviscous effect of a simulation involving both bidispersity and many-body hydrodynamic interaction will be confronted to experimental results.

[1] G. BOSSIS, E. COQUELLE, Ann. Ch. Sci. Mat. 29 (2004) 43 [2] Z. WANG, C. HOLM, Phys. Rev. E. 68 (2003) 041401

DY 35.3 Wed 15:00 SCH 251

Pattern formation in the Faraday instability on a ferrofluid in a vertical magnetic field — •Vladislav Mekhonoshin — Institut für Theoretische Physik, Universität des Saarlandes, PF 151150, Saarbrücken

The parametrical generation of standing waves on a surface of a liquid is well known as Faraday instability since its discovery in 1831. Ferrofluids are colloidal dispersions of single-domain particles in an ordinary (non-magnetic) carrier liquid. Thus, ferrofluids combine the ability to flow with strong interaction with magnetic field. This allows one to use magnetic field to control the motion of a ferrofluid, and in particular, the pattern formation in the Faraday instability.

In this work, an amplitude equation for the Faraday instability is derived following the standard procedure, described in [1]. The amplitude equation is used to investigate the pattern formation in the system and to explain the experimental observations.

DY 35.4 Wed 15:15 SCH 251

Rheology of a bidisperse inverse ferrofluid — •Robert Krauss, Reinhard Richter, and Ingo Rehberg — Experimentalphysik 5, Universität Bayreuth, D-95440 Bayreuth, Germany

By dispersing non-permeable particles in a common ferrofluid we obtain a so called inverse ferrofluid [1]. In our case fairly large polystyrene particles create magnetic holes which have magnetic moments opposite to the ferrofluid they are displacing. In previous studies we investigated the viscoelastic properties of a mono- vs a polydisperse inverse ferrofluid [2]. In order to quantify the influence of polydispersity we prepare samples of a bidisperse size distribution of spherical particles. The ratio of small to large particles is varied systematically. On the one hand rheological measurements are carried out to describe the viscoelastic properties of the magneto-rheological fluid. On the other hand we investigate optically the chain formation of the system in an external field by a long-range microscope. We compare the results with the ones obtained for monodisperse samples.

[1] A.T. Skjeltorp, Phys. Rev. Lett. 51, 2306 (1983).

[2] Ruben Saldivar-Guerrero, Reinhard Richter, Ingo Rehberg, Nuri Aksel, Lutz Heymann and Oliverio S. Rodriguez-Fernández, Viscoelasticity of mono- and polydisperse inverse ferrofluids, subm. to J. Chem. Phys. (2005).

DY 35.5 Wed 15:30 SCH 251

Pattern reorientation at the tilted field instability — •Christopher Groh, Reinhard Richter, and Ingo Rehberg — Experimentalphysik 5, Univ. Bayreuth, D-95440 Bayreuth, Germany

We investigate the surface instability of a horizontal layer of magnetic liquid in a magnetic field experimentally. By means of two pairs of orthogonal Helmholtz coils we are able to apply a vertical and a tangential magnetic field. Whereas the vertical component destabilizes the flat layer, the tangential one preserves its stability. In this way different surface patterns can be observed, comprising regular hexagons, stretched hexagons and ridges [1,2]. We measure transitions between these patterns under variation of the field components. The surface reliefs are quantitatively characterized via help of a radioscopic technique [3]. This enables us to present the proper bifurcation diagrams and phase diagrams for the tilted field instability. Moreover, we report a new effect: the rotation of the hexagonal pattern under a increasing tangential field component.

[1] Rene Friedrichs, Phys. Rev. E **66**, 066215 (2002).

[2] Bert Reimann, Reinhard Richter, Holger Knieling, Rene Friedrichs, and Ingo Rehberg, Phys. Rev. E. **71** 1(R) (2005).

[3] Reinhard Richter, and Jürgen Bläsing, Rev. Sci. Instrum. **72**, 1729 (2001).

DY 35.6 Wed 15:45 SCH 251

The effect of rough surfaces on nematic liquid crystals. — •Friederike Schmid[1], David Cheung[1,2], and Jens Elgeti[1,3] — [1]Universität Bielefeld — [2]University of Warwick UK — [3]Forschungszentrum Jülich

We investigate the effect of rough surfaces on nematic liquid crystals with continuum theories and computer simulations. First we reconsider the phenomenon of Berreman anchoring, were highly ordered nematic liquid are oriented by surfaces with anisotropic roughness. Then we study liquid crystals close to the nematic-isotropic transition. Surface roughness reduces the order and the anchoring strength at the surface. As a result, the transition between the isotropic and the nematic phase is shifted in confined systems. Under certain circumstances, one can even enforce a wetting-induced anchoring transition.

DY 35.7 Wed 16:00 SCH 251

The influence of shear rate fluctuations on the orientational dynamics — •Sebastian Heidenreich[1], Patrick Ilg[1,2], and Siegfried Hess[1] — [1]Institut für Theoretische Physik, Technische Universität Berlin, D-10623, Germany — [2]Department de Physique des Materiaux, UCB Lyon1, F-69622 Villeurbanne, France

The flow behavior of liquid crystals is strongly affected by the coupling between the flow and the molecular orientation. Nematic liquid crystals which respond with a time-dependent orientational behavior can be rather complex. A relatively simple model based on a nonlinear equation for the second rank alignment tensor which can be derived form irreversible thermodynamics [1-3]. Here we investigate the influence of fluctuating shear rates on the orientational dynamics in the case of spatially homogeneous and spatially inhomogeneous alignment. We found that uncorrelated fluctuations of the shear rate in general have little effect on the orientational dynamics of nematics, whereas the effect of correlated fluctuation is more significant. Further we present a new amended potential modeling the isotropic-to-nematic transition. In contrary to the Landau-de Gennes potential our potential has the advantage to restrict the order parameter to physically admissible values.

[1] S. Hess,Z. Naturforsch. **30a**, 728 (1975), **31a** 1507 (1976). [2] P. D. Olmsted and P. Goldbart,Phys. Rev. A **41**, 4578 (1990); Phys. Rev. A **46**,4966 (1992). [3] C. Pereira Borgmeyer and S. Hess, J. Non-Equilib. Thermodyn. **20**, 359 (1995).

DY 35.8 Wed 16:15 SCH 251

The surface relief of the Rosensweig instability – experimental and numerical results compared quantitatively — •Christian Gollwitzer[1], Gunar Matthies[2], Reinhard Richter[1], Ingo Rehberg[1], and Lutz Tobiska[3] — [1]Experimentalphysik V, Universität Bayreuth, 95440 Bayreuth, Germany — [2]Ruhr-Universtät Bochum, Universitätsstraße 150, — [3]Institut für Analysis und Numerik, Otto-von-Guericke-Universität Magdeburg, PF 4120, D-39106 Magdeburg

The surface of a magnetic fluid exposed to a normal magnetic field above a threshold B_c forms a pattern of hexagonal crests [1]. We record the full three-dimensional surface profile recently made possible by the attenuation of an X-ray beam [2]. This enables us to compare the amplitude and shape of the peak pattern in an extended container with those obtained from numerical simulations [3]. We have measured 540 surface reliefs under adiabatic increase and decrease of the magnetic induction. The measured nonlinear magnetization law and material parameters have been taken into account in the simulations. Very good qualitative agreement with the experiment is found for both the pattern amplitude and the shape of the peaks. Very good quantitative agreement within the statistical errors is achieved with almost no adjustable parameter. "Almost" will be explained in the talk. Fourier decomposition of the shape exposes, that most ($\approx 90\%$) of the energy is in the first Fourier mode.

[1] M. D. Cowley and R. E. Rosensweig, J. Fluid Mech. **30**, 671 (1967).
[2] R. Richter and J. Bläsing, Rev. Sci. Instrum. **72**, 1729 (2001).
[3] G. Matthies and L. Tobiska, JMMM **289**, 346 (2005).