Preface

Magnetic control of the properties and the flow of liquids can be a challenging field for basic research as well as for applications. An important condition for a technically interesting magnetic control of fluids is that the requested magnetic fields should be as small as possible.

An excellent material fulfilling this condition are suspensions of magnetic nanoparticles - commonly called ferrofluids. These fluids exhibit coupled liquid and superparamagnetic properties, leading to the possibility to control their flows and properties with magnetic fields having a strength of about 10mT. After the first synthesis of stable ferrofluids in 1964, a rapid development of ideas for applications as well as of basic fluid mechanics investigations took place. Till now the research field experiences a strong ongoing growth, recently triggered by the establishment of a national research program on magnetic fluids in Germany and documented by numerous presentations of the 9th International Conference on Magnetic Fluids (ICMF9), held in Bremen in 2001.

One of the most challenging aspects of ferrofluid research is the interdisciplinarity of the field. Besides chemistry for the preparation of magnetic fluids, basic theoretical physics for the description of their properties and behavior, fluid physics and rheology for the investigation of flows and rheological properties under influence of magnetic fields are needed to cover the basic research interests. In addition engineering and medical applications contribute to the importance of ferrofluid research for everyday life.

Most of these aspects are covered in this issue of *Lecture Notes in Physics*, which is mainly based on a series of plenary talks given during ICMF9. Starting with a review of preparation techniques for ferrofluids the chemical aspect of production of stable magnetic colloids is highlighted, followed by two contributions showing different approaches for a quantitative characterization of ferrofluids.

Part two of the issue is devoted to basic questions concerning the behavior of ferrofluids in the presence of magnetic fields. Three contributions highlight different ways to describe the fluids theoretically. Macro- and microscopic approaches are shown together to enable a comparison of their advantages and problems. The section ends with a specific example of magnetic control - the influence of fields on heat and mass transfer in ferrofluids.

In the third part, the question of magnetic control of the fluids properties is addressed using the example of magnetoviscosity - i.e. the change of the viscous properties of magnetic fluids in a magnetic field. The combination of theoret-

ical description and experimental investigations documents the complexity of the problem and gives a good overview on the actual state of knowledge in these problems. The part ends with a contribution on magnetorheological fluids, building the bridge to the application possibilities of magnetoviscous effects.

Finally, part four deals with question concerning application of magnetic fluids. Since the major progress in this respect is actually concentrated in the field of medical applications, a single contribution on cancer therapy using ferrofluids as a drug carrier is included in this issue.

In total, this issue of *Lecture Notes in Physics* provides the reader with all basic knowledge needed to enter the field of ferrofluid research as well as with the most recent developments achieved.

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