Preface

Magnetism often has a slight overtone of being mysterious. This is probably caused by the surprisingly strong forces between magnets which everybody can experience with magnetic toys, magnet boards, or similar objects. A strange effect is the unique ability of magnetic fields to penetrate many substances without any attenuation. Though the physical basis of magnetism is well explored, the outsider usually does not know very much about the details and sometimes tends to overestimate the real possibilities provided by magnetism. Nevertheless, the limits of applications have not yet been reached. Considerable progress has taken place in medicine during recent years, and there is no reason to assume that this development has already come to an end.

Progress in medicine has often been initiated by the discoveries and results of research studies conducted among the various disciplines of natural science. One of the most famous examples to date is the discovery of a certain type of electromagnetic radiation, the X-ray, by Wilhelm Conrad Röntgen in 1895. In this case, the importance of the discovery with respect to medical applications was recognized immediately. Development was started and propelled by fruitful cooperation between both physicians and physicists. This teamwork is still very strong, and has led recently to the introduction of what is called electron beam tomography (EBT). In other cases – for example, that of nuclear magnetic resonance – the time taken between its discovery and subsequent application in medicine was longer. Sometimes, a new method has become established in clinical practice only after having passed through a long period of *in-vitro* investigations and preclinical trials. However, there are applications – for example, in biomagnetism – which could not be developed before other crucial parts (in this case the superconducting quantum interference device, SQUID, as a sensitive magnetic field detector) had been invented and further developed.

This cooperation between physicians, scientists, and engineers has proved itself in the past to be effective. It is a necessary condition for the continuing development of new methods or more sophisticated techniques and instruments. This is of particular relevance for the application of magnetism in medicine. Knowledge in this field is comparatively poor, even in the case of physicists. Specialists working in different fields of science and technology are, as a rule, not familiar with relevant problems in medicine, and as a consequence possible new ideas or solutions

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to problems cannot be found until partners from different fields have been introduced to the physical and medical basis of this interdisciplinary topic.

One fundamental intention of this book is, therefore, to impart information about both the state of the art as well as the need for further progress with magnetism in medicine. This can only be done, within the ambit of this book, by means of reference to typical examples. A complete review of all existing contributions in this field would result in an edition of several volumes. We hope that the examples presented are suitable both for initiating cooperation between specialists already working on specific topics, and to encourage a response from newcomers who might contribute original ideas. In our opinion, the successful development of important methods such as functional magnetic resonance imaging (fMRI) and magnetic source imaging (MSI) in recent years is proof enough of the fact that even high-level technologies, which are already in existence, can be essentially improved and expanded as soon as interdisciplinary teams are involved. Moreover, there are also topics for which a level of knowledge has not yet been attained that would enable a ''chain reaction'' to start and thus accelerate further development. Here, in the language of physicists, a ''critical mass'' of interdisciplinary cooperating specialists has probably not been achieved.

During the years since the first edition of this book was published, many new developments have been made in the areas of medical research and clinical practice. Therefore, all contributions to the Second Edition have been updated, with most articles having been completely rewritten. Several new topics have been added, including: safety aspects of magnetic fields; fetal magnetography; new MRI techniques for cardiovascular imaging; clinical applications at ultra-high fields; interventional magnetic resonance imaging; concepts, systems, applications and new approaches in diagnostic and therapeutic MR mammography; monitoring of magnetic markers; remote-controlled drug delivery; and magnetic drug targeting.

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