C. R. Physique 14 (2013) 1

Contents lists available at SciVerse ScienceDirect

Comptes Rendus Physique

www.sciencedirect.com

Physics in High Magnetic Fields / Physique en champ magnétique intense

Foreword

A magnetic field is a very powerful and versatile thermodynamic parameter influencing the state of any material system. Consequently, magnetic fields serve as an experimental tool in very diverse research areas, like condensed matter physics, molecular physics, chemistry, and, with increasing importance, biology. The versatility and universality of magnetic fields as a research tool is based on their coupling to the charge and spin of the particles that constitute the matter that surrounds us. Many magnetic field based research techniques are widespread and can often be done with commercially available magnets and associated equipment (MRI-scanners, ICR, NMR, and ESR spectrometers, etc.). On the other hand, there are many cases where very high magnetic fields, above what is commercially available, are necessary and where the prospect of new discoveries is often the greatest. This scientific motivation has always formed a strong drive to develop techniques and installations to generate the highest possible magnetic fields, to improve the instrumentation around these magnets, and to perform experiments with them. In surveys, both by the European Science Foundation (ESF, "The Scientific Case for a European Laboratory for 100 T Science", 1998) and by the USA National Research Council ("Opportunities in High Magnetic Field Sciences", COHMAG 2005), a compelling case has been made for high magnetic fields as a research tool for a wide variety of research topics and strong recommendations were made to stimulate high magnetic field infrastructures. Such evaluations have stimulated new investments in high magnetic field facilities. The last 15 years have seen significant progress in the performance of high field magnets and groundbreaking scientific results have followed suit.

The generation of such high magnetic fields is a technological challenge and their exploitation requires a large financial commitment. Therefore, only a few infrastructures exist where very high magnetic fields can be generated and used for research. Large infrastructures for generating continuous magnetic fields in excess of 30 T, powered with 15+ MW power supplies, can be found in the USA (Tallahassee), in Japan (Tsukuba), and in Europe (Grenoble and Nijmegen). Large pulsed field installations based either on motor generators or large (>10 MJ) capacitor banks are found in Los Alamos (USA), in Kashiwa (Japan), and in Europe in Toulouse and Dresden. In China, a static field installation in Heifei and a pulsed field installation in Wuhan are being commissioned.

For a long time, Europe has been leading high magnetic field research, but by the end of the last century, due to major investments in the USA and Japan, this was no longer the case. An important contribution to improving Europe's collective position in high magnetic field science were the EuroMagNET Integrating Infrastructure Initiatives under the European FP6 and FP7 programmes, uniting all major European high-field facilities, with a common transnational access programme, networking and joint research activities. This integration will be further pursued through the creation of a European Magnetic Field Laboratory, a project on the Roadmap of the European Strategy Forum for Research Infrastructures (ESFRI) (www.emfl.eu) that should see the light in 2013.

It seemed therefore timely to make an overview of the recent developments in high magnetic field science and technology from a European perspective. This issue of the *Comptes rendus Physique* reviews the major scientific topics that intensively use high magnetic fields, like cuprate and pnictide superconductors, heavy fermions, organic conductors, semiconductor quantum dots and graphene. Terahertz spectroscopy is illustrated to be a natural partner for high magnetic fields. Highly original is the use of high magnetic fields to test quantum electrodynamics, and two contributions summarize the generation of very high fields for research purposes.

Clément Faugeras, William Knafo, Geert Rikken, Jean-Louis Tholence
Guest editors
Laboratoire national des champs magnétiques intenses, 143, avenue de Rangueil, 31400 Toulouse, France
25, rue des Martyrs, BP 166, 38042 Grenoble, Cedex 9, France

1631-0705/$ – see front matter
http://dx.doi.org/10.1016/j.crhy.2013.01.002