

# Summer School 'Nanomagnetism and Spintronics' (Prague, September 8–17, 2008)

## **Abstract**

The purpose of the summer school is to provide a qualified overview on the rapidly developing areas of spintronics, magnetoelectronics and nanomagnetism. The lectures will be oriented on last year PhD students and postdoctoral researchers. The scientific scope will include important topics, such as half-metals and diluted magnetic semiconductors, hybrid systems, spin-dependent transport properties, effects of finite temperatures, spin dynamics, magnetism of nanostructures, relativistic effects, and electron correlations.

## **1 Scientific summary**

The proposed Summer School on Nanomagnetism and Spintronics reflects the enormous rapid development that took place during the last decade in the fields of spintronics, magnetoelectronics and nanomagnetism. Undoubtedly, this progress becomes very important for possible technological applications. On the other hand, the rich variety of physical phenomena and unexpected properties attract ongoing interest from a purely scientific point of view. Standard workshops and conferences focused on the latest achievements in these fields are now regularly organized. Nevertheless, we feel a need for a similarly oriented school with introductory lectures on current problems on a high scientific level.

The summer school will aim at providing the participants not only an overview on the present state of the art and understanding but mainly on theoretical and experimental research techniques. Attention will also be paid to other aspects of the field, such as possible future development and technological applications. Most of these topics can be covered by experts in the community of first-principles electronic structure calculations, to which majority of the participants will probably belong. However, the theoretical lectures will be followed by experimental ones wherever possible.

The lectures of the school will be divided into three basic sections:

- (i) Electronic structure and ground-state properties of magnetic crystals, multilayers, and nanostructures as described by the density-functional theory.  
While the ground-state properties can be treated reliably for bulk magnetic metals and metallic alloys by employing standard approximations (LSDA) and tools, the effects of reduced dimensionality and/or loss of translational invariance represent a difficulty that requires new techniques as well as theoretical concepts. Special emphasis will also be put on introduction of approaches relevant for strongly correlated electron systems.
- (ii) Non-collinear magnetism, exchange interactions, relativistic effects and magnetic properties at finite-temperatures.  
The tutorial accounts will report on modern techniques of electronic structure calculations and of statistical physics that are inevitable for reliable description of complex magnetic structures and phase transitions. Attention will also be paid to proper understanding of relativistic effects in modern experimental techniques (magneto-optical effects, magnetic dichroism).
- (iii) Spin-dependent transport properties, spin dynamics and non-equilibrium phenomena.  
Spin-polarized transport properties will be key for this school since a number of important phenomena falls into this category, such as giant and tunneling magnetoresistance, angular magnetoresistance, spin injection, Gilbert damping, current-induced switching of magnetization, spin Hall effect, etc. Systems far from thermodynamic equilibrium represent another challenge for the present condensed-matter physics and the lectures will address the recent progress in this area including the time-dependent density functional formalism and non-equilibrium Green's functions.

Concerning the particular physical systems, the participants will gain basic knowledge on all relevant materials and systems, such as diluted magnetic semiconductors, half-metallic magnets, thin films, free and supported clusters, molecular magnets, monowires, stepped surfaces, magnetic tunnel junctions, etc.

## 2 Meeting programme

The school will last one week with six hours of lectures each day and one free day. There will be no parallel lectures. Sufficient time for discussion will be planned at the end of all lectures as well as during coffee breaks. Two poster sessions will be organized allowing the participants to present their own recent results and to discuss them with invited speakers and other participants.

### 3 Curriculum vitae of scientific organiser

Doc. RNDr. Ilja Turek, DrSc.

Born: 16 April 1959 in Hradec Králové, Czech Republic

Affiliation: Institute of Physics of Materials (IPM), Academy of Sciences of the Czech Republic, Brno, and Faculty of Mathematics and Physics (FMP), Charles University, Prague, Czech Republic

#### Education and professional career

1978–1983	student at FMP, Prague, specialization theoretical physics
1983	RNDr. degree at FMP, Prague
1984–1985	research assistant at the IPM, Brno
1986–1989	postgraduate student at the IPM, Brno
1990	CSc. (=Ph.D.) degree at the IPM, Brno
1990–present	research scientist at the IPM, Brno
1991–1992	post-doctoral stay at the Institute for Theoretical Physics, TU Vienna
1996–present	collaboration with the Center for Computational Materials Science, TU Vienna – magnetism of layered metallic systems
1998	Prize of the Academy of Sciences of the Czech Republic (together with V. Drchal, J. Kudrnovský and M. Šob)
2000–present	research scientist at FMP, Prague (part-time employment)
2001	DrSc. degree at FMP, Prague
2004	member of the team of P. Weinberger (TU Vienna) on the short list for the Descartes Research Prize of the European Union
2005	Doc. degree (habilitation) at FMP, Prague

#### Professional experience

*Field of research, specialization:* theoretical physics, theory of condensed matter.

*Topics:* electronic structure and magnetism of metals, alloys, surfaces and multilayers; disordered alloys; exchange interactions; electron transport.

**Scientific output:** more than 100 papers in refereed journals, co-author of 1 monograph, more than 700 citations.

## Selected publications of I. Turek

1. I. Turek, J. Kudrnovský, M. Diviš, P. Franek, G. Bihlmayer, S. Blügel:  
*First-principles study of the electronic structure and exchange interactions in bcc europium,*  
Phys. Rev. B 68 (2003) 224431.
2. S. Khmelevskiy, I. Turek, P. Mohn:  
*Large negative magnetic contribution to the thermal expansion in iron-platinum alloys: Quantitative theory of the Invar effect,*  
Phys. Rev. Lett. 91 (2003) 037201.
3. I. Turek, J. Kudrnovský, V. Drchal, P. Weinberger:  
*Residual resistivity of diluted III-V magnetic semiconductors,*  
J. Phys.: Condens. Matter 16 (2004) S5607–14.
4. K. Carva, I. Turek, J. Kudrnovský, O. Bengone:  
*Disordered magnetic multilayers: Electron transport within the coherent potential approximation,*  
Phys. Rev. B 73 (2006) 144421.
5. I. Turek, J. Kudrnovský, V. Drchal, P. Bruno:  
*Exchange interactions, spin waves, and transition temperatures in itinerant magnets,*  
Philos. Mag. 86 (2006) 1713–52.

## 4 Provisional list of proposed speakers

Stefan Blügel	IFF, FZ Juelich
Patrick Bruno	MPI Halle
Carlo Carbone	Trieste
Hubert Ebert	LMU Munich
Balazs Gyorffy	University of Bristol
Albert Fert	Universite Paris-Sud, Orsay
Peter Oppeneer	Uppsala University
Jürgen Hafner	University of Vienna
Bretislav Heinrich	S. Fraser Univ., Burnaby, BC
Werner Hofer	University College London
Paul Kelly	University of Twente
Tomas Jungwirth	Acad. Sci. Czech. Rep., Prague
Juergen Kirschner	MPI Halle
Colin Lambert	Lancaster University
Stefano Sanvito	Trinity College, Dublin
Olle Eriksson	Uppsala University
Walter Temmerman	Daresbury Laboratory
Vaclav Drchal	Acad. Sci. Czech. Rep., Prague
Phivos Mavropoulos	IFF, FZ Juelich
Laszlo Szunyogh	TU Budapest
Alexander Lichtenstein	University of Hamburg
Ingrid Mertig	TU Dresden
Laurens W. Molenkamp	University Wuerzburg

## 5 Additional information

- The summer school will be organized within the project 'Psi-k Training in Computational Nanoscience' (with financial support of 27.500 EUR).
- The other people involved in organization of the school are:  
for the scientific part - Prof. Patrick Bruno (Max-Planck-Institut for Microstructure Physics, Halle) and Dr. Josef Kudrnovský (Academy of Sciences of the Czech Republic, Prague),  
for the local organization - Prof. Vladimír Sechovský (Faculty of Mathematics and Physics, Charles University in Prague).
- The course will be held in the premises of the Faculty of Mathematics and Physics, Charles University in Prague at affordable prices of accommodation for students and hire of lecture rooms.