

PREFACE

The Winter Schools of Theoretical Physics in Karpacz (or briefly, Karpacz Winter Schools) are now well known in the world community of physicists as scientific and cultural events that have been created by a few generations of theoretical physicists from the University of Wrocław, Poland. The Schools have been organized by the Institute of Theoretical Physics of the University of Wrocław (ITP UWr) annually for 44 years. Only once, in February 1982, did the School, being at its final stage of organization, have to be canceled because of the martial law imposed in Poland two months earlier.

Till the early nineties of the 20th century, the Schools served as a meeting ground for physicists from West and East and were held at University houses in Karpacz (Sudeten Mountains). For many researchers and physics students in Poland and other Eastern Block countries, they offered a unique opportunity to discuss physics with outstanding scientists — including Nobel Prize winners — from Western Europe, both Americas, Japan and the Soviet Union. For more information about the Karpacz Winter Schools, the reader is invited to consult the ITP UWr web page (www.ift.uni.wroc.pl).

Reflecting diverse research directions pursued by members of ITP UWr, the topics of the Schools have been varied, almost periodically, from the physics of elementary particles and high energy physics to mathematical physics and field theory to condensed matter physics and statistical physics. Also the character of the Schools has varied, oscillating between a conference with many specialized talks addressed to advanced researchers, and a school with lectures addressed to young adepts of physics.

The 43rd School, entitled “Condensed Matter Physics in the Prime of XXI Century: Phenomena, Materials, Ideas, Methods” was held at Łądek Zdrój, Poland (one of the recent substitutes for Karpacz), between 5th and 11th February 2007. It was designed and organized by representatives of the three largest institutions in Wrocław that educate and employ physicists: Janusz Jędrzejewski (University of Wrocław), Romuald Lemański (Institute of Low Temperature and Structure Research of the Polish Academy of Sciences), and Arkadiusz Wójs (Wrocław University of

Technology). This team was joined by Manuel Richter (Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden e.V.) from neighbouring Dresden, Germany.

As planned, the 43rd School was a genuine school. The lectures delivered by 13 lecturers — renowned specialists — were organized into coherent series of a few talks per topic. A number of modern, promising, dynamically-developing research directions in condensed matter physics were presented to participants. The topics included: dynamical mean-field theory, density functional theory, quantum spin models, frustrated quantum magnets, quantum dots, quantum gates, spintronics, carbon nanostructures, thermal transport, and warm dense matter.

This volume constitutes a collection of articles written by 11 lecturers, specialists in a number of modern, promising, dynamically-developing research directions in condensed matter/solid state theory. The lectures are concerned with phenomena, materials and ideas, discussing theoretical and experimental features, as well as with methods of calculations. It should be emphasized that the lectures are addressed primarily to young researchers. Due to the style of presentation and extensive lists of references, the lectures should prove helpful in acquainting oneself with the subjects discussed in this volume. Concerning methods, the reader will find up-to-date presentations of methods of carrying out efficient calculations for electronic systems (most powerful, versatile and rapidly developing methods of dynamical mean-field theory, density-functional theory, finite frequency theory for thermoelectric transport) and quantum spin systems (Jordan-Wigner fermionization, localized-magnon and localized-electron states in frustrated lattices), together with applications in describing phenomena and designing new materials. Concerning phenomena and materials, systems of quantum dots, quantum gates, semiconductor materials for spintronics, and last but not least, unusual characteristics of warm dense matter, are neatly discussed.

One of the lecturers, professor Bengt Lundqvist (Göteborg, Sweden), who delivered lectures entitled “Density-Functional Theory of Dense and Sparse Matter” has kindly sent us pdf files of his lecture notes with a permission to display them at the School’s web page.

I am grateful to my younger colleagues from ITP UW_r, who undertook the burden of dealing with: financial matters, Dr. Artur Duda; the School’s correspondence, Dr. Volodymyr Derzhko; WLAN at the School’s site, Mr Szymon Owczarek; the School’s web page, Mr Łukasz Andrzejewski.

It is my pleasure to thank professors David Blaschke and Zygmunt Petru from ITP UW \r for their invaluable advice at various stages of the organization process.

Of course no school can be organized without financial means. The organizers are particularly grateful to our traditional and generous sponsors of Karpacz Winter Schools: the University of Wrocław and the Committee on Physics of the Polish Academy of Sciences. Financial support from the Institute of Low Temperature and Structure Research of the Polish Academy of Sciences (Wrocław) and of the Institute of Physics of the Wrocław University of Technology is gratefully acknowledged.

In the name of all the organizers, I take the opportunity to thank once more all the lecturers for their excellent lectures and for writing articles to this volume. I express my sincere thanks to all the participants from various research institutions in Europe for creating the ambiance of the School.

This volume, the School's poster and badges, as in numerous previous Schools, have been prepared in camera-ready form by Mrs Anna Jadczyk, to whom the organizers address special thanks.

Janusz Jędrzejewski

Head of the Organizing Committee

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