

Proceedings of the 20th National
Conference on Superconductivity
“New Phases, Concepts and Advances”

Lublin, Poland
May 22–26, 2022

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Preface

The 20th National Conference on Superconductivity “New Phases, Concepts, and Advances” was held in Lublin from 22nd to 26th May 2022 as a fully in-person event. The conference was organized jointly by Marie Curie-Skłodowska University, the Lublin Branch of the Polish Physical Society, and the Technical University of Lublin. Former conferences in this series were devoted initially to high-temperature superconductivity and later on, they have included several related phenomena, for example: colossal magnetoresistance, strongly correlated systems, spin and charge ordering, unconventional superconductivity, and other emergent phenomena.

This Conference focussed on topics such as high-temperature superconductors and other highly correlated systems, synergy of magnetism with superconductivity in hybrid structures, critical phenomena in superconductors and superfluids, exotic quasiparticles in topological states of matter, dynamic effects in non-equilibrium superconducting structures, and applications of conventional and unconventional superconductors. The Conference was attended by 76 participants. The opening talk was delivered by Professor Wiesław I. Gruszecki, Vice-Rector of M. Curie-Skłodowska University, who addressed important aspects concerning the retina of the human eye (*Dlaczego warto zadbać, aby żółta plamka w naszym oku była naprawdę żółta*). Three plenary lectures were delivered by the Professors: Józef Spałek (*A brief perspective in high temperature superconductivity*), Marta Z. Cieplak (*Interplay of various order parameters and disorder in iron chalcogenides*), and Tomasz Dietl (*Exchange interactions in magnetically doped semiconductors*). Also, 20 invited lectures, 23 brief contributed talks, and 23 posters were presented. The list of all presentations, along with their abstracts and a detailed time-frame, is available on the conference webpage (see sites.google.com/view/kkn2022).

We would like to thank all the attendees for their participation and for creating an exciting scientific atmosphere during the Conference. The next event of this series will be organized by colleagues from Cracow.

Tadeusz Domański,
Nicholas Sedlmayr
Karol I. Wysokiński
Guest Editors

Plenary speakers:

- Marta Z. Cieplak (Institute of Physics, Polish Academy of Sciences, Warsaw)
Interplay of Various Order Parameters and Disorder in Iron Chalcogenides
- Tomasz Dietl (MagTop, Warsaw & Tohoku University, Sendai (Japan))
Exchange Interactions in Magnetically Doped Semiconductors
- Józef Spalek (Jagiellonian University, Cracow)
A Brief Perspective in High Temperature Superconductivity

Invited lecturers:

- Tomasz Cichorek (Polish Academy of Sciences, Wrocław)
Two-band Superconductivity in Electron-Irradiated $\text{PrOs}_4\text{Sb}_{12}$ and CeCu_2Si_2 Studied by Local Magnetization Measurements
- Maciej Fidrysiak (Jagiellonian University, Cracow)
Spin and Charge Quantum Excitations in High T_c Cuprates
- Paweł Jakubczyk (University of Warsaw, Warsaw)
Stability of the Fulde–Ferrel–Larkin–Ovchinnikov Phases in Fermi Mixtures: Role of the Lifshitz Point
- Grzegorz Jung (Ben Gurion Univ. Negev, Israel & Institute of Physics PAS, Warsaw)
Chiral Molecule Mediated Proximity Effect
- Tomasz Klimczuk (Gdańsk University of Technology, Gdańsk)
Superconductivity in the Heusler-Type Intermetallic Compounds
- Kamil Kolincio (Gdańsk University of Technology, Gdańsk)
Spin Chirality Produced by Thermal Spin Fluctuations
- Tomasz Kostyrko (A. Mickiewicz University, Poznań)
Theory of Superconductivity with Local Electron Pairing: History and Perspectives
- Artur Malinowski (Polish Academy of Sciences, Warsaw)
Pseudogap in Underdoped Cuprate Seen in Longitudinal Magnetoresistance
- Maciej M. Maška (Wrocław University of Science and Technology, Wrocław)
Topological Superconductivity Driven by Self-Organized Spin Structures
- Marcin Mierzejewski (Wrocław University of Science and Technology, Wrocław)
Interaction-Induced Majorana Edge States in Multiorbital Chains
- Andrzej M. Oleś (Jagiellonian University, Cracow)
Hubbard Subbands in the Infinite-Layer Nickelate
- Andrzej Ptok (Institute of Nuclear Physics, Polish Academy of Sciences, Cracow)
Ab Initio Study of Chiral Phonons
- Roman Puźniak (Polish Academy of Sciences, Warsaw)
Enhancement of Superconducting State Properties and Crystallinity Degradation as a Result of Chemical Substitutions, Under Pressure, and After Hydrogenation in Fe–Te–Se Single Crystals
- Krzysztof Rogacki (Polish Academy of Sciences, Wrocław)
Superconductivity by Dislocation Bundles in SrTiO_3
- Nicholas Sedlmayr (M. Curie-Skłodowska University, Lublin)
Instability of Majorana States in Shiba Chains due to Leakage into a Topological Substrate
- Paweł Starowicz (Jagiellonian University, Cracow)
Electronic Structure of the Heavy Fermion Superconductor $\text{Ce}_3\text{PdI}_{11}$ with Two Inequivalent Crystallographic Positions of Ce Atoms
- Wojciech Tabiś (AGH University of Science and Technology, Cracow)
Cuprates — the Perspective of Electronic Transport
- Mircea Trif (MagTop, Warsaw)
Yu–Shiba–Rusinov Qubit
- Andrzej Wiśniewski (Institute of Physics, Polish Academy of Sciences, Warsaw)
Properties of $(\text{Nb}, \text{Pb}, \text{In})/\text{NbP}$ — Superconductor Weyl Semimetal Junctions
- Kacper Wrześniewski (A. Mickiewicz University, Poznań)
Dynamical Quantum Phase Transition in a Mesoscopic Superconducting System



In memoriam:
Professor Roman Micnas
(1947–2022)



Professor Roman Micnas, a distinguished Polish physicist, passed away on January 13, 2022. He took a very active part in the whole series of National Conferences on Superconductivity, both as a member of the Scientific Committees and as a lecturer. Professor Micnas provided a substantial contribution to the success of these Conferences and to superconductivity research in Poland.

Roman Micnas was born in Nowice on November 4, 1947. In 1970 he graduated from Adam Mickiewicz University (AMU) with a Master of Science (MSc) degree. He also received his doctoral (PhD) degree there in 1978, and then habilitation (Dr hab.) in 1988. In 1990 he became a professor of physics. In the years 1998–2018, Professor Micnas was the head of the Solid State Theory Division in the Faculty of Physics of AMU. He published a number of important papers that contributed to the theory of condensed matter physics. In his works, R. Micnas dealt mainly with the theory of superconductivity, strongly correlated materials, magnetism, phase transitions, and ultracold atoms on optical lattices. His

main achievement consists of the development of the theory of superconductivity with local electron pairing. In this field, he published a number of seminal works, including the highly cited review article *Rev. Mod. Phys.* **62**, 113 (1990) written with Julius Ranninger and Stanisław Robaszkiewicz as the co-authors. Professor Micnas published over 140 articles in various fields of physics, *inter alia*, together with Karl Alex Müller. R. Micnas gave over 60 invited talks at international conferences and promoted six doctoral students.

Professor Micnas paid long-term research visits to: the University of Linköping, Sweden (for a collaboration with K.A. Chao); ICTP Trieste, Italy; University of Grenoble; the Institute Laue–Langevin, Grenoble; CNRS Grenoble, France (for a collaboration with J. Ranninger). In total, as a visiting professor, he stayed in 15 scientific institutions in Sweden, Brazil, France, Italy, Germany, Switzerland, and the USA.

For the development of the theory of superconductivity with local electron pairing, together with Stanisław Robaszkiewicz, R. Micnas was awarded the Marie Skłodowska-Curie Scientific Prize of the Polish Academy of Sciences (PAS) in 1989. In 1994 he became a Corresponding Member of PAS, and in 2016 — an Ordinary Member. He served a number of important functions in PAS, amongst others he was a member of the Committee for Physics of PAS, and from 2015 — a Dean of Division III of Exact Sciences and Earth Sciences of PAS. Professor Micnas was a member of several scientific societies: the Polish Physical Society, the European Physical Society, the American Physical Society, and the American Association for the Advancement of Science. He co-organized 35 national and international conferences, including the cycle of European conferences “Physics of Magnetism”, which he co-chaired since 1993.

We shall remember Professor Roman Micnas as an excellent scientist and a very friendly Member of our Community.

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