

<b>Masaryk University</b>	
<b>Faculty</b>	Faculty of Science
<b>Procedure field</b>	Condensed Matter Physics
<b>Applicant</b>	Mgr. Jiří Chaloupka, Ph.D.
<b>Applicant's home unit, institution</b>	Faculty of Science, Masaryk University
<b>Habilitation thesis</b>	Exotic Magnetism in Relativistic Transition Metal Compounds
<b>Board members</b>	
<b>Chair</b>	prof. Rikard von Unge, Ph.D. <i>Faculty of Science, Masaryk University</i>
<b>Members</b>	prof. RNDr. Josef Humlíček, CSc. <i>Faculty of Science, Masaryk University</i> doc. RNDr. Tomáš Novotný, Ph.D. <i>MFF UK Praha</i> doc. RNDr. Ilija Turek, DrSc. <i>Ústav fyziky materiálů AV ČR Brno</i> Prof. Dr. Maria Daghofer <i>Uni Stuttgart, Německo</i>

### Evaluation of the applicant's scholarly/artistic qualifications

Jiří Chaloupka received his Master degree in physics from Masaryk University in 2005, his thesis deals with Wave scattering in Phononic Crystals. A part of the results was published in Physical Review B, this was Chaloupka's first publication. After having completed his Master, Chaloupka continued studying Physics at Masaryk University but he chose a completely different field of research: Electrodynamics of superconductors. In 2009 he defended his Ph.D. thesis entitled "Microscopic Gauge-invariant Theory of the c-axis Infrared Response of Bilayer High-Tc Cuprate Superconductors". His findings contributed to the understanding of infrared active collective electronic modes in the high-Tc cuprates. In the course of his Ph.D. studies, Chaloupka stayed for about one year at the Max Planck Institute for Solid State Research in Stuttgart, Germany (MPI Stuttgart in the following). It was at this time that a long-term fruitful collaboration between Chaloupka and Khaliullin began. In their paper "Orbital order and possible superconductivity in LaNiO<sub>3</sub>/LaMO<sub>3</sub> superlattices" (published in the Physical Review Letters, 2008) they predicted high-Tc superconductivity in LaNiO<sub>3</sub>/LaMO<sub>3</sub> superlattices. Here M denotes a trivalent cation such that the MO<sub>2</sub> planes are insulating. This prediction stimulated a lot of research activities focused on this novel class of materials and the paper has been cited more than 250 times. In 2010-2012 Chaloupka worked as a postdoctoral research associate at MPI Stuttgart, in the Solid-State Spectroscopy department headed by professor Bernhard Keimer. The postdoctoral stay was supported by the prestigious AvH research fellowship that Chaloupka received. Already in 2010, Chaloupka in collaboration with Jackeli and Khaliullin (both MPI Stuttgart) made an important discovery in the field of magnetism in honeycomb-lattice iridium oxides: they derived an effective spin one-half Hamiltonian describing exchange interactions between Ir<sup>4+</sup> ions, interpolating between the Heisenberg and the exactly solvable Kitaev models, and demonstrated that the model provides unique spin phases – a spin liquid phase and a stripy antiferromagnetic phase. Their paper (Physical Review Letters, 2010) became a classic in the field, and it gained more than 600 citations. This work was followed by a sequence of papers extending the model of the 2010 PRL paper and confronting the predictions with experimental data (e.g., the Nature Physics paper by S.W. Chun et al., 2015, with a substantial contribution by Chaloupka). After returning from the postdoc stay, Chaloupka joined the RG Functional properties of nanostructures at CEITEC MU and the Department of Condensed Matter Physics of Faculty of Science, MU. His research has been focused on the physics of strongly correlated electron systems, such as cuprates, layered cobaltates, superconducting iron pnictides, iridates and more recently ruthenates. Chaloupka collaborates with his colleagues from MPI Stuttgart, with the group of professor Oles at Jagiellonian University in Krakow, with J. Kim from Argonne National Laboratory etc. Among others, Chaloupka has contributed to the development of a theoretical description of Higgs mode excitations occurring in the two-dimensional antiferromagnet Ca<sub>2</sub>RuO<sub>4</sub>.

Jiří Chaloupka has authored or coauthored 31 publications listed in the WOS database, 3 of them in Nature Physics, 9 in Physical Review Letters, 6 of them as first-author. The publications have been cited – at the time of the submission of the application – 1228 times, 5 of them have gained more than 200 citations. He has given four invited talks at respected international conferences.

**Conclusion:** The applicant's scholarly/artistic capabilities meet the requirements expected of applicants participating in a habilitation appointment procedure in the field of Condensed Matter Physics.

### Evaluation of the applicant's pedagogical experience

Jiří Chaloupka has been involved in teaching at the Faculty of Science, Masaryk University since 2005, when he was responsible for the class exercise of the course Solid State Physics. For a long time he participated in teaching laboratory courses within both the bachelor and the master degree programs. In 2008-2009 he taught the class exercises accompanying the lectures on classical electrodynamics and since 2012 he is responsible for the class exercises in quantum mechanics for final year undergraduate students. Currently (April 2021) he is further responsible for six other courses involving, with the exception of the first one, lectures: Oscillations, waves, optics – seminar, Basic Numerical Methods, Advanced Numerical Methods, Introduction to Nonlinear Dynamics, Collective and Cooperative Phenomena (a course prepared for the Master's students of Condensed Matter Physics), Diagrammatic methods in Modern Condensed Matter Physics (a course

prepared for Ph.D. students of Condensed Matter Physics) and he contributes to several other courses. He supervised two Bachelor's theses (both successfully defended), three Master's theses (all successfully defended), at the moment he supervises one Master's thesis and two doctoral candidates.

**Conclusion:** The applicant's pedagogical capabilities **meet** the requirements expected of applicants participating in a habilitation appointment procedure in the field of Condensed Matter Physics.

#### **Habilitation thesis evaluation**

Chaloupka's habilitation thesis entitled "Exotic Magnetism in Relativistic Transition Metal Compounds" is based on Chaloupka's papers addressing (i) the physics of the Kitaev model and related experimental findings, and (ii) the physics of soft-spin systems, including models and related experimental findings. The thesis consists of an extensive introduction that can be used as a tutorial on the subject of the thesis and fourteen reprints of Chaloupka's papers. The thesis has been reviewed by three experienced scientists: Professor Raymond Fressard (Laboratoire CRISMAT-ENSICAEN, Caen, France), Dr. Karlo Penc (Wigner Research Centre for Physics, Budapest, Hungary) and Professor Peter Prelovšek (University of Ljubljana, Slovenia). All reviewers conclude that the habilitation thesis fulfils the requirements expected of a habilitation thesis in the field of Condensed Matter Physics. In their reports, they stress the excellence of Chaloupka's research and his publications and also his ability to explain the essence of his findings, despite their complexity. Professor Fressard appraises the thesis as follows: "Summarizing, with this habilitation thesis Dr. Jiří Chaloupka demonstrated his marvelous capability to explain the works he has undertaken, despite of their complexity. It is furthermore evident that it reiterately succeeded in bridging well established concepts to the most modern ones, leading to important and highly recognized articles published in the best journals. Reading, in this nearly flawless document, about RIXS response, spin liquid, triplon condensation, quantum critical point, Higgs modes and massive numerical work justifies stating that Dr. Jiří Chaloupka is at the forefront of condensed matter theory. And Professor Prelovšek concludes with: "The contribution of J. Chaloupka to recent development of this interesting field is evident and well known. I support fully his habilitation at the Masaryk University in Brno, and I am confident that he will play further an important role in performing and promoting top research in his local environment and also be able to convey his knowledge and enthusiasm to students and colleagues."

**Conclusion:** The applicant's habilitation thesis **meet** the requirements expected of habilitation theses in the field of Condensed Matter Physics.

### Secret vote results

Voting took place: electronically

Number of board members		5
Number of votes cast		5
of which	in favour	5
	against	0

### Board decision

Based on the outcome of the secret vote and following an evaluation of the applicant's scholarly or artistic qualifications, pedagogical experience and habilitation thesis, the board hereby submits a proposal to the scientific board of the Faculty of Faculty of Science of Masaryk University to **appoint the applicant associate professor** of Condensed Matter Physics.

In Brno on 12.05.2021

prof. Rikard von Unge, Ph.D.

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