FM 65: Poster: Quantum & Information Science

Time: Wednesday 16:30–18:30 Location: Tents

FM 65.1 Wed 16:30 Tents

Quantum physics and Cosmology: The secured findings — •Hille Helmut — Fritz-Haber-Sraße 34, 74081 Heilbronn

"Especially in times where physics seems to describe not even five percent of the universe while the rest lies in the dark, it could be worth to put the fundamentals of a science to the test and to revise them." (Quotation by Meinard Kuhlmann, June 2016 in the magazine "Physik Journal"). Before starting with it, I think it is important to realize which secured findings on cosmology there are already today, far from all ideology and hypotheses. As I can point out, these findings and their consequences should be sufficient to create a cosmological conception of the world of great simplicity, clearness and beauty by means of quantum physics using its potential. In this way, quantum physics re-establishes the unity in physics and overcomes the standstill in theoretical physics, which the American physicist Richard Feynman called "The melancholy of the 20th century". Preparations of the text see www.helmut-hille-philosophie.de/freiburg2019.html.

FM 65.2 Wed 16:30 Tents

Quantum Technologies in Applications for Satellite Operations — •Andreas Spörl[1], Nikolas Pomplun[1], Tobias Stollenwerk[2], Florian Moll[3], and Steffen Glaser[4] — [1]DLR-RB MIT OP — [2]DLR-KN SAN OP — [3]DLR-SC HPC KP — [4]TUM Chemie

DLR's German Space Operations Center (GSOC) operates various satellite and human spaceflight missions, ranging from low earth to geostationary orbit, e.g. the Columbus Module at the ISS, several earth-observing missions like TanDEM-X and Firebird or the EuropeanDataRelaySystem. To steadily improve quality of operations, future technologies are always under inspection with respect to their potential for applicability in space and ground operations. Several future applications and methods of quantum technology are currently analyzed by GSOC and its partners: i) QuATHMoS: definition and implementation of an interface between an accessible quantum annealing device (D-WAVE) and an inhouse developed anomaly detection software suite (with DLR-KÖLN); ii) GRAPE4SPACE: application of quantum control methods in satellite attitude control systems (with TUM); iii) Support of upcoming quantum key distributing satellite missions and analysis of how quantum keys can be used in space operations.

FM 65.3 Wed 16:30 Tents

Learning and Planning in Quantum Experiments — •Lea Marion Trenkwalder[1], Hendrik Poulsen Nautrup[1], and Hans J. Briegel[1,2] — [1]Institute for Theoretical Physics, University of Innsbruck, Innsbruck, Austria — [2]Department of Philosophy, University of Konstanz, Konstanz, Germany

The focus of this work lies on the study of artificial learning agents that can be used to design quantum protocols and experiments. As has been shown in earlier work, the structure of many quantum information experiments can be mapped to a navigation problem on a complex maze. Using the projective simulation framework, we present an agent capable of learning and planning in this maze structure and show its applications in quantum information, such as quantum error correction protocols and photonic experiments.

FM 65.4 Wed 16:30 Tents

Applications of Neural Networks on Small-Angle X-Ray Scattering Data — •Thomas Stielow, Paula Respondek, and Stefan Scheel — Institut für Physik, Universität Rostock, Albert-Einstein-Straße 23, 18059 Rostock

Modern phase retrieval algorithms allow for a detailed reconstruction of two dimensional electronic densities from small-angle scattering patterns obtained in FEL experiments. However, despite major improvements, such algorithms still suffer from convergence to local minima and perform best if structural information such as the object's silhouette is provided [1]. Deep learning algorithms have recently been employed in the reconstruction of wide-angle scattering patterns [2]. Here we demonstrate how such a procedure can be adopted to the small-angle regime. In particular, we show that deep learning models can both be used in orientation and density reconstruction. The observed reconstruction results are highly stable due to the possibility of including known propeerties of the observed system into the neural network.

[1] T. Ekeberg et al., PRL **114**, 098102 (2015).
[2] T. Stielow et al., arXiv:1906.06883 (2019).

FM 65.5 Wed 16:30 Tents

Theoretical study of structure-property relations in disordered magnetic Fe-Al phases with vacancies — •Ivana Miháliková[1,2], Martin Friák[1,2], Nikola Koutná[2,3], David Holec[4], and Mojmír Šob[5,1,6] — [1]Institute of Physics of Materials, Czech Academy of Sciences, Brno, Czech Republic — [2]Department of Condensed Matter Physics, Faculty of Science, Masaryk University, Brno, Czech Republic — [3]Institute of Materials Science and Technology, TU Wien, Vienna, Austria — [4]Department of Materials Science, Montanuniversität Leoben, Leoben, Austria — [5]Department of Chemistry, Faculty of Science, Masaryk University, Brno, Czech Republic — [6]Central European Institute of Technology, CEITEC MU, Masaryk University, Brno, Czech Republic

Vacancies are very common point defects in magnetic phases present in Fe-Al-based superalloys. In particular, when focusing on disordered Fe-rich solid solutions of aluminium in iron, there is enormous number of different local environments of vacancies. The chemical composition and locally distorted structure around each vacancy have a significant impact on its properties. We have performed quantum-mechanical calculations to examine these complex structure-property relations. A series of supercells was used and their thermodynamic, magnetic and structural properties were computed employing density-functional theory [1]. We present a statistical analysis of the obtained data and relations among them.

[1] I. Miháliková, M. Friák, N. Koutná, D. Holec and M. Šob, Materials 12 (2019) 1430; https://doi.org/10.3390/ma12091430.

FM 65.6 Wed 16:30 Tents

Anti-/correlations between environment and magnetism of Fe atoms in disordered magnetic Fe-Al-based materials — •Martin Friák[1,2], Ivana Miháliková[1,2], Nikola Koutná[2,3], David Holec[4], and Mojmír Šob[2,1] — [1]Institute of Physics of Materials, Czech Academy of Sciences, Brno, Czech Republic — [2]Faculty of Science, Masaryk University, Brno, Czech Republic — [3]Institute of Materials Science and Technology, TU Wien, Vienna, Austria — [4]Montanuniversität Leoben, Leoben, Austria

The nano-scale structure of Fe-Al-based superalloys is formed by two coherently co-existing phases. They are typically Fe-rich, magnetic and at least partly chemically disordered [1-3]. Next to this intra-phase disorder, there are numerous interfaces which represent another compositional disorder affecting a few layers of atoms away from the interfaces [4,5]. These two types of disorder result in an enormous number of different local environments of Fe atoms. Importantly, local magnetic moments of Fe atoms are known to sensitively depend on surrounding atoms. We have performed high-throughput quantum-mechanical study of anti-/correlations between the local atomic environment of Fe atoms and their magnetic moments in Fe-Al-based superalloy phases.

[1] M. Friák *et al.*, Materials 11 (2018) 1732.
[2] M. Friák *et al.*, Crystals 9 (2019) 299.
[3] M. Friák *et al.*, Materials 11 (2018) 1543.
[4] I. Miháliková *et al.*, Nanomaterials 8 (2018) 1059.
[5] M. Friák, D. Holec, M. Šob, Nanomaterials 8 (2018) 1057.