



## Orbital Physics in Correlated Matter

Eva Pavarini and Erik Koch (Eds.)

Forschungszentrum Jülich GmbH  
Institute for Advanced Simulation

**Lecture Notes of the Autumn School on  
Correlated Electrons 2023**

Eva Pavarini and Erik Koch (Eds.)

## **Orbital Physics in Correlated Matter**

Autumn School organized by  
the Institute for Advanced Simulation  
at Forschungszentrum Jülich  
18 – 22 September 2023

Schriften des Forschungszentrums Jülich  
Modeling and Simulation

Band / Volume 13

---

ISSN 2192-8525

ISBN 978-3-95806-689-2

# Contents

## Preface

1. Orbital Ordering in Materials  
*Eva Pavarini*
2. The Jahn-Teller Effect  
*Arnout Ceulemans*
3. Orbitally Induced Peierls Mechanism for Charge-Orbital Orderings  
in Transition-Metal Compounds  
*Takashi Mizokawa*
4. Multiplets in Transition Metal Ions and Introduction to Multiband Hubbard Models  
*Robert Eder*
5. Exchange Mechanisms  
*Erik Koch*
6. Spin-Orbital Entanglement in Mott Insulators  
*Andrzej Oleś*
7. Imaging Orbitals with X-rays  
*Hao Tjeng*
8. Probing Spin, Charge and Orbital Degrees of Freedom by X-Ray Spectroscopy  
*Eva Benckiser*
9. Strong Correlations at Oxide Interfaces: What is Hidden in a Plane View?  
*Jak Chakhalian*
10. Orbitals, Frustration and Quantum Criticality  
*Matthias Vojta*
11. Quantum Compass and Kitaev Models  
*Jeroen van den Brink*
12. Kitaev Magnets  
*Simon Trebst*
13. Self Interaction Corrections to Density Functional Theory  
*Mark Pederson*
14. Coupled-Cluster Theory for Materials Science  
*Andreas Grüneis*
15. Slave-Boson Theories of Multi-Orbital Correlated Systems  
*Nicola Lanatà*
16. DMFT for  $f$ -Electron Systems  
*Bernard Amadon*
17. Super-QMC: Strong Coupling Perturbation for Lattice Models  
*Alexander Lichtenstein*

## Index