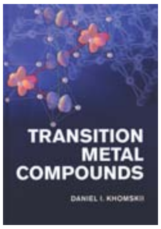
compounds, which fall into the subclass of strongly correlated electron systems. Daniel Khomskii's new monograph, *Transition Metal Compounds*, updates and further develops Goodenough's ideas while sticking to the original approach; it also focuses on TM oxides and summarizes Khomskii's long-term activity researching their electric and magnetic properties.



Khomskii is a well-known theoretician; the Kugel–Khomskii Hamiltonian, for example, describes many phenomena observed in TM oxides. However, *Transition Metal Compounds* is not a monograph for theorists. Rather, it is a compendium of basic ideas and a qualitative review of those oxides' generic properties.

The field's main motivating crystallographic picture is of a TM ion enclosed in an octahedron of oxygen ions. Depending on how those octahedrons are packed, the oxide is classified as a perovskite, rutile, corundum, or other crystalline structure. The TM oxide's widely varied magnetic and electronic properties are determined by the interplay between strong correlation effects in TM ions' 3*d* shells and the covalent bonding of the TM-ion and oxygen-ion orbitals.

The book opens with an introduction to the theory of correlated 3*d* electrons in crystals and isolated atoms. Then the first three chapters present such topics as the interplay between electronic motion and magnetism in Mott–Hubbard insulators (also known as Mott insulators), atomic Hund's rules, and the crystal-field and ligand-field theory for TM oxides.

Chapter 4 is the key part of the book; there the author adapts the general mechanism of the Mott–Hubbard transition for the TM oxide geometry. The key idea is that covalent bonding in the octahedral structure results in specific charge-transfer contributions to the transition and thus a specific change in the Mott–Hubbard phase diagram. Here's a note for the more experienced readers: The metal–insulator transition, when controlled by charge transfer, is described by the Zaanen-Sawatzky-Allen phase diagram.

Based on that charge-transfer effect, the author, in chapter 5, describes indirect effective exchange mechanisms and various magnetic structures realized in TM oxides, with special attention to frustrated magnets and spin liquids. That content is followed by discussions in chapter 6 of the orbital and lattice degrees of freedom characteristic of TM ions and in chapter 7 of the various possibilities of charge ordering.

Chapter 8 is devoted to the recently discovered multiferroic materials, which combine ferromagnetism and ferroelectricity. In it, Khomskii discusses those compounds in the context of classical ferroelectrics and magnetoelectrics. The next two chapters are devoted to some applications of the main ideas and mechanisms. Chapter 9 considers doping, in particular how doping influences the properties of Mott–Hubbard insulators and high-T_c superconductors (both cuprates and ferropnictides). The superconductor discussion, however, is too laconic to serve as a sufficient introduction. Chapter 10 covers metal–insulator transitions.

The description of heavy-fermion and mixed-valence systems in chapter 11 is also, I think, too concise to be an adequate introduction. In my opinion, those two systems, because they exist in compounds containing rare-earth metals, are beyond the scope of a monograph devoted largely to TM oxides. Besides, the basic physical mechanism (Kondo screening) that leads to so-called mass enhancement in such systems radically differs from the correlation effects discussed in the other 10 chapters.

The author concludes each chapter with a short summary that repeats the chapter's main ideas in a concentrated form. Those addenda enhance the pedagogical effect of the monograph and make it a highly useful introduction to the physics of TM oxides for nascent and experienced experimentalists and theoreticians working in that and adjacent fields of strongly correlated systems.

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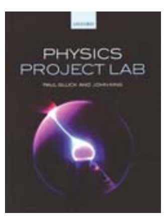
Physics Project Lab

Paul Gluck and John King
Oxford U. Press, 2015. $99.99
(317 pp.). ISBN 978-0-19-870457-7

With *Physics Project Lab*, authors Paul Gluck and the late John King invite instructors to guide their students to be apprentice physics researchers. For instructors who have never given a project-based lab course, this collection serves as a great starting point. Instructors who already use project-based labs in their classrooms are likely to find new project ideas to challenge themselves and their students.



The book's main target is college-level physics instructors. High school instructors may find some of the projects suitable, but they may have a hard time acquiring the necessary instrumentation and may find that some projects involve concepts too advanced for students at that level. However, adventurous high school teachers should not be discouraged from picking up this book and will no doubt find ideas to challenge their most motivated students. A successful lab project, like any real scientific research pursuit, depends only in part on the researcher's current knowledge; it relies heavily on his or her motivation, ingenuity, and persistence. Thus, by engaging with project-based labs, clever high school students may discover their love of physics before they end up pursuing another subject in college.

Physics Project Lab describes about fifty projects in detail, split up into six fields of classical physics: mechanics, electromagnetism, acoustics, liquids, optics, and thermodynamics. Projects range from Johnson noise to the physics of tuning forks, laser speckles, and the Leidenfrost effect. Appendices offer additional and less-detailed project ideas, a reference library of recommended books, and advice on setting up lab facilities and instrumentation.

The underlying pedagogy of *Physics Project Lab* goes back decades. And yet the book addresses the concerns stated in the American Association of Physics Teachers' *Recommendations for the Undergraduate Physics Laboratory Curriculum* (2014) and the science and engineering practices identified in the *Next Generation Science Standards* (2013). Each project presents a short introduction to the research question, theoretical background, possible research goals, experimental suggestions, and a list of references—the references are frequently to articles from the *Physics Teacher, American Journal of Physics, Physics Education,* or some topic-specific journals.

If you are looking for a cookbook-like lab instruction manual, you are out of luck. Lab instructors, referred to in the book as "guides," and their students, referred to as "researchers," will need to consult the literature and figure out how to design an experiment with the resources available to them. Furthermore, the authors encourage instructors and students to come up with their own project ideas; but especially when designing a new project-based course, a list of ideas that have been successfully implemented is certainly valuable.

In keeping with the concept of open exploration, no specific difficulty level or time requirement is given for any particular experiment. The projects presented in the book are part of a collection of experiments that have been used for the past 30 years at MIT and for the past 20 years at the Israel Arts and Sciences Academy, a high school for gifted students.

The MIT course is one semester long with weekly five-hour lab sessions. Instructors of project-based courses will need to give their students both time and guidance to succeed. However, having worked with undergraduate students on year-long assignments developing labs for pre-health students, I wholeheartedly believe that lab projects are time well spent. Not surprisingly, the students who learned the most were the ones who helped design the labs.

Gluck, who teaches at the Azrieli College of Engineering Jerusalem, dedicated the book to King, who passed away in 2014, after a long and distinguished career as a researcher and educator at MIT. In many ways the book embodies King's passion for experimental physics. One can hope that it will spark the interest of future experimentalists to become scientists in his mold. I encourage instructors to take the authors' advice and dive into the adventure and uncertainty of a project that does not have a predetermined, easily found answer. Although it is not a substitute for your and your students' ingenuity and creativity, *Physics Project Lab* is a valuable resource.

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