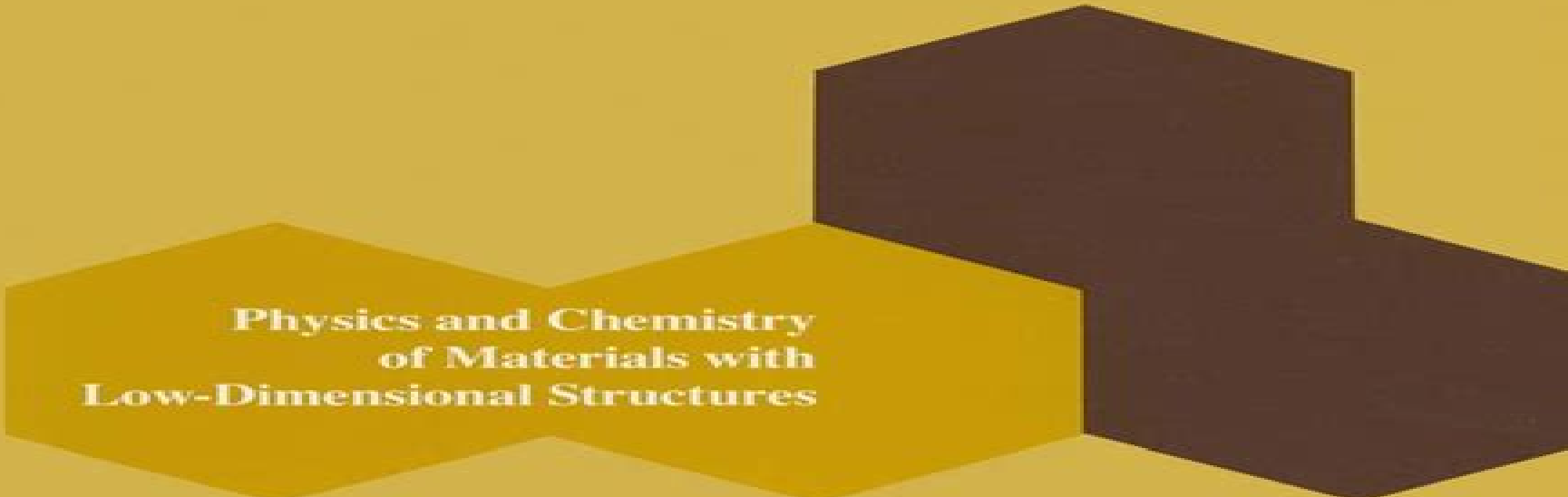


# **Low-Dimensional Electronic Properties of Molybdenum Bronzes and Oxides**

Edited by  
**Claire Schlenker**



**Physics and Chemistry  
of Materials with  
Low-Dimensional Structures**

**Kluwer Academic Publishers**

# Low Dimensional Electronic Properties Of Molybdenum Bronzes And Oxides

**C. Schlenker, Jean Dumas, Milton  
Greenblatt, Sander van Smaalen**



## **Low Dimensional Electronic Properties Of Molybdenum Bronzes And Oxides:**

Low-Dimensional Electronic Properties of Molybdenum Bronzes and Oxides C. Schlenker, 2012-12-06 The history of low dimensional conductors goes back to the prediction more than forty years ago by Peierls of the instability of a one dimensional metallic chain leading to what is known now as the charge density wave state At the same time Frohlich suggested that an ideal conductivity could be associated to the sliding of this charge density wave Since then several classes of compounds including layered transition metal dichalcogenides quasi one dimensional organic conductors and transition metal tri and tetrachalcogenides have been extensively studied The molybdenum bronzes or oxides have been discovered or rediscovered as low dimensional conductors in this last decade A considerable amount of work has now been performed on this subject and it was time to collect some review papers in a single book Although this book is focused on the molybdenum bronzes and oxides it has a far more general interest in the field of low dimensional conductors since several of the molybdenum compounds provide from our point of view model systems This is the case for the quasi one dimensional blue bronze especially due to the availability of good quality large single crystals This book is intended for scientists belonging to the fields of solid state physics and chemistry as well as materials science It should especially be useful to many graduate students involved in low dimensional oxides It has been written by recognized specialists of low dimensional systems

*Physics and Chemistry of Low-Dimensional Inorganic Conductors* C. Schlenker, Jean Dumas, Milton Greenblatt, Sander van Smaalen, 2012-12-06 The field of low dimensional conductors has been very active for more than twenty years It has grown continuously and both the inorganic and organic materials have remarkable properties such as charge and spin density waves and superconductivity The discovery of superconductivity at high temperature in copper based quasi two dimensional conducting oxides nearly ten years ago has further enlarged the field and stimulated new research on inorganic conductors It was obviously impossible to cover such a broad field in a ten day Institute and it seemed pertinent to concentrate on inorganic conductors excluding the high  $T_c$  superconducting oxides In this context it was highly desirable to include both physics and chemistry in the same Institute in order to tighten or in some cases to establish links between physicists and chemists This Advanced Study Institute is the continuation of a series of similar ones which have taken place every few years since 1974 73 participants coming from 13 countries have taken part in this School at the beautiful site of the Centre de Physique des Houches in the Mont Blanc mountain range The scientific programme included more than forty lectures and seminars two poster sessions and ten short talks Several discussion sessions were organized for the evenings one on New Materials one on New Topics and one on the special problem of the Fermi and Luttinger liquids The scientific activity was kept high from the beginning to the end of the Institute *Electron Spectroscopies Applied to Low-Dimensional Structures* H.P. Hughes, H. Starnberg, 2006-04-11 The effect of reduced dimensionality inherent at the crystallographic level on the electronic properties of low dimensional materials can be dramatic leading to structural and electronic instabilities including

superconductivity at high temperatures charge density waves and localisation which continue to attract widespread interest The layered transition metal dichalcogenides have engaged attention for many years partly arising from the charge density wave effects which some show and the controlled way in which their properties can be modified by intercalation while the development of epitaxial growth techniques has opened up promising areas based on dichalcogenide heterostructures and quantum wells The discovery of high temperature superconducting oxides and the realisation that polymeric materials too can be exploited in a controlled way for various optoelectronic applications have further stimulated interest in the effects of structural dimensionality It seems timely therefore to draw together some strands of recent research involving a range of disparate materials which share some common characteristics of low dimensionality This resulting volume is aimed at researchers with specialist interests in the particular materials discussed but who may also wish to examine the related phenomena observed in different systems and at a more general solid state audience with broad interests in electronic properties and low dimensional phenomena Space limitations have required us to be selective as regards particular materials though we have managed to include those as dissimilar as polymeric semiconductors superconducting oxides bronzes and layered chalcogenides New Horizons in Low-Dimensional Electron Systems Hideo Aoki, Masahiko Tsukada, M.

Schlüter, Francis Lévy, 1991-12-31 In Bird of Passage by Rudolf Peierls we find a paragraph in which he describes his Cambridge days in the 1930s On these relativistic field theory problems my main contacts were Dirac and the younger theoreticians These included in particular Nevill now Sir Nevill Mott perhaps the friendliest among many kind and friendly people we met then Professor Kamimura became associated with Sir Rudolf Peierls in the 1950s when he translated with his colleagues Peierls's 1955 textbook Quantum Theory of Solids into Japanese This edition to which Sir Rudolf himself contributed a preface benefitted early generations of Japanese solid state physicists Later in 1974-5 during a sabbatical year spent at the Cavendish Laboratory Professor Kamimura met and began a long association with Sir Nevill Mott In particular they developed ideas for disordered systems One of the outcomes is a paper coauthored by them on ESR induced variable range hopping in doped semiconductors A series of works on disordered systems together with those on two dimensional systems have served as building blocks for Physics of Interacting Electrons in Disordered Systems in the International Series of Monographs on Physics coauthored by Aoki and published in 1989 by the Oxford University Press Soon after Professor Kamimura obtained a D Sc in 1959 for the work on the ligand field theory under the supervision of Masao Kotani his strong connections in the international physical community began when he worked at the Bell Telephone Laboratories in 1961-64

**Low-Dimensional Conductors and Superconductors** D. Jerome, L.G. Caron, 2013-12-14 Research activities in low dimensional conductors have shown a rapid growth since 1972 and have led to the discovery of new and remarkable physical properties unique to both molecular and inorganic conductors exhibiting one dimensional transport behaviour This NATO Institute was a continuation of a series of NATO Advanced Study Institutes or Workshops which took place at regular intervals

till 1979 This is the first time however that charge density wave transport and electronic properties of low dimensional organic conductors are treated on an equal footing The program of the Institute was framed by tutorial lectures in the theories and experiments of low dimensional conductors The bulk of the course covered two series of low dimensional materials with their respective properties 1 The 1D inorganic conductors exhibiting the phenomena of sliding charge density waves narrow band noise memory effects etc 2 Low dimensional crystallized organic conductors giving rise to various possibilities of ground states spin Peierls spin density wave Peierls superconductivity and magnetic field induced spin density wave etc Since it has been established from the beginning that this Institute was to be devoted essentially to the Physics of Low Dimensional Conductors only one main course summarized the progress in chemistry and material preparation

**Orbital Approach to the Electronic Structure of Solids** Enric Canadell, Marie-Liesse Doublet, Christophe Jung, 2012-01-12 This book provides an intuitive yet sound understanding of how structure and properties of solids may be related The natural link is provided by the band theory approach to the electronic structure of solids The chemically insightful concept of orbital interaction and the essential machinery of band theory are used throughout the book to build links between the crystal and electronic structure of periodic systems In such a way it is shown how important tools for understanding properties of solids like the density of states the Fermi surface etc can be qualitatively sketched and used to either understand the results of quantitative calculations or to rationalize experimental observations Extensive use of the orbital interaction approach appears to be a very efficient way of building bridges between physically and chemically based notions to understand the structure and properties of solids

**Neutron Scattering in Layered Copper-Oxide Superconductors** Albert Furrer, 2012-12-06 The phenomenon of superconductivity after its discovery in metals such as mercury lead zinc etc by Kamerlingh Onnes in 19 has attracted many scientists Superconductivity was described in a very satisfactory manner by the model proposed by Bardeen Cooper and Schrieffer and by the extensions proposed by Abrikosov Gorkov and Eliashberg Relations were established between superconductivity and the fundamental properties of solids resulting in a possible upper limit of the critical temperature at about 23 K The breakthrough that revolutionized the field was made in 1986 by Bednorz and Muller with the discovery of high temperature superconductivity in layered copper oxide perovskites Today the record in transition temperature is 133 K for a Hg based cuprate system The last decade has not only seen a revolution in the size of the critical temperature but also in the myriads of research groups that entered the field In addition high temperature superconductivity became a real interdisciplinary topic and brought together physicists chemists and materials scientists who started to investigate the new compounds with almost all the available experimental techniques and theoretical methods As a consequence we have witnessed an avalanche of publications which has never occurred in any field of science so far and which makes it difficult for the individual to be thoroughly informed about the relevant results and trends Neutron scattering has outstanding properties in the elucidation of the basic properties of high temperature

superconductors     Two-Dimensional Electron Systems E.Y. Andrei, 2012-12-06 Recent studies on two dimensional systems have led to new insights into the fascinating interplay between physical properties and dimensionality Many of these ideas have emerged from work on electrons bound to the surface of a weakly polarizable substrate such as liquid helium or solid hydrogen The research on this subject continues to be at the forefront of modern condensed matter physics because of its fundamental simplicity as well as its connection to technologically useful devices This book is the first comprehensive overview of experimental and theoretical research in this exciting field It is intended to provide a coherent introduction for graduate students and non experts while at the same time serving as a reference source for active researchers in the field The chapters are written by individuals who made significant contributions and cover a variety of specialized topics These include the origin of the surface states tunneling and magneto tunneling out of these states the phase diagram collective excitations transport and magneto transport     **Complex Oxides: An Introduction** Thomas Vogt, Douglas J

Buttrey, 2019-03-20 Chapter contribution from John B Goodenough Nobel Laureate in Chemistry 2019 This book provides a unique look at the chemistry and properties of complex metal oxides from the perspectives of some of the most active researchers on this class of materials Applications of complex oxide materials are highly varied Topics reviewed in this volume include solid state battery research the chemistry of transparent conductors ternary uranium oxides magnetic perovskites non linear optical materials complex molybdenum vanadium bronzes and other complex materials used in selective oxidation catalysis It is written to serve as an introduction to the subject for and those beginning to work on these materials particularly new graduate students     Microscopic Aspects of Nonlinearity in Condensed Matter Alan R. Bishop, V.L. Pokrovsky, V. Tognetti, 2012-12-06 Proceedings of a NATO ARW held in Florence Italy June 7 13 1990

**Inorganic Reactions and Methods, The Formation of Bonds to O, S, Se, Te, Po (Part 2)** A. D. Norman, 2009-09-17 Die langerwartete Komplettierung der Reihe Inorganic Reactions and Methods beginnt jetzt mit der Publikation des 6 Bandes Seit Jahren vielfach in Forschung und Berufsalltag bew hrt behandelt die Reihe alle Gebiete der anorganischen Synthesechemie die Chemie der Elemente Koordinationsverbindungen Donor Acceptor Addukte organometallische Stoffe Polymere und Festk rper sowie bioanorganische Materialien Mit Autoren Sach und Verbindungsregister 07 98     *Advances in the Crystallographic and Microstructural Analysis of Charge Density Wave Modulated Crystals* F.W. Boswell, J. Craig Bennett, 2012-12-06 Modulated crystals have been intensively investigated over the past several years and it is now evident that an understanding of their crystallography and microstructure is fundamental to the elucidation of the physical properties and phase transitions in these materials This book brings together for the first time the crystallographic descriptions and experimental methods for the structural and microstructural analysis of modulated crystals as described by well known researchers in the various areas The emphasis is on charge density wave modulations and the detailed analysis of the prototypical NbTe<sub>4</sub> TaTe<sub>4</sub> system gives practical applications of the methods Scanning Tunnelling Microscopy is a new

technique providing significant new insights into atomic scale details of the modulations structures and a chapter on this method is included

**Carbyne and Carbynoid Structures** R.B. Heimann, S.E. Evsyukov, Ladislav Kavan, 1999-02-28 This is a book on one of the most fascinating and controversial areas in contemporary science of carbon chemistry and materials science It concisely summarizes the state of the art in topical and critical reviews written by professionals in this and related fields

**Phase Transitions and Relaxation in Systems with Competing Energy Scales** T. Riste, David Sherrington, 2012-12-06 Systems with competing energy scales are widespread and exhibit rich and subtle behaviour although their systematic study is a relatively recent activity This text presents lectures given at a NATO Advanced Study Institute reviewing the current knowledge and understanding of this fascinating subject particularly with regard to phase transitions and dynamics at an advanced tutorial level Both general and specific aspects are considered with competitions having several origins differences in intrinsic interactions interplay between intrinsic and extrinsic effects such as geometry and disorder irreversibility and non equilibration Among the specific physical application areas are supercooled liquids and glasses high temperature superconductors flux or vortex pinning and motion charge density waves domain growth and coarsening and electron solidification

*Charge Density Waves in Solids* L.P. Gor'kov, G. Grüner, 2012-12-02 The latest addition to this series covers a field which is commonly referred to as charge density wave dynamics The most thoroughly investigated materials are inorganic linear chain compounds with highly anisotropic electronic properties The volume opens with an examination of their structural properties and the essential features which allow charge density waves to develop The behaviour of the charge density waves where interesting phenomena are observed is treated both from a theoretical and an experimental standpoint The role of impurities in statics and dynamics is considered and an examination of the possible role of solitons in incommensurate charge density wave systems is given A number of ways to describe charge density waves theoretically using computer simulations as well as microscopical models are presented by a truly international board of authors

**New Trends in Optical Soliton Transmission Systems** Akira Hasegawa, 2012-12-06 This book summarizes the proceedings of the invited talks presented at the International Symposium on New Trends in Optical Soliton Transmission Systems held in Kyoto during November 18 21 1997 As a result of worldwide demand for ultra high bitrate transmissions and increased scientific interest from the soliton community research on optical solitons in fibres has made remarkable progress in recent years In view of these trends the Research Group for Optical Soliton Communications ROSC chaired by Akira Hasegawa was established in Japan in April 1995 to promote collaboration and information exchange among communication service companies industries and academic circles in the theory and application of optical solitons This symposium was organized as a part of the ROSC activities As with the 1 st ROSC symposium this symposium attracted enthusiastic response from worldwide researchers involved in the subject of soliton based communications and intensive discussions were held throughout the symposium Particular emphases were made to dispersion managements of soliton transmission I would like to

note that in the t symposium the adiabatic dispersion managements just began to appear in reducing radiation at amplifiers and reducing collision effects in WDM system These have become standard this time but in addition new non adiabatic dispersion managements have been introduced independently by various scientists all over the world      **Magnetic**

**Properties of Layered Transition Metal Compounds** L.J. de Jongh,2012-12-06 In the last two decades low dimensional low d physics has matured into a major branch of science Quite generally we may define a system with restricted dimensionality d as an object that is infinite only in one or two spatial directions d 1 and 2 Such a definition comprises isolated single chains or layers but also fibres and thin layers films of varying but finite thickness Clearly a multitude of physical phenomena notably in solid state physics fall into these categories As examples we may mention Magnetic chains or layers thin film technology Metallic films homogeneous or heterogeneous crystalline amorphous or microcrystalline etc I d or 2 d conductors and superconductors Intercalated systems 2 d electron gases electrons on helium semiconductor interfaces Surface layer problems 2 d melting of monolayers of noble gases on a substrate surface problems in general Superfluid films of He or He Polymer physics Organic and inorganic chain conductors superionic conductors I d or 2 d molecular crystals and liquid crystals I d or 2 d ferro and antiferro electrics      **Applications of Statistical and Field Theory Methods to**

**Condensed Matter** Dionys Baeriswyl,Alan R. Bishop,J. Camelo,2012-12-06 There is no doubt that we have during the last decade moved into a golden age of condensed matter science The sequence of discoveries of novel new states of matter and their rapid assimilation into experimental and theoretical research as well as devices has been remarkable To name but a few spin glasses incommensurate fractal quasicrystal structures synthetic metals quantum well fabrication fractional quantum Hall effect solid state chaos heavy fermions and most spectacularly high temperature superconductivity This rapid evolution has been marked by the need to address the reality of materials in extreme conditions disordered nonlinear systems in reduced dimensions restricted geometries and at mesoscopic scales often with striking competitions between several length and frequency scales and between strong electron phonon and electron electron interactions In such new territory it is not surprising that very interdisciplinary approaches are being explored and traditional boundaries between subjects and disciplines re defined In theory this is evident for instance in attempts 1 to advance the state of the art for elec tronic structure calculations so as to handle strongly interacting many body systems and delicate competitions for collective ground states spin models or many electron Hamiltoni ans field theory band structure quantum chemistry and numerical approaches or 2 to understand pattern formation and complex including chaotic dynamics in extended sys tems This demands close involvement with applied mathematics numerical simulations and statistical mechanics techniques      **Nuclear**

**Spectroscopy on Charge Density Wave Systems** T. Butz,2013-04-17 Nuclear magnetic resonance NMR nuclear quadrupole resonance NQR time differential perturbed angular correlations TDPAC and the M ssbauer effect ME have been applied to the study of charge density wave CDW systems These hyperfine techniques provide unique tools to probe the



structure and symmetry of commensurate CDWs give a clear fingerprint of incommensurate CDWs and are ideally suited for CDW dynamics. This book represents a new attempt in the series *Physics and Chemistry of Materials with Low dimensional Structures* to bring together a consistent group of scientific results obtained by nuclear spectroscopy related to CDW phenomena in pseudo one and two dimensional systems. The individual chapters contain the theory of CDWs in chain like transition metal tetrachalcogenides, NMR, NQR, TDPAC and ME investigations of layered transition metal dichalcogenides, NMR studies of CDW transport in chain like NbSe<sub>3</sub> and molybdenum bronzes, multinuclear NMR of KCP, high resolution NMR of organic conductors. This book is of interest to graduate students and all scientists who want to acquire a broader knowledge of nuclear spectroscopy techniques applied to CDW systems.

**Progress in Intercalation Research** W. Müller-Warmuth, R. Schöllhorn, 2012-12-06. The combination of solid materials of different structural dimensionality with atomic or molecular guest species via intercalation processes represents a unique and widely variable low temperature synthesis strategy for the design of solids with particular composition, structure and physical properties. In the last decade this field has experienced a rapid development and represents now an established specific domain of solid state research and materials science. Substantial progress has been made with respect to an understanding of the complex relationship between structure, bonding, physical properties and chemical reactivity since the first volume on the subject appeared in this series in 1979, *Intercalated Layered Materials* F. Levy ed. The purpose of this volume is to present a survey on progress and perspectives based on the treatment of a series of major areas of activities in this field. By the very nature of its subject, this monograph has an interdisciplinary character and addresses itself to chemists, physicists and materials scientists interested in intercalation research and related aspects such as design and characterization of complex materials, low temperature synthesis, solid state reaction mechanisms, electronic/ionic conductivity, control of electronic properties of solids with different structural dimensionality and application of intercalation systems. Several chapters have been devoted to specific groups of host lattices.

## Reviewing **Low Dimensional Electronic Properties Of Molybdenum Bronzes And Oxides**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is really astonishing. Within the pages of "**Low Dimensional Electronic Properties Of Molybdenum Bronzes And Oxides**," an enthralling opus penned by a highly acclaimed wordsmith, readers embark on an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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### **Low Dimensional Electronic Properties Of Molybdenum Bronzes And Oxides Introduction**

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