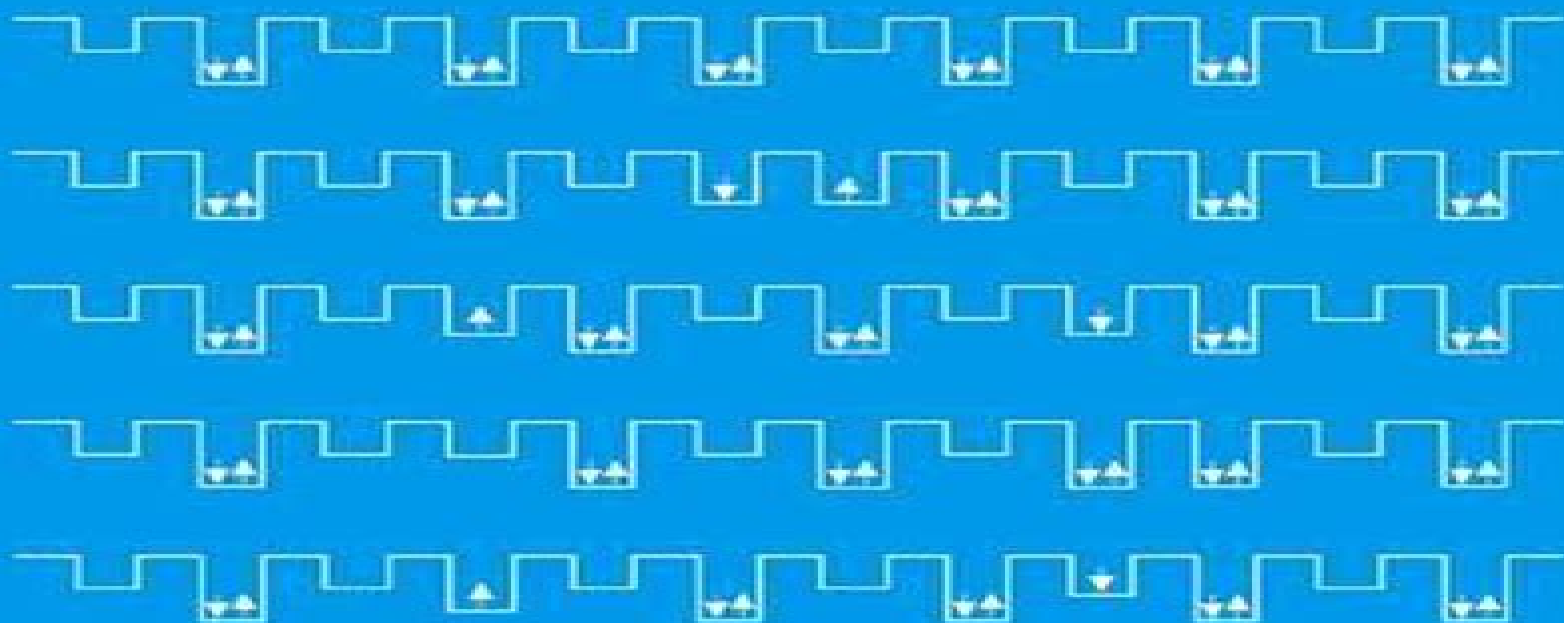


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K. NASU
editor

Photoinduced Phase Transitions

Keiichiro Nasu



Photoinduced Phase Transitions:

Photoinduced Phase Transitions Keiichiro Nasu, 2004-09-09 A new class of insulating solids was recently discovered When irradiated by a few visible photons these solids give rise to a macroscopic excited domain that has new structural and electronic orders quite different from the starting ground state This occurrence is called photoinduced phase transition and this multi authored book reviews recent theoretical and experimental studies of this new phenomenon Why and how do photoexcited few electrons finally result in an excited domain with a macroscopic size How is the resultant photoinduced phase different from the ordinary thermal induced phase This review volume answers those essential questions This book has been selected for coverage in CC Physical Chemical Earth Sciences Index to Scientific Book Contents ISBC [Emergent States in Photoinduced Charge-Density-Wave Transitions](#) Alfred Zong, 2021-09-17 This book advances understanding of light induced phase transitions and nonequilibrium orders that occur in a broken symmetry system Upon excitation with an intense laser pulse materials can undergo a nonthermal transition through pathways different from those in equilibrium The mechanism underlying these photoinduced phase transitions has long been researched but many details in this ultrafast non adiabatic regime still remain to be clarified The work in this book reveals new insights into this phenomena via investigation of photoinduced melting and recovery of charge density waves CDWs Using several time resolved diffraction and spectroscopic techniques the author shows that the light induced melting of a CDW is characterized by dynamical slowing down while the restoration of the symmetry breaking order features two distinct timescales A fast recovery of the CDW amplitude is followed by a slower re establishment of phase coherence the latter of which is dictated by the presence of topological defects in the CDW Furthermore after the suppression of the original CDW by photoexcitation a different competing CDW transiently emerges illustrating how a hidden order in equilibrium can be unleashed by a laser pulse **Photoinduced Phase Transitions and Irreversible Dynamics Studied with Single-shot Spectroscopy** Samuel Welch Teitelbaum, 2016 Single shot femtosecond spectroscopy was developed to study irreversible processes and materials far from equilibrium It was then applied to investigate photoinduced phase transitions in semimetals and manganites The dual echelon single shot instrument was developed and noise sources experimental artifacts and the fundamental limits of the single shot technique were explored In this thesis advances in the single shot technique that allow for more detailed investigation of material processes and characterization of far from equilibrium dynamics in a wider range of systems are discussed Experiments and modeling of photoinduced phase transitions in two classes of systems semimetals and manganites are presented Both systems show collective structural change under photoexcitation that ultimately results in a low symmetry to high symmetry phase transition In semimetals the high symmetry phase relaxes after a few picoseconds and in manganites the higher symmetry

phase persists essentially indefinitely A photoinduced structural phase transition in bismuth is discussed in terms of the removal of a Peierls distortion by electronic excitation When more than 2% of the valence electrons are excited the Peierls distortion is inverted and the bismuth crystal is collectively driven into a symmetric crystalline phase An extended two temperature model is used to interpret and identify a photoinduced symmetric phase that exists above the damage threshold at low temperature and high excitation density Analogous experiments and analysis on antimony and tellurium are discussed demonstrating the generality of this method to exploring phase transitions in Peierls distorted systems A recently discovered photoinduced insulator to metal phase transition in epitaxially strained $\text{La}_{2-x}\text{Ca}_x\text{MnO}_3$ on an NdGaO_3 001 substrate at low temperature is characterized by frequency domain and time domain spectroscopy The ground state and metastable photoinduced phase in LCMO are characterized by their steady state behavior Conventional pump probe and single shot experiments are interpreted in terms of an effective medium model that describes the density of charge transfer excitations in the material An extended two parameter Ginzburg Landau model with biquadratic coupling describes the ground state of the manganite phase diagram and the stability of the photoinduced metallic phase

Photoinduced Phase Transitions K.

Nasu,2004 A new class of insulating solids was recently discovered When irradiated by a few visible photons these solids give rise to a macroscopic excited domain that has new structural and electronic orders quite different from the starting ground state This occurrence is called photoinduced phase transition and this multi authored book reviews recent theoretical and experimental studies of this new phenomenon

Theory of Photoinduced Phase Transitions in Itinerant Electron Systems

Kenji Yonemitsu,2008 **Relaxations of Excited States and Photo-Induced Phase Transitions** Keiichiro

Nasu,2012-12-06 Message from The Taniguchi Foundation Dr Kanamori Distinguished Guests and Friends The Taniguchi Foundation wishes to welcome the participants of the nine tenth International Symposium on the Theory of Condensed Matter who have come from within this country and from different parts of the world The concept of the symposium is unique in that participants both Japanese and from abroad are limited in number to small discussion groups and live together although for a short period as a close knit community We feel that this kind of environment will assist towards the strengthening of understanding and the fostering of friendship among the attendees It is easy to talk about but difficult to realize the ideal of international friendship and understanding in a world which is steadily growing smaller So far the Foundation has invited a total of 149 participants in this division from 24 foreign countries and 299 participants from Japan And we are all friends We hope and trust that even after they have reached the heights of academic fame during the coming decades the participants will continue to join forces and help to forge closer bonds of friendship and cooperation that will make major contributions not only to academia but also towards world peace and the welfare of mankind We hope that all the participants will return home with warm memories of both this symposium and the pleasant times that we have shared Thank you

Photoinduced Phase Transitions Studied by Femtosecond Single-shot Spectroscopy Taeho Shin,2010 Single

shot femtosecond spectroscopy has been developed and employed for the study of phase transitions of solid state materials. Using two crossed echelons a two dimensional spatial delay gradient was generated across a single probe pulse profile. This novel scheme enables us to monitor irreversible change in solids by acquiring many time resolved data points with a single laser pulse. With the integration with a non collinear optical parametric amplifier (NOPA) and a conventional pump probe instrument, ultrafast dynamics of coherent lattice vibrations and photo induced phase transitions were examined in two different systems. Ultrafast dynamics such as coherent lattice vibrations and bond softening were investigated for Bi thin films and bulk single crystals. Depending on the thickness, transient reflectivity was changed significantly. The variations are ascribed to different electronic structures possibly originating from quantum confinement. Bond softening exhibits a strong thickness dependence due to hot carrier dynamics as well as to the different electronic structures. At high pump fluences, no phonon oscillations were observed, suggesting a phase transition to liquid or to a higher symmetry crystalline phase, reverse Peierls distortion. Together with thermal modeling, double pump measurements reveal nonthermal melting occurring in bulk and thin Bi films. A higher threshold fluence for nonthermal melting is observed in bulk bismuth as compared to thin films, suggesting ultrafast carrier dynamics such as ballistic transport. In addition to nonthermal effects, thermal effects such as inelastic electron phonon scattering and nonradiative recombination play a crucial role in melting and cooling at later times after nonthermal melting takes place. A quasi one dimensional platinum iodide complex showed strong oscillations in reflectivity which are attributed to oscillatory motions of wave packets on a self-trapped exciton (STE) potential surface. As optical excitation increased, electron transfer from Pt 2 to an adjacent Pt4 occurred over a wider range of lattice sites and weakened the oscillations. Above a certain pump fluence, oscillations disappeared completely, indicating that the mixed valence charge density wave state changed to monovalent Mott Hubbard phase. The reverse phase transition, i.e. from the Mott-Hubbard phase to the charge density wave state, began within 3 ps of the optical pump.

The Photoinduced Phase Transitions of Vanadium Dioxide Kunal Tiwari, 2015. The insulator to metal transition of vanadium dioxide has attracted the interest of condensed matter physicists for over half a century. In its high temperature phase, VO₂ is metallic with tetragonal rutile crystallography. In its low temperature phase, it has correlated semiconducting electronic character and a charge density wave like paired monoclinic lattice structure. Determining the relative roles of electron-electron and electron-phonon interactions in the electronic structure of the low temperature phase has been the source of the physics community's interest in VO₂. Over the past two decades, it has been shown that the insulator to metal transition may be photoinduced with ultrafast laser pulses. In this thesis, we present ultrafast electron diffraction and ultrafast time-resolved terahertz spectroscopy measurements of this photoinduced phase transition. Our ultrafast electron diffraction results reveal that at low fluences, a novel metastable phase exists. This phase has the crystallography of the insulating state but a dramatically collapsed band gap. A reorganization of valence charge density accompanies this modulated spectroscopic activity. These results have twofold

significance They show that the insulating behavior of the low temperature phase is affected primarily by electron electron correlations not by lattice structure Importantly they also show that ultrafast electron diffraction may be used to probe both electronic and lattice structure dynamics it is sensitive to valence charge density reorganizations Our time resolved terahertz spectroscopy results complement these ultrafast electron diffraction data We show that in the novel metastable monoclinic phase the band gap does not collapse below 50 meV We also show that dynamics in the time resolved terahertz conductivity through the full photoinduced phase transition occur on two timescales one fast 240 femtosecond timescale characteristic of the coherent athermal photoinduced phase transition and one slow picosecond timescale characteristic of the astructural transition to the metastable monoclinic phase In conjunction with our ultrafast electron diffraction measurements these results suggest that the slow dynamics of the astructural phase transition and the structural phase transition may be affected by the same underlying mechanism *Ultrafast Dynamics of Photoinduced Phase Transitions in Correlated Electron*

Materials Steffen Eich,2016 **Photoinduced Phase Transitions in 1/4 Filled Organic Materials** Matthieu Chollet,2006

Le contr le par la lumi re des propri t s physiques de mat riaux est associ l mergence d une nouvelle physique des tats hors quilibre Dans des solides les processus coop ratifs entre mol cules sont port s l extr me et peuvent induire une commutation vers un nouvel tat macroscopique avec des propri t s physiques diff rentes optiques magn tiques structurales De v ritables transitions de phase peuvent ainsi tre gouvern es par la lumi re Ces transitions photoinduites ont t ici tudi es dans des conducteurs organiques commutant entre diff rentes phase sur des chelles de temps allant de la picoseconde quelques heures La compl mentarit des tudes optiques et structurales permet de mieux comprendre la nature et les m canismes de ces transitions de phase hors quilibre Des techniques novatrices r solues en temps de diffraction X et de spectroscopie ultra rapides ont t utilis es pour tudier ces tats transitoires *Excitonic Processes In Condensed Matter, Proceedings Of 2000*

International Conference (Excon2000) Kikuo Cho,Atsuo Matsui,2001-08-22 At Yamada Conference LIII papers on many novel materials and on novel phenomena in condensed matter physics were presented for instance the achievement of simultaneous creation of excitons and free electron hole pairs in rare gas solids and a low frequency fluctuation of the spectral shift of indirect excitons in GaAs coupled quantum wells Single molecule spectroscopy is a powerful tool for studying molecules including biological systems the study of delocalization of excitons in the photosynthetic light harvesting antenna system was also reported The proceedings thus contain many excellent papers dealing with current research topics on the excitonic processes in bulk quantum wells quantum dots and other confined systems This book will serve as an excellent source of recent references and reviews for a wide range of researchers in physics chemistry engineering and biological sciences The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP CDRom version ISI Proceedings **Proceedings of 2000 International Conference on Excitonic Processes in Condensed Matter**

Kikuo Ch?,Atsuo Matsui,2001 At Yamada Conference LIII papers on many novel materials and on novel phenomena in

condensed matter physics were presented for instance the achievement of simultaneous creation of excitons and free electron hole pairs in rare gas solids and a low frequency fluctuation of the spectral shift of indirect excitons in GaAs coupled quantum wells Single molecule spectroscopy is a powerful tool for studying molecules including biological systems the study of delocalization of excitons in the photosynthetic light harvesting antenna system was also reported The proceedings thus contain many excellent papers dealing with current research topics on the excitonic processes in bulk quantum wells quantum dots and other confined systems This book will serve as an excellent source of recent references and reviews for a wide range of researchers in physics chemistry engineering and biological sciences The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTEP CDROM version ISI Proceedings

Optical Properties Of Low-dimensional Materials, Vol 2 Tetsuo Ogawa, Yoshihiko Kanemitsu, 1998-08-06 This book surveys recent theoretical and experimental studies of optical properties of low dimensional materials As an extended version of Optical Properties of Low Dimensional Materials Volume 1 published in 1995 by World Scientific Volume 2 covers a wide range of interesting low dimensional materials including both inorganic and organic systems such as disordered polymers deformable molecular crystals dilute magnetic semiconductors SiGe Si short period superlattices GaAs quantum wires semiconductor microcavities and photonic crystals There are excellent review articles by promising researchers in each field All the materials introduced in this book yield new optical phenomena originating from their mesoscopic and low dimensional electronic characters and electron lattice couplings which offer a new research field of materials science as well as condensed matter and optical physics Volumes 1 and 2 are interrelated but can be read independently They are pitched at the level of graduate students and are useful to both students and scientists

Dancing with Light Haifeng Yu, 2015-02-25 Liquid crystal LC displays dominating in the present market of flat panel displays are generally based on interactions of light and LCs Recent progress in this field indicates that integrating photochromic molecules into LC materials enables one to photomanipulate unique features such as photoinduced phase transition photocontrolled alignment

Photoactive Functional Soft Materials Quan Li, 2019-04-29 This book covers the design synthesis properties and applications of functional photoactive soft materials including aspects of polymers block copolymers elastomers biomaterials liquid crystals chemical and physical gels colloids and host guest systems It combines in a unified manner authoritative accounts describing various structural and functional aspects of photoactive soft materials Photoactive Functional Soft Materials Preparation Properties and Applications Brings together the state of the art knowledge on photoactive functional soft materials in a unified manner Covers a vibrant research field with tremendous application potential in areas such as optoelectronics photonics and energy generation Appeals to a large interdisciplinary audience because it is highly useful for researchers and engineers working on photonics optoelectronics imaging and sensing nanotechnology and energy materials Photoactive Functional Soft Materials Preparation Properties and Applications focuses on the design and fabrication of photoactive functional soft materials for materials

science nanophotonics nanotechnology and biomedical applications **Optical Properties of Low-dimensional Materials**

Tetsuo Ogawa, Yoshihiko Kanemitsu, 1998 This book surveys recent theoretical and experimental studies of optical properties of low dimensional materials As an extended version of Optical Properties of Low Dimensional Materials Volume 1 published in 1995 by World Scientific Volume 2 covers a wide range of interesting low dimensional materials including both inorganic and organic systems such as disordered polymers deformable molecular crystals dilute magnetic semiconductors SiGe Si short period superlattices GaAs quantum wires semiconductor microcavities and photonic crystals There are excellent review articles by promising researchers in each field All the materials introduced in this book yield new optical phenomena originating from their mesoscopic and low dimensional electronic characters and electron lattice couplings which offer a new research field of materials science as well as condensed matter and optical physics Volumes 1 and 2 are interrelated but can be read independently They are pitched at the level of graduate students and are useful to both students and scientists

Supramolecular Soft Matter Takashi Nakanishi, 2011-10-11 The pivotal text that bridges the gap between fundamentals and applications of soft matter in organic electronics Covering an expanding and highly coveted subject area Supramolecular Soft Matter enlists the services of leading researchers to help readers understand and manipulate the electronic properties of supramolecular soft materials for use in organic opto electronic devices such as photovoltaics and field effect transistors some of the most desired materials for energy conservation Rather than offering a compilation of current trends in supramolecular soft matter this book bridges the gap between fundamentals and applications of soft matter in organic electronics in an effort to open new directions in research for applying supramolecular assembly into organic materials while also focusing on the morphological functions originating from the materials self assembled architectures This unique approach distinguishes Supramolecular Soft Matter as a valuable resource for learning to identify concepts that hold promise for the successful development of organic polymeric electronics for use in real world applications Supramolecular Soft Matter Combines important topics to help supramolecular chemists and organic electronics researchers work together Covers an interdisciplinary field of prime importance to government supported R D research Discusses the concepts and perspectives in a dynamic field to aid in the successful development of organic electronics Includes applications for energy conservation like photovoltaics and field effect transistors Teeming with applicable information on both molecular design and synthesis as well as the development of smart molecular assemblies for organic electronic systems Supramolecular Soft Matter provides more practical in depth coverage of this rapidly evolving technology than any other book in its field

Material Designs and New Physical Properties in MX- and MMX-Chain Compounds Masahiro Yamashita, Hiroshi Okamoto, 2012-12-13 This is the first book to comprehensively address the recent developments in both the experimental and theoretical aspects of quasi one dimensional halogen bridged mono MX and binuclear metal MMX chain complexes of Pt Pd and Ni These complexes have one dimensional electronic structures which cause the various physical properties as well as

electronic structures In most MX chain complexes the Pt and Pd units are in M II M IV mixed valence or charge density wave CDW states due to electron phonon interactions and Ni compounds are in Ni III averaged valence or Mott Hubbard states due to the on site Coulomb repulsion More recently Pd III Mott Hubbard MH states have been realized in the ground state by using the chemical pressure Pt and Pd chain complexes undergo photo induced phase transitions from CDW to MH or metal states and Ni chain complexes undergo photo induced phase transitions from MH to metal states Ni chain complexes with strong electron correlations show tremendous third order optical nonlinearity and nonlinear electrical conductivities They can be explained theoretically by using the extended Peierls Hubbard model For MMX chain complexes averaged valence CDW charge polarization and alternating charge polarization states have been realized by using chemical modification and external stimuli such as temperature photo irradiation pressure and water vapor All of the electronic structures and phase transitions can be explained theoretically *EMMA-2000* V.G. Baryakhtar, 2001-08-08 European Magnetic Materials and Applications Proceedings of the 8th European Magnetic Materials and Applications Conference Kyiv Ukraine June 7 10 2000

Organic Photochromic and Thermochromic Compounds John C. Crano, Robert J. Guglielmetti, 2006-04-11 This major treatise on photochromism involving organic molecules and derived systems is a result of increased international interest in the field Volume 1 offers a detailed examination of the synthesis and specific photochromic properties of the best known photochromic and thermochromic compounds It includes numerous physico chemical methods by which photochromic substances can be studied as well as practical information and commercial applications for known photochromic families

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