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Review

Magnetic dichroism in atomic core level photoemission

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Abstract. The overview covers selected topics on magnetic dichroism in atomic core level photoemission: the geometrical model in photoionization of laser polarized atoms and its generalization, contributions to the complete experiment from magnetic dichroism studies and nondipole effects in magnetic dichroism.

1 Introduction

The term "dichroism" is generally used to reflect the dependence of photon interaction with a material on the polarization of the photon and on the anisotropy of the material. One speaks about "magnetic" dichroism (MD) when its origin is in the latter. The MD with circularly and linearly polarized radiation is called circular magnetic dichroism (CMD) and linear magnetic dichroism (LMD), respectively. A rapid progress in the VUV and X-ray CMD and LMD studies was stimulated by the advent of new high-brilliance synchrotron radiation (SR) sources with controlled variable polarization. In solids and nanoobjects, MD in photoabsorption near the core level ionization thresholds, accompanied by remarkable theoretical developments, provides valuable information on the element-specific magnetic structure and has become a magnetometry tool (e.g. [1–3] and references therein). In the photoionization region, new aspects of the MD come up associated with a new degree of freedom, namely the escape direction of the photoelectron. Besides, in contrast to photoabsorption, the final wave function is a scattering state, leading to complex amplitudes with non-zero relative phases. These two important points increase the potential of the MD method, in particular an analysis of the CMD and LMD in the angular distribution of the photoelectrons (CMDAD and LMDAD, respectively) becomes possible (e.g. [4–7] and references therein).

Another class of VUV and X-ray MD studies deals with atoms in the gas phase. In practice, the target atom polarization, which is an analogue of magnetization in solid materials, can be induced by photoabsorption, optical laser pumping, or an inhomogeneous external magnetic field. Photoionization of the polarized atoms is an important tool to investigate subtle details of the photoionization dynamics, reaching the stage of a complete quantum mechanical experiment. From another side, as a consequence of the localized character of the core electrons, the atomic picture of core level photoemission can serve as a reasonable first approximation for the photoemission from solid samples and films. Comparison of photoemission from atoms and condensed materials open an access to separate intra-atomic and interatomic effects in the spectra of bound atoms.

The combination of optical laser pumping and intense SR resulted in a breakthrough in investigations of MD in gaseous atomic targets [8–11]. High intensity of the SR permits to decrease the atomic density in the reaction volume and therefore to avoid collisions and radiation trapping, which destroy the target polarization. Furthermore, the energy resolution improved

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Magnetic Dichroism In Corelevel Photoemibion

Robert E. Camley,Zbigniew Celinski,Robert L. Stamps

Magnetic Dichroism In Corelevel Photoemibion:

Magnetic Dichroism in Core-Level Photoemission Kai Starke,2013-10-03 The book is a review of a rapidly developing field in thin film magnetism Between 1990 when magnetic dichroism in core level photoemission MDPE was discovered and today the attitude of scientists in the field has changed from surprise to a full appreciation of the physical basis Special emphasis is laid on the application of MDPE as an element specific magnetization probe for two dimentional rare earth systems *Core Level Spectroscopies for Magnetic Phenomena* Paul S. Bagus,Gianfranco Pacchioni,Fulvio Parmigiani,2013-11-11 For several years core level spectroscopies and other c osely related electron spectroscopies have provided very useful information about the atomic composition the geometric structure and the electronic structure of condensed matter Recently these spectroscopies have also been used for the study of magnetic properties such studies have a great potential to extend our knowledge and understanding of magnetic systems This volume collects the lectures presented at the NATO Advanced Study Institute on Core Level Spectroscopies for Magnetic Phenomena Theory and Experiment held at the Ettore Majorana Centre Erice Sicily on 15 to 26 May 1994 The topics considered at the ASI covered a wide range of subjects involving the use of core level and related spectroscopies to study magnetic phenomena There are a large and growing number of applications of these spectroscopies to the study of magnetic materials an important objective of the ASI was to stimulate further growth The topics covered at the ASI can be placed into three general groups 1 fundamental principles of core level spectroscopies 2 basic aspects of magnetic phenomena and 3 the combination of the two previous topics embodied in applications of the spectroscopies to magnetism In all three groups theoretical interpretations as weH as experimental measurements were presented often both of these aspects were covered in a single lecture or series oflectures The theoretical treatments ofthe spectroscopies as weH as of the magnetic phenomena help to establish a framework for understanding many of the experimental measurements on magnetic materials **Angle and Temperature Dependence of Magnetic Circular Dichroism in Core-level Photoemission from Gd(0001).** ,1997 Magnetic dichroism in core level photoelectron emission from solids represents a promising new element specific probe of surface and interface atomic structure and magnetic order One way of measuring such effects is by using photoelectrons excited by circular polarized radiation thus leading to magnetic circular dichroism MCD if the intensity with right circular polarized RCP light is not equal to that with left circular polarized LCP light The spin integrated photoelectron intensity in a certain emission direction also in general depends on the direction of the magnetization in a magnetic material In fact if the magnetization lies in a surface mirror plane then inverting its direction can provide a second way of measuring MCD Purely atomic theoretical models have been successful in explaining many aspects of such data By varying the emission direction one also probes the geometric structure of the sample But such MCD in photoelectron angular distributions MCDAD then has to be interpreted also in terms of photoelectron diffraction Measuring the temperature dependence of such MCD effects also provides a useful

tool for studying magnetic transition temperatures The authors have here studied such effects in core level emission from Gd 0001 *Magnetism of Surfaces, Interfaces, and Nanoscale Materials* Robert E. Camley,Zbigniew Celinski,Robert L. Stamps,2015-10-27 In the past 30 years magnetic research has been dominated by the question of how surfaces and interfaces influence the magnetic and transport properties of nanostructures thin films and multilayers The research has been particularly important in the magnetic recording industry where the giant magnetoresistance effect led to a new generation of storage devices including hand held memories such as those found in the ipod More recently transfer of spin angular momentum across interfaces has opened a new field for high frequency applications This book gives a comprehensive view of research at the forefront of these fields The frontier is expanding through dynamic exchange between theory and experiment Contributions have been chosen to reflect this giving the reader a unified overview of the topic Addresses both theory and experiment that are vital for gaining an essential understanding of topics at the interface between magnetism and materials science Chapters written by experts provide great insights into complex material Discusses fundamental background material and state of the art applications serving as an indispensable guide for students and professionals at all levels of expertise Stresses interdisciplinary aspects of the field including physics chemistry nanocharacterization and materials science Combines basic materials with applications thus widening the scope of the book and its readership **Electronic and Magnetic Properties of Chiral Molecules and Supramolecular Architectures** Ron Naaman,David N Beratan,David Waldeck,2011-02-15 Time dependent density functional response theory for electronic chiroptical properties of chiral molecules by Jochen Autschbach Lucia Nitsch Velasquez and Mark Rudolph Chiroptical Properties of Charge Transfer Compounds by Yoshihisa Inoue Tadashi Mori G C content independent long range charge transfer through DNA by Tetsuro Majima Induced chirality in porphiryn aggregates the role of weak and strong interactions by Roberto Purrello Vibrational circular dichroism spectroscopy of chiral molecules in solution by Yunjie Xu Magneto electric properties of self assembled monolayers of chiral molecules by Zeev Vager and Ron Naaman Theory of adsorption induced chirality and electron transfer through chiral systems by Spiros Skourtis and David Beratan Chiral selective surface chemistry induced by spin polarized secondary electrons by Richard Rosenberg Compton Scattering Frank Wissmann,2003-12-03 A comprehensive summary of experiments on Compton scattering from the proton and neutron performed at the electron accelerator MAMI The experiments cover a photon energy range from 30 MeV to 500 MeV The reader is introduced to the theoretical concepts of Compton scattering followed by a description of the experiments on the proton their analysis and results **Photoelectron Diffraction in Magnetic Dichroism in Core Level Photoemission** Xingyu Gao,1999 *Core Level Spectroscopy of Solids* Frank de Groot,Akio Kotani,2008-03-10 Core level spectroscopy has become a powerful tool in the study of electronic states in solids From fundamental aspects to the most recent developments Core Level Spectroscopy of Solids presents the theoretical calculations experimental data and underlying physics of x ray

photoemission spectroscopy XPS x ray absorption spectroscopy XAS x Equilibrium Structure and Properties of Surfaces and Interfaces A. Gonis,G.M. Stocks,2012-12-06 It is almost self evident that surface and interface science coupled with the electronic structure of bulk materials playa fundamental role in the understanding of materials properties If one is to have any hope of understanding such properties as catalysis microelectronic devices and contacts wear lubrication resistance to corrosion ductility creep intragranular fracture toughness and strength of steels adhesion of protective oxide scales and the mechanical properties of ceramics one must address a rather complex problem involving a number of fundamental parameters the atomic and electronic structure the energy and chemistry of surface and interface regions diffusion along and across interfaces and the response of an interface to stress The intense need to gain an understanding of the properties of surfaces and interfaces is amply attested to by the large number of conferences and workshops held on surface and interface science Because of this need the fields of surface and interface science have been established in their own right although their development presently lags behind that of general materials science associated with bulk translationally invariant systems There are good reasons to expect this situation to change rather dramatically in the next few years Existing techniques for investigating surfaces and interfaces have reached maturity and are increasingly being applied to systems of practical relevance New techniques are still being created which drastically widen the scope of applicability of surface and interface studies On the experimental side new microscopies are bearing fruit **Surface Microscopy with Low Energy Electrons** Ernst Bauer,2014-07-10 This book written by a pioneer in surface physics and thin film research and the inventor of Low Energy Electron Microscopy LEEM Spin Polarized Low Energy Electron Microscopy SPLEEM and Spectroscopic Photo Emission and Low Energy Electron Microscopy SPELEEM covers these and other techniques for the imaging of surfaces with low energy slow electrons These techniques also include Photoemission Electron Microscopy PEEM X ray Photoemission Electron Microscopy XPEEM and their combination with microdiffraction and microspectroscopy all of which use cathode lenses and slow electrons Of particular interest are the fundamentals and applications of LEEM PEEM and XPEEM because of their widespread use Numerous illustrations illuminate the fundamental aspects of the electron optics the experimental setup and particularly the application results with these instruments Surface Microscopy with Low Energy Electrons will give the reader a unified picture of the imaging diffraction and spectroscopy methods that are possible using low energy electron microscopes **Spin Polarization and Magnetic Dichroism in Core-level Photoemission from Ferromagnets** ,1997 In this thesis we present a theoretical investigation of angle and spin resolved core level photoemission from ferromagnetic Fe and Ni We also consider magneto dichroic effects due to reversal of the photon helicity or reversal of the sample magnetization direction In chapter 1 we provide a brief outline of the history of photoemission and show how it has played an important role in the development of modern physics We then review the basic elements of the theory of core level photoemission and discuss the validity of the some of the commonly used approximations In chapter 2 we present a one

electron theory to calculate spin and angle resolved photoemission spectra for an arbitrary photon polarization The Hamiltonian includes both spin orbit and exchange interactions As test cases for the theory we calculate the spin polarization and magnetic dichroism for the Fe 2p core level and find that agreement with experiment is very good **Photoelectron Spectroscopy** Shigemasa Suga,Akira Sekiyama,Christian Tusche,2021-06-30 This book presents photoelectron spectroscopy as a valuable method for studying the electronic structures of various solid materials in the bulk state on surfaces and at buried interfaces This second edition introduces the advanced technique of high resolution and high efficiency spin and momentum resolved photoelectron spectroscopy using a novel momentum microscope enabling high precision measurements down to a length scale of some tens of nanometers The book also deals with fundamental concepts and approaches to applying this and other complementary techniques such as inverse photoemission photoelectron diffraction scanning tunneling spectroscopy as well as photon spectroscopy based on soft x ray absorption and resonance inelastic soft x ray scattering This book is the ideal tool to expand readers understanding of this marvelously versatile experimental method as well as the electronic structures of metals and insulators *Properties of Complex Inorganic Solids 2* Annemarie Meike,A. Gonis,Patrice E.A. Turchi,Krishna Rajan,2012-12-06 The triennial International Alloy Conferences lACs aim at the identification and promotion of the common elements developed in the study either experimental phenomenological or theoretical and computational of materials properties across materials types from metals to minerals To accomplish this goal the lACs bring together scientists from a wide spectrum of materials science including experiment theory modeling and computation incorporating a broad range of materials properties The first lAC lAC I took place in Athens Greece June 16 21 1996 The present volume of proceedings contains the papers presented at IAC 2 that took place in Davos Switzerland August 8 13 1999 The topics in this book fall into several themes which suggest a number of different classification schemes We have chosen a scheme that classifies the papers in the volume into the categories Microstructural Properties Ordering Kinetics and Diffusion Magnetic Properties and Elastic Properties We have juxtaposed apparently disparate of revealing the dynamic character approaches to similar physical processes in the hope of the processes under consideration We hope this will invigorate new kinds of discussion and reveal challenges and new avenues to the description and prediction of properties of materials in the solid state and the conditions that produce them **Scientific and Technical Aerospace Reports** ,1995 *Advances in Imaging and Electron Physics* ,2000-04-19 Advances in Imaging Electron Physics merges two long running serials Advances in Electronics Electron Physics and Advances in Optical Electron Microscopy The series features extended articles on the physics of electron devices especially semiconductor devices particle optics at high and low energies microlithography image science and digital image processing electromagnetic wave propagation electron microscopy and the computing methods used in all these domains Dynamics at Solid State Surfaces and Interfaces, Volume 1 Uwe Bovensiepen,Hrvoje Petek,Martin Wolf,2010-11-29 This two volume work covers ultrafast structural and electronic dynamics

of elementary processes at solid surfaces and interfaces presenting the current status of photoinduced processes Providing valuable introductory information for newcomers to this booming field of research it investigates concepts and experiments femtosecond and attosecond time resolved methods as well as frequency domain techniques The whole is rounded off by a look at future developments **Applications of Synchrotron Radiation Techniques to Materials Science II: Volume 375** Louis J. Terminello,1995-03-16 Volume I in this series promised that the advent of third generation light sources would enhance synchrotron based materials research This second volume fulfills the promise featuring many experiments that required newer higher brightness sources and could not have been performed with earlier vintage synchrotrons The book focuses on the characterization of reduced dimensional systems and highlights studies of surfaces interfaces polymers glasses thin films magnetic materials metal systems multilayers and electronic materials Topics include thin films magnetic materials surfaces clusters quantum systems and methods interfaces solid solid solid liquid layered compounds alloys and novel materials and microprobe tomography and microscopy **Proceedings of the 11th International Conference on Vacuum Ultraviolet Radiation Physics** T. Miyahara,Y. Azuma,M. Watanabe,T. Ishii,2012-12-02 These volumes contain 365 of the 505 papers presented at the VUV 11 Conference held at Rikkyo University Tokyo from August 27th to September 1st 1995 The papers are divided into three sections atomic and molecular spectroscopy solid state spectroscopy and instrumentation and technological applications New aspects presented were both quantitative and qualitative improvements in fluorescence spectroscopy and magnetic circular dichroism measurements The fluorescence data are complementary to those of photoemission in a sense but they appear to open up a new method to analyze the optical excitation and relaxation processes The application of magnetic circular dichroism has proved to be useful not only in analyzing the electronic structures of magnetic materials but also in practical applications to material engineering as found in experiments combined with photoelectron microscopy Excellent developments in applications are only found in the field of surface photochemistry where the technique of etching using VUV light has been appreciably refined Although the majority of distinctive scientific features in the VUV 11 Conference have been brought about by the application of synchrotron radiation experiments using a different type of light source appear to have progressed steadily This is evident in the studies of plasma radiation

Applications of Synchrotron Radiation Techniques to Materials Science ,1998 **Magnetism and Synchrotron Radiation** E. Beaurepaire,F. Scheurer,G. Krill,J.-P. Kappler,2008-01-11 The aim of this book is to provide both an introduction and a state of the art report on research into magnetism and magnetic materials Particular emphasis has been put on the contribution of synchrotron radiation in relevant experimental investigations Graduate students and nonspecialists will benefit from the tutorial approach while specialists will find the latest results that round off the material presented in the lectures

Unveiling the Magic of Words: A Overview of "**Magnetic Dichroism In Corelevel Photoemibion**"

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