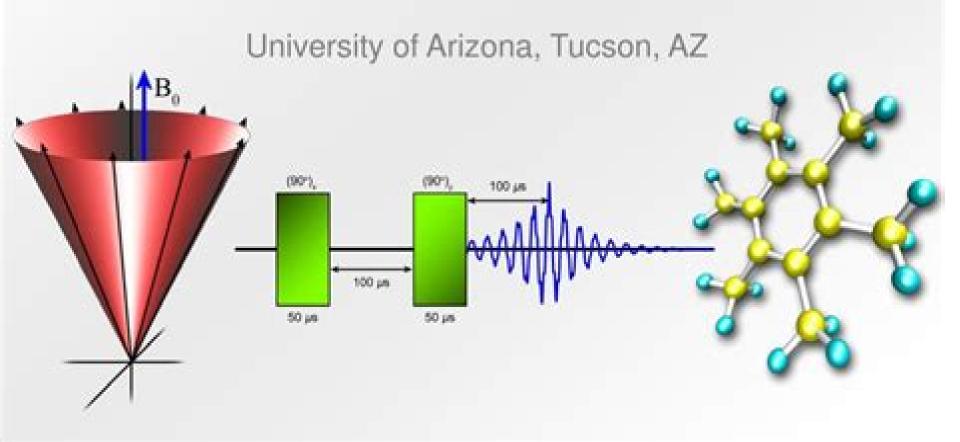
# Solid-state <sup>2</sup>H NMR Spectroscopy for the Undergraduate Physics Laboratory

Jacob J. Kinnun, Avi Leftin, Michael F. Brown



# **Solid State Nmr Spectroscopy**

**Jicheng Xie** 

# **Solid State Nmr Spectroscopy:**

Solid-State NMR David C. Apperley, Robin K. Harris, Paul Hodgkinson, 2012-06-10 The power of nuclear magnetic resonance NMR for characterizing molecules dissolved in solution is widely acknowledged and NMR forms an essential component of undergraduate chemistry degrees However the application of NMR to the solid state is much less well appreciated This text sets out the fundamental principles of solid state NMR explaining how NMR in solids differs from that in solution showing how the various interactions of NMR can be manipulated to yield high resolution spectra and to give information on local structure and dynamics in solids This book aims to take some of the mystique out of solid state NMR by providing a comprehensible discussion of the methodology including the basic concepts and a practical guide to implementation of the experiments A basic knowledge of solution state NMR is assumed and is only briefly covered The text is intended for those in academia and industry expecting to use solid state NMR in their research and looking for an accessible introduction to the field It will also be valuable for non experts interested in learning how NMR can be usefully applied to solid systems Detailed mathematical treatments are delayed to a chapter at the mid point of the text and can be skipped Introductions to experiments and numerical simulations are provided to help link NMR results to experimental practice The different aspects of solid state NMR from basic pulse and acquire experiments to sophisticated techniques for the measurement of anisotropy information are presented Examples illustrate the wide variety of applications of the technique and its complementarity to other solid state characterization techniques such as X ray diffraction Various aspects of NMR crystallography are covered as are topics of motion in solids Modern Methods in Solid-state NMR Paul Hodgkinson, 2018-04-05 Solid state NMR covers an enormous range of material types and experimental techniques Although the basic instrumentation and techniques of solids NMR are readily accessible there can be significant barriers even for existing experts to exploring the bewildering array of more sophisticated techniques In this unique volume a range of experts in different areas of modern solid state NMR explain about their area of expertise emphasising the practical aspects of implementing different techniques and illustrating what questions can and cannot be addressed Later chapters address complex materials showing how different NMR techniques discussed in earlier chapters can be brought together to characterise important materials types The volume as a whole focusses on topics relevant to the developing field of NMR crystallography the use of solids NMR as a complement to diffraction crystallography This book is an ideal complement to existing introductory texts and reviews on solid state NMR New researchers wanting to understand new areas of solid state NMR will find each chapter to be the equivalent to spending time in the laboratory of an internationally leading expert learning the hints and tips that make the difference between knowing about a technique and being ready to put it into action With no equivalent on the market it will be of interest to every solid state NMR researcher academic and postgraduate working in the chemical sciences Solid-State NMR in Materials Science Vladimir I. Bakhmutov, 2016-04-19 Solid state

NMR is a powerful physical method widely applied in modern fundamental and applied science medicine and industry Its role is particularly valuable in materials chemistry due to the capability of solid state NMR to rapidly solve tasks connected with structural descriptions of complex systems on macro and or molecular levels and the i **Multinuclear Solid-State** Nuclear Magnetic Resonance of Inorganic Materials Kenneth J.D. MacKenzie, M.E. Smith, 2002-04-26 Techniques of solid state nuclear magnetic resonance NMR spectroscopy are constantly being extended to a more diverse range of materials pressing into service an ever expanding range of nuclides including some previously considered too intractable to provide usable results At the same time new developments in both hardware and software are being introduced and refined This book covers the most important of these new developments With sections addressed to non specialist researchers providing accessible answers to the most common questions about the theory and practice of NMR asked by novices as well as a more specialised and up to date treatment of the most important areas of inorganic materials research to which NMR has application this book should be useful to NMR users whatever their level of expertise and whatever inorganic materials Solid-State NMR IV Methods and Applications of Solid-State NMR, 2011-12-21 Solid State NMR is a they wish to study branch of Nuclear Magnetic Resonance which is presently experiencing a phase of strongly increasing popularity The most striking evidence is the large number of contributions from Solid State Resonance at NMR meetings approaching that ofliquid state resonance Important progress can be observed in the areas of methodological developments and applications to organic and inorganic matter. One volume devoted to more or less one of each of these areas has been published in the preceding three issues This volume can be considered an addendum to this series Selected methods and applications of Solid State NMR are featured in three chapters The first one treats the recoupling of dipolar interactions in solids which are averaged by fast sample rotation Following an introduction to effective Hamiltonians and Floquet theory different types of experiment such as rotary resonance dipolar chemical shift correlation spectroscopy rotational resonance and multipulse recoupling are treated in the powerful Floquet formalism In the second chapter the different approaches to line narrowing of quadrupolar nuclei are reviewed in a consistent formulation of double resonance DaR and dynamic angle spinning DAS Practical aspects of probe design are considered as well as advanced 2D experiments sensitivity enhancement techniques and spinning sideband manipulations. The use of such techniques dramatically increases the number of nuclei which can be probed in high resolution NMR spectroscopy The final chapter describes new experimental approaches and results of structural studies of noncrystalline solids Multidimensional Solid-State NMR and Polymers Klaus Schmidt-Rohr, Hans Wolfgang Spiess, 2012-12-02 NMR spectroscopy is the most valuable and versatile analytical tool in chemistry While excellent monographs exist on high resolution NMR in liquids and solids this is the first book to address multidimensional solid state NMR Multidimensional techniques enable researchers to obtain detailed information about the structure dynamics orientation and phase separation of solids which provides the basis of a better understanding of materials properties on the

molecular level Dramatic progress much of it pioneered by the authors has been achieved in this area especially in synthetic polymers Solid state NMR now favorably competes with well established techniques such as light x ray or neutron scattering electron microscopy and dielectric and mechanical relaxation The application of multidimensional solid state NMR inevitably involves use of concepts from different fields of science This book also provides the first comprehensive treatment of both the new experimental techniques and the theoretical concepts needed in more complex data analysis. The text addresses spectroscopists and polymer scientists by treating the subject on different levels descriptive technical and mathematical approaches are used when appropriate It presents an overview of new developments with numerous experimental examples and illustrations which will appeal to readers interested in both the information content as well as the potential of solid state NMR The book also contains many previously unpublished details that will be appreciated by those who want to perform the experiments The techniques described are applicable not only to the study of synthetic polymers but to numerous problems in solid state physics chemistry materials science and biophysics Presents original theories and new perspectives on scattering techniques Provides a systematic treatment of the whole subject Gives readers access to previously unpublished material Includes extensive illustrations Solid State NMR Klaus Müller, Marco Geppi, 2021-06-23 Solid State NMR A thorough and comprehensive textbook covering the theoretical background experimental approaches and major applications of solid state NMR spectroscopy Nuclear Magnetic Resonance NMR spectroscopy is a powerful non destructive technique capable of providing information about the molecular structure and dynamics of molecules Alongside solution state NMR a well established technique to study chemical structures and investigate physico chemical properties of molecules in solutions solid state NMR SSNMR offers many exciting possibilities for the analysis of solid and soft materials across scientific fields SSNMR shows unique capabilities for a detailed investigation of structural and dynamic properties of materials over wide space and time ranges For this reason and thanks to significant advances in the past several years the application of SSNMR to materials is rapidly increasing in disciplines such as chemistry physics and materials and life sciences Solid State NMR Principles Methods and Applications offers a systematic introduction to the theory methodological concepts and major experimental methods of SSMR spectroscopy Exploring the unique potential of SSNMR for the structural and dynamic characterization of soft and either amorphous or crystalline solid materials this comprehensive textbook provides foundational knowledge and recent developments of SSNMR covering physical and theoretical background experimental methods and applications to pharmaceuticals polymers inorganic and hybrid materials liquid crystals and model membranes Written by two expert authors to ensure a clear and consistent presentation of the subject this textbook Includes a brief introduction to the historical aspects and broad theoretical background of solid state NMR spectroscopy Provides helpful illustrations to explain the various SSNMR concepts and methods Features accessible descriptive text with self consistent use of quantum mechanics Covers the experimental aspects of SSNMR spectroscopy and in particular a description of many

useful pulse sequences Contains references to relevant literature Solid State NMR Principles Methods and Applications is the ideal textbook for university courses on SSNMR advanced spectroscopies and a valuable single volume reference for New Techniques in Solid-State NMR Jacek spectroscopists chemists and researchers in the field of materials Klinowski, 2004-12-10 With contributions by numerous experts **Current Developments in Solid State NMR Spectroscopy** Norbert Müller, Perunthiruthy K. Madhu, 2013-04-17 Why to apply solid state NMR By now we should have learned that NMR is mainly used for the study of molecules in solution while x ray diffraction is the method of choice for solids Based on this fact the two recent NMR Nobelprizes went indeed into the liquid phase my own one eleven years ago and particularly the most recent one to Kurt Wuthrich His prize is beyond any doubts very well justified His contribution towards the study of biomolecules in solution in their native or almost native environment is truly monumental We all will profit from it indirectly when one of our future diseases will be cured with better drugs based on the insightful knowledge gained through liquid state NMR Two fields of NMR are still left out of the Nobel Prize game magnetic reso nance imaging MRI and solid state NMR The disrespect for MRI in Stockholm is particularly difficult to understand but this is not a subject to be discussed at the present place Solid state NMR is the third of the three great fields of NMR powerful already today and very promising for the near future **Solid State NMR Spectroscopy** Melinda J. Duer, 2008-04-15 This book is for those familiar with solution state NMR who are encountering solid state NMR for the first time It presents the current understanding and applications of solid state NMR with a rigorous but readable approach making it easy for someone who merely wishes to gain an overall impression of the subject without details This dual requirement is met through careful construction of the material within each chapter The book is divided into two parts Fundamentals and Further Applications The section on Fundamentals contains relatively long chapters that deal with the basic theory and practice of solid state NMR The essential differences and extra scope of solid state NMR over solution state is dealt with in an introductory chapter The basic techniques that all chapters rely on are collected into a second chapter to avoid unnecessary repetition later Remaining chapters in the Fundamentals part deal with the major areas of solid state NMR which all solid state NMR spectroscopists should know about Each begins with an overview of the topic that puts the chapter in context The basic principles upon which the techniques in the chapter rely are explained in a separate section Each of these chapters exemplifies the principles and techniques with the applications most commonly found in current practice. The Further Applications section contains a series of shorter chapters which describe the NMR techniques used in other more specific areas The basic principles upon which these techniques rely will be expounded only if not already in the Fundamentals part

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