

# LASER SPECTROSCOPY OF HIGHLY VIBRATIONALLY EXCITED MOLECULES



Edited by V S Letokhov

# Laser Spectroscopy Of Highly Vibrationally Excited Molecules

**Vladilen Stepanovich Letokhov**



## **Laser Spectroscopy Of Highly Vibrationally Excited Molecules:**

*Laser Spectroscopy of Highly Vibrationally Excited Molecules* Vladilen Stepanovich Letokhov, 2021-07-28 Laser spectroscopy has been perfected over the last fifteen years to become a precise tool for the investigation of highly vibrationally excited molecules Intense infrared laser radiation permits both the multiple photon resonant excitation and the dissociation of polyatomic molecules In this book the latest results of some of the foremost Soviet researchers are published for the first time in the West Laser Spectroscopy of Highly Vibrationally Excited Molecules contains a comprehensive study of both the experimental and theoretical aspects of the basic photophysical interactions that occur in these processes The book first focuses on the nonlinear interaction between the resonant vibrational mode and the intense infrared field and then examines the nonlinear interaction between the vibrational modes themselves due to anharmonicity These interrelated processes determine all the characteristics of polyatomic molecules in an infrared field The book also discusses related phenomena such as spectra broadening optical resonance photon echoes and dynamical chaos It includes examples of multiple photon resonant excitation such as the excitation of OsO<sub>4</sub> by CO O<sub>2</sub> laser radiation which is detected by the visible luminescence that results This book will be of great interest to researchers and postgraduate students in infrared laser spectroscopy and the laser chemistry of molecules and applications of isotope separation Laser Spectroscopy of Highly

Vibrationally Excited Molecules Vladilen Stepanovich Letokhov, 2021-07-29 Laser spectroscopy has been perfected over the last fifteen years to become a precise tool for the investigation of highly vibrationally excited molecules Intense infrared laser radiation permits both the multiple photon resonant excitation and the dissociation of polyatomic molecules In this book the latest results of some of the foremost Soviet researchers are published for the first time in the West Laser Spectroscopy of Highly Vibrationally Excited Molecules contains a comprehensive study of both the experimental and theoretical aspects of the basic photophysical interactions that occur in these processes The book first focuses on the nonlinear interaction between the resonant vibrational mode and the intense infrared field and then examines the nonlinear interaction between the vibrational modes themselves due to anharmonicity These interrelated processes determine all the characteristics of polyatomic molecules in an infrared field The book also discusses related phenomena such as spectra broadening optical resonance photon echoes and dynamical chaos It includes examples of multiple photon resonant excitation such as the excitation of OsO<sub>4</sub> by CO O<sub>2</sub> laser radiation which is detected by the visible luminescence that results This book will be of great interest to researchers and postgraduate students in infrared laser spectroscopy and the laser chemistry of molecules and applications of isotope separation **Spectroscopy, Reaction, and Photodissociation in Highly Vibrationally**

**Excited Molecules**, 1991 Highly vibrationally excited molecules often control the course of chemical reactions in the atmosphere combustion plasmas and many other environments The research described in this Progress Report uses laser excitation and interrogation techniques to study and control the dynamics of highly vibrationally excited molecules In

particular they show that it is possible to unravel the details and influence the course of photodissociation and bimolecular reaction The experiments use laser excitation of overtone vibrations to prepare highly vibrationally excited molecules frequently with single quantum state resolution and laser spectroscopy to monitor the subsequent behavior of the excited molecule We have studied the vibrationally mediated photodissociation and the bond and state selected bimolecular reaction of highly vibrationally excited molecules In the first process one photon creates a highly excited molecule a second photon from another laser dissociates it and light from a third laser detects the population of individual product quantum states This approach allows us to explore otherwise inaccessible regions of the ground and excited state potential energy surface and by exciting to the proper regions of the surface to control the breaking of a selected chemical bond In the second process the highly vibrationally excited molecule reacts with an atom formed either in a microwave discharge or by photolysis and another laser interrogates the products We have used this approach to demonstrate mode and bond selected bimolecular reactions in which the initial excitation controls the subsequent chemistry 30 refs 8 figs

**Spectroscopy, Reaction, and Photodissociation in Highly Vibrationally Excited Molecules. Technical Progress Report** ,1991 Highly vibrationally excited molecules often control the course of chemical reactions in the atmosphere combustion plasmas and many other environments The research described in this Progress Report uses laser excitation and interrogation techniques to study and control the dynamics of highly vibrationally excited molecules In particular they show that it is possible to unravel the details and influence the course of photodissociation and bimolecular reaction The experiments use laser excitation of overtone vibrations to prepare highly vibrationally excited molecules frequently with single quantum state resolution and laser spectroscopy to monitor the subsequent behavior of the excited molecule We have studied the vibrationally mediated photodissociation and the bond and state selected bimolecular reaction of highly vibrationally excited molecules In the first process one photon creates a highly excited molecule a second photon from another laser dissociates it and light from a third laser detects the population of individual product quantum states This approach allows us to explore otherwise inaccessible regions of the ground and excited state potential energy surface and by exciting to the proper regions of the surface to control the breaking of a selected chemical bond In the second process the highly vibrationally excited molecule reacts with an atom formed either in a microwave discharge or by photolysis and another laser interrogates the products We have used this approach to demonstrate mode and bond selected bimolecular reactions in which the initial excitation controls the subsequent chemistry 30 refs 8 figs

**Scientific and Technical Aerospace Reports** ,1995 Molecular Reaction Dynamics Raphael D. Levine,2009-06-04 Molecular reaction dynamics is the study of chemical and physical transformations of matter at the molecular level The understanding of how chemical reactions occur and how to control them is fundamental to chemists and interdisciplinary areas such as materials and nanoscience rational drug design environmental and astrochemistry This book provides a thorough foundation to this area The first half is introductory detailing experimental

techniques for initiating and probing reaction dynamics and the essential insights that have been gained The second part explores key areas including photoselective chemistry stereochemistry chemical reactions in real time and chemical reaction dynamics in solutions and interfaces Typical of the new challenges are molecular machines enzyme action and molecular control With problem sets included this book is suitable for advanced undergraduate and graduate students as well as being supplementary to chemical kinetics physical chemistry biophysics and materials science courses and as a primer for practising scientists Energy Research Abstracts, 1994 Research in Progress United States. Army Research Office, 1991 Vols for 1977 consist of two parts Chemistry biological sciences engineering sciences metallurgy and materials science issued in the spring and Physics electronics mathematics geosciences issued in the fall *Research in Progress*, 1991 *Handbook of High-resolution Spectroscopy* Martin Quack, Frederic Merkt, 2011-09-26 The field of High Resolution Spectroscopy has been considerably extended and even redefined in some areas Combining the knowledge of spectroscopy laser technology chemical computation and experiments Handbook of High Resolution Spectroscopy provides a comprehensive survey of the whole field as it presents itself today with emphasis on the recent developments This essential handbook for advanced research students graduate students and researchers takes a systematic approach through the range of wavelengths and includes the latest advances in experiment and theory that will help and guide future applications The first comprehensive survey in high resolution molecular spectroscopy for over 15 years Brings together the knowledge of spectroscopy laser technology chemical computation and experiments Brings the reader up to date with the many advances that have been made in recent times Takes the reader through the range of wavelengths covering all possible techniques such as Microwave Spectroscopy Infrared Spectroscopy Raman Spectroscopy VIS UV and VUV Combines theoretical computational and experimental aspects Has numerous applications in a wide range of scientific domains Edited by two leaders in this field Provides an overview of rotational vibration electronic and photoelectron spectroscopy Volume 1 Introduction Fundamentals of Molecular Spectroscopy Volume 2 High Resolution Molecular Spectroscopy Methods and Results Volume 3 Special Methods Applications *Encyclopedia of Chemical Physics and Physical Chemistry* John H. Moore, Nicholas D. Spencer, 2023-07-03 The Encyclopedia of Physical Chemistry and Chemical Physics introduces possibly unfamiliar areas explains important experimental and computational techniques and describes modern endeavors The encyclopedia quickly provides the basics defines the scope of each subdiscipline and indicates where to go for a more complete and detailed explanation Particular attention has been paid to symbols and abbreviations to make this a user friendly encyclopedia Care has been taken to ensure that the reading level is suitable for the trained chemist or physicist The encyclopedia is divided in three major sections FUNDAMENTALS the mechanics of atoms and molecules and their interactions the macroscopic and statistical description of systems at equilibrium and the basic ways of treating reacting systems The contributions in this section assume a somewhat less sophisticated audience than the two subsequent sections

At least a portion of each article inevitably covers material that might also be found in a modern undergraduate physical chemistry text METHODS the instrumentation and fundamental theory employed in the major spectroscopic techniques the experimental means for characterizing materials the instrumentation and basic theory employed in the study of chemical kinetics and the computational techniques used to predict the static and dynamic properties of materials APPLICATIONS specific topics of current interest and intensive research For the practicing physicist or chemist this encyclopedia is the place to start when confronted with a new problem or when the techniques of an unfamiliar area might be exploited For a graduate student in chemistry or physics the encyclopedia gives a synopsis of the basics and an overview of the range of activities in which physical principles are applied to chemical problems It will lead any of these groups to the salient points of a new field as rapidly as possible and gives pointers as to where to read about the topic in more detail

*14th Symposium on High-Resolution Molecular Spectroscopy* Leonid Nikiforovich Sinit'skiĭ, 2004 Proceedings of SPIE present the original research papers presented at SPIE conferences and other high quality conferences in the broad ranging fields of optics and photonics These books provide prompt access to the latest innovations in research and technology in their respective fields Proceedings of SPIE are among the most cited references in patent literature

**Chemical and Biochemical Applications of Lasers V3** C. Bradley Moore, 2012-12-02 Chemical and Biochemical Applications of Lasers Volume III presents the fundamental principles and methods of selective photophysical and photochemical processes The book discusses isotopic separations and related research for each eight classes of laser methods and their applications in chemistry biology and materials science The experimental results on multiphoton infrared processes and their theoretical interpretation are likewise thoroughly discussed and described Organic and inorganic chemists physical chemists and optical physicists will find the text a valuable reference material

**Laser Spectroscopy** Wolfgang Demtröder, 2013-06-29 Keeping abreast of the latest techniques and applications this new edition of the standard reference and graduate text on laser spectroscopy has been completely revised and expanded While the general concept is unchanged the new edition features a broad array of new material e g frequency doubling in external cavities reliable cw parametric oscillators tunable narrow band UV sources more sensitive detection techniques tunable femtosecond and sub femtosecond lasers X ray region and the attosecond range control of atomic and molecular excitations frequency combs able to synchronize independent femtosecond lasers coherent matter waves and still more applications in chemical analysis medical diagnostics and engineering

*Progress in Fourier Transform Spectroscopy* Janos Mink, Gabor Keresztury, Robert Kellner, 2013-11-11 19 plenary lectures and 203 poster papers presented at the 10th International Conference of Fourier Transform Spectroscopy in Budapest 1995 give an overview on the state of the art of this technology and its wide range of applications The reader will get information on any aspects of FTS including the latest instrumental developments e g in diode array detection time resolution FTS microscopy and spectral mapping double modulation and two dimensional FTS

Gas-Phase IR Spectroscopy and Structure of Biological Molecules

Anouk M. Rijs, Jos Oomens, 2015-06-03 The series Topics in Current Chemistry presents critical reviews of the present and future trends in modern chemical research The scope of coverage is all areas of chemical science including the interfaces with related disciplines such as biology medicine and materials science The goal of each thematic volume is to give the non specialist reader whether in academia or industry a comprehensive insight into an area where new research is emerging which is of interest to a larger scientific audience Each review within the volume critically surveys one aspect of that topic and places it within the context of the volume as a whole The most significant developments of the last 5 to 10 years are presented using selected examples to illustrate the principles discussed The coverage is not intended to be an exhaustive summary of the field or include large quantities of data but should rather be conceptual concentrating on the methodological thinking that will allow the non specialist reader to understand the information presented Contributions also offer an outlook on potential future developments in the field Review articles for the individual volumes are invited by the volume editors Readership research chemists at universities or in industry graduate students

Isotope Effects In Chemistry and Biology

Amnon Kohen, Hans-Heinrich Limbach, 2005-11-01 The field of isotope effects has expanded exponentially in the last decade and researchers are finding isotopes increasingly useful in their studies Bringing literature on the subject up to date Isotope Effects in Chemistry and Biology covers current principles methods and a broad range of applications of isotope effects in the physical biolo

**Global and Accurate Vibration Hamiltonians from High-Resolution Molecular Spectroscopy**

Michel Herman, Jacques Lievin, Jean Vander Auwera, Alain Campargue, 2009-09-09 The latest in a series providing chemical physicists with a forum for critical authoritative evaluations of advances in every area of the discipline this stand alone volume focuses on using high resolution molecular spectroscopy to arrive at global and accurate Vibration Hamiltonians

High Energy Chemistry, 1998

**Photodissociation Dynamics** Reinhard Schinke, 1995-05-11 Photodissociation

induced by the absorption of single photons permits the detailed study of molecular dynamics such as the breaking of bonds internal energy transfer and radiationless transitions The availability of powerful lasers operating over a wide frequency range has stimulated rapid development of new experimental techniques which make it possible to analyse photodissociation processes in unprecedented detail This text elucidates the achievements in calculating photodissociation cross sections and fragment state distributions from first principles starting from multi dimensional potential energy surfaces and the Schrödinger equation of nuclear motion Following an extended introduction in which the various types of observables are outlined the book summarises the basic theoretical tools namely the time independent and the time dependent quantum mechanical approaches as well as the classical picture of photodissociation The discussions of absorption spectra diffuse vibrational structures the vibrational and rotational state distributions of the photofragments form the core of the book More specific topics such as the dissociation of vibrationally excited molecules emission during dissociation or nonadiabatic effects are also discussed It will be of interest to graduate students and senior scientists working in molecular physics spectroscopy

molecular collisions and molecular kinetics

The book delves into Laser Spectroscopy Of Highly Vibrationally Excited Molecules. Laser Spectroscopy Of Highly Vibrationally Excited Molecules is a crucial topic that must be grasped by everyone, from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Laser Spectroscopy Of Highly Vibrationally Excited Molecules, encompassing both the fundamentals and more intricate discussions.

1. This book is structured into several chapters, namely:
    - Chapter 1: Introduction to Laser Spectroscopy Of Highly Vibrationally Excited Molecules
    - Chapter 2: Essential Elements of Laser Spectroscopy Of Highly Vibrationally Excited Molecules
    - Chapter 3: Laser Spectroscopy Of Highly Vibrationally Excited Molecules in Everyday Life
    - Chapter 4: Laser Spectroscopy Of Highly Vibrationally Excited Molecules in Specific Contexts
    - Chapter 5: Conclusion
  2. In chapter 1, this book will provide an overview of Laser Spectroscopy Of Highly Vibrationally Excited Molecules. This chapter will explore what Laser Spectroscopy Of Highly Vibrationally Excited Molecules is, why Laser Spectroscopy Of Highly Vibrationally Excited Molecules is vital, and how to effectively learn about Laser Spectroscopy Of Highly Vibrationally Excited Molecules.
  3. In chapter 2, the author will delve into the foundational concepts of Laser Spectroscopy Of Highly Vibrationally Excited Molecules. This chapter will elucidate the essential principles that need to be understood to grasp Laser Spectroscopy Of Highly Vibrationally Excited Molecules in its entirety.
  4. In chapter 3, the author will examine the practical applications of Laser Spectroscopy Of Highly Vibrationally Excited Molecules in daily life. The third chapter will showcase real-world examples of how Laser Spectroscopy Of Highly Vibrationally Excited Molecules can be effectively utilized in everyday scenarios.
  5. In chapter 4, the author will scrutinize the relevance of Laser Spectroscopy Of Highly Vibrationally Excited Molecules in specific contexts. This chapter will explore how Laser Spectroscopy Of Highly Vibrationally Excited Molecules is applied in specialized fields, such as education, business, and technology.
  6. In chapter 5, this book will draw a conclusion about Laser Spectroscopy Of Highly Vibrationally Excited Molecules. This chapter will summarize the key points that have been discussed throughout the book.
- This book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Laser Spectroscopy Of Highly Vibrationally Excited Molecules.

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## **Laser Spectroscopy Of Highly Vibrationally Excited Molecules Introduction**

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