Contents

Part I	Biological Systems	
Protein Dy By T.G. S	rnamics From UV Resonance Raman Spectroscopy piro, K. Rodgers, and C. Su	3
Ultrafast In By R. Dille M. Sarisky	nfrared Spectroscopic Studies of Protein Dynamics er, M. Iannone, B. Cowen, S. Maiti, J. Owrutsky, M. Li, Y. Y.R. Kim, R.B. Locke, T. Lian, and R.M. Hochstrasser gures)	6
Time-Reso Dynamics By T. Kita	lved Resonance Raman Investigation of Photodissociation of Liganded Hemoglobin and Myoglobin gawa, Y. Sakan, S. Kaminaka, T. Ogura, M. Nagai, da-Saito	10
of Photodis	lved Resonance Raman Study ssociated Oxy-Myoglobin and Carbonmonoxy-Myoglobin an, T. Ogura, and T. Kitagawa	14
and Fast St	leasurements of Energy Flow, Geminate Recombination, ructural Rearrangements in Photoexcited Heme Proteins (le, Jr., H. Zhu, X. Xu, and J.B. Hopkins (With 2 Figures)	16
Intermediat with Oxyge	es Formed in the Reaction of Cytochrome c Oxidase	
(With 2 Fig	Infrared Study of Carbonmonoxy Cytochrome c Oxidase:	20
Ligand Trai By K.A. Pe	nsfer Dynamics and Binding Orientations sterson, P.O. Stoutland, R.B. Dyer, and W.H. Woodruff sures)	24
Dioxygen C Revealed by By T. Ogur	Chemistry of Cytochrome Oxidase y Time-Resolved Resonance Raman Spectroscopy a, S. Takahashi, K. Shinzawa-Itoh, S. Yoshikawa,	
and T. Kita	gawa	28

VII



Observation of the O-O Stretching Resonance Raman Band for Cytochrome P-450 _{cam} Under Catalytic Conditions By T. Egawa, T. Ogura, R. Makino, Y. Ishimura, and T. Kitagawa	30
Rapid Mixing Resonance Raman Spectroscopy of Peroxidase Intermediates By V. Palaniappan, M.M. Fitzgerald, A.M. Sullivan, J.R. Shifflett, and J. Terner (With 2 Figures)	32
Picosecond Time-Resolved Vibrational Spectroscopy By G.H. Atkinson	36
Picosecond Time-Resolved Resonance Raman Anti-Stokes Spectroscopy: Vibrationally-Excited Populations in the Bacteriorhodopsin Photocycle By T.L. Brack and G.H. Atkinson	41
Picosecond Time-Resolved Spectroscopy of Artificial Bacteriorhodopsin Pigments By T.L. Brack, W. Gärtner, M. Sheves, M. Ottolenghi, and G.H. Atkinson	43
Picosecond Time-Resolved Resonance Raman Spectroscopy of Bacteriorhodopsin: Structure and Kinetics of the J, K, and KL Intermediates By S.J. Doig, P.J. Reid, and R.A. Mathies (With 3 Figures)	45
Structural Variety of Bacteriorhodopsin By I. Harada, T. Yamagishi, K. Uchida, S. Hashimoto, H. Takeuchi, and F. Tokunaga (With 3 Figures)	49
Time-Resolved Resonance Raman Studies on Bacteriorhodopsin – Implications for Chromophore/Protein Interaction By R. Lohrmann and M. Stockburger (With 2 Figures)	53
Chromophore and Protein Reactions of Bacteriorhodopsin Studied by Sub-Microsecond Time-Resolved Step-Scan FTIR Spectroscopy By K. Noelker, O. Weidlich, and F. Siebert (With 2 Figures)	57
Time-Resolved FTIR Studies on Bacteriorhodopsin By K. Gerwert (With 5 Figures)	61
FTIR-TRS Studies of the Influence of pH on BR Photocycle By Xinyao Hu, Yanying Pi, Suqin Sun, and Weiqin Lu (With 6 Figures)	65
Low Temperature FTIR Studies on the Photointermediates L, M, and N of Bacteriorhodopsin	-•
By A. Maeda, JM. Pfefferlé, J. Sasaki, Y. Shichida,	

By Y. Koyama	70
Vibrational Spectroscopy of Excited Electronic States in Carotenoids in vivo: Picosecond Time-Resolved Resonance Raman Scattering By H. Hayashi, T. Noguchi, M. Tasumi, and G.H. Atkinson (With 2 Figures)	74
Vibrational Relaxation in Carotenoids in vivo and in vitro: Picosecond Time-Resolved Anti-Stokes Resonance Raman Spectroscopy By H. Hayashi, T. Brack, T. Noguchi, M. Tasumi, and G.H. Atkinson (With 2 Figures)	76
Time-Resolved FTIR Difference Spectroscopy of Photosynthetic Bacterial Reaction Centers By D.L. Thibodeau, E. Nabedryk, R. Hienerwadel, F. Lenz, W. Mäntele, and J. Breton (With 3 Figures)	79
Time-Resolved Vibrational Analysis of Quinone Binding and Interaction in the Electron Transfer of Bacterial Photosynthetic Reaction Centers By R. Hienerwadel, D. Thibodeau, F. Lenz, J. Breton, E. Nabedryk, W. Kreutz, and W. Mäntele (With 2 Figures)	83
Part II Metal Complex and Organometallic Systems	
Fast and Ultrafast Processes in Organometallic Chemistry By J.J. Turner (With 1 Figure)	89
Femtosecond Infrared Spectroscopy: The Condensed Phase Photochemistry of Metal Carbonyl Dimers By T. Lian, B. Locke, M. Iannone, and R.M. Hochstrasser (With 2 Figures)	93
Excited States of Metalloporphyrin Photosensitizers By R.E. Hester (With 2 Figures)	96
Rate of Translation of a Ligand Molecule Along a DNA-Duplex Chain By G.D. Strahan, D. Lu, M. Tsuboi, and K. Nakamoto (With 3 Figures)	100
Resonance Raman and CARS Investigations of Short-Living Transients n Metalloporphyrin Solutions By P.A. Apanasevich, S.G. Kruglik, V.V. Kvach, and V.A. Orlovich With 2 Figures)	105
Fime-Resolved Resonance Raman Spectra of Photoreduction intermediates of Iron(III)-Octaethylporphyrin Complex	109
, , , , , , , , , , , , , , , , , , , ,	. 07

in the Excited Triplet State By M. Asano, S. Sato, and T. Kitagawa	111
Time-Resolved Resonance Raman Spectroscopy of the Excited States of Ru(II) Complexes with Novel Polynucleating Ligands By S.E.J. Bell, K.C. Gordon, J.J. McGarvey, D.I.C. Martin, A. Kirsch-de Mesmaeker, and JP. Lecomte (With 1 Figure)	113
Resonance Raman Spectra of the ³ MLCT Excited States of Ruthenium Complexes with Asymmetric Ligands By G.D. Danzer and J.R. Kincaid (With 2 Figures)	117
Time-Resolved Resonance Raman Spectral Analysis of Ruthenium Tris(bipyridine) Excited State: Revisited By S. Umapathy and R.E. Hester	121
Part III Photochemical Reactions	
Photochemical Ring Openings are Complete in Picoseconds: A Time-Resolved UV Resonance Raman Study By P.J. Reid, S.J. Doig, and R.A. Mathies (With 2 Figures)	125
Combined Transient Absorption and Resonance Raman Studies of the Photoreduction of 2,2'-Bipyridine by 1,4-Diazabicyclo(2.2.2)octane (DABCO) in Acetonitrile By B. Bayri, G. Buntinx, O. Poizat, P. Valat, and V. Wintgens (With 3 Figures)	127
Solvent Effects on the Structures and Dynamics of the T ₁ State and Radical Anion of Benzil Investigated by Time-Resolved Resonance Raman Spectroscopy By K. Ebihara, H. Hiura, and H. Takahashi (With 2 Figures)	131
Structures and Dynamics of Transient Species of Diphenylacetylene from Time-Resolved Resonance Raman Spectroscopy By H. Hiura, H. Yoneda, and H. Takahashi (With 2 Figures)	134
Transient Raman Spectra and Structure of Chloranil in T ₁ Chloranil-Alkylbenzene Complexes By T. Tahara and H. Hamaguchi (With 2 Figures)	137
Time-Resolved Infrared Study of the Photoinduced Energy Transfer Process in the Phthalocyanine-Aromatic Amine System By C. Kato and H. Hamaguchi (With 2 Figures)	139
Transient Resonance CARS Study on Photoionization of Shorter Diphenylpolyenes in Various Polar Solvents By T. Kamisuki, T. Dudev, and C. Hirose (With 1 Figure)	141

Raman Scattering Study on Monocation Radical Formation Processes of Heptyl Viologen at Silver Electrode Surfaces By Y. Mineo, K. Shibasaki, N. Yamasawa, and K. Itoh (With 5 Figures)	145
Development of Infrared Diode Laser Kinetic Spectroscopy and Its Applications to Chemical Reactions By E. Hirota	150
Part IV Transient Species	
The Potential Energy Surface of the T ₁ State of 1,3,5-Hexatrienes and Methylated Derivatives: A Survey of Present Knowledge By R. Wilbrandt, S. Møller, F.W. Langkilde, A.M. Brouwer, F. Negri, and G. Orlandi (With 4 Figures)	155
Transient Raman Study of the Low-Lying Singlet Manifold (S ₁ and S ₂) of Biphenyl By Y. Sasaki, Y. Koike, and H. Hamaguchi (With 2 Figures)	159
Resonance Raman Spectra and Excited States of Psoralen and Coumarin By K. Tamagake, M. Tsuboi, and K. Nakamoto (With 2 Figures)	161
Raman Spectra and Normal Coordinate Analysis of Radical Ions of trans-Stilbene and Some Ring-Fluorinated Derivatives By S. Schneider (With 1 Figure)	163
Resonance Raman Spectroscopic Studies of Organic Radical Ions By M. Aoyagi, M. Ata, Y. Gondo, H. Kihara, Y. Kubozono, and H. Ujita	167
Transient Infrared Spectroscopy of Photochromic Spiropyran-Photomerocyanine Systems in Solution By T. Yuzawa, H. Takahashi, C. Kato, and H. Hamaguchi (With 2 Figures)	167 169
Structures of Spiropyranic Photomerocyanines Investigated by Time-Resolved Resonance Raman Spectroscopy	171
Raman Spectroscopic Studies of Long-Lived Colored Merocyanine Conformers in the Aggregates: A Poor-Man's Time-Resolved Study By Y. Onai, M. Mamiya, M. Kobayashi, H. Shinohara, and H. Sato	174
Time-Dependent SERS Study: An Implication of SERS Mechanism	174

Functions, and Conformations of 2-Cyclopenten-1-one, Propanal, and Propynal in the $S_1(n,\pi^*)$ Electronic Excited State By C.M. Cheatham and J. Laane (With 4 Figures)	
Part V Excited State Dynamics	
Ultrafast Laser Photolysis Studies on Photoinduced Electron Transfer and Related Relaxation Phenomena By N. Mataga	185
Iodine Kinetic Energy: A Monitor for Dynamics of and Structure of Radicals Produced in the Photodissociation of Organic Iodides By H.J. Hwang, J. Freitas, and M.A. El-Sayed (With 3 Figures)	189
Vibrational Mode Dynamics of Photocyclization in cis-Stilbene and Its Related Compounds By K. Yoshihara, H. Petek, Y. Fujiwara, J.H. Penn, and J.H. Frederick (With 4 Figures)	194
Spectroscopy and Dynamics of a Model Polyene Decatetraene: A Study of Non-Radiative Pathways in S ₁ and S ₂ States Under Isolated Conditions By H. Petek, A.J. Bell, H. Kandori, K. Yoshihara, and R.L. Christensen (With 1 Figure)	198
Solvent/Solute Interactions: Mode Specific, Solvent Dependent Dynamics Observed Using Picosecond Transient Raman Spectroscopy By T.L. Gustafson, K. Iwata, L.A. Huston, and W.L. Weaver (With 2 Figures)	200
Time Dependence of the Depolarization Ratio in Picosecond Time-Resolved Raman Spectroscopy: Effect of Reorientation By K. Iwata, L.A. Huston, W.L. Weaver, and T.L. Gustafson (With 1 Figure)	204
Raman Band Shapes and Vibrational Dynamics of Electronically Excited Molecules in Solution By H. Hamaguchi (With 2 Figures)	206
Ultraslow and Ultrafast Time-Resolved Resonance Raman Spectra of cis-Stilbene Photoproducts By D.L. Phillips, JM. Rodier, and A.B. Myers (With 4 Figures)	209
Resonance Raman Studies of CH ₃ I Sub-Picosecond Mode-Specific Photodissociation and Radiation-Induced Pure Dephasing Effects By L.D. Ziegler (With 1 Figure)	214
Dy D.D. Diegiei (With I Figure)	214

in the Methyl Radical Rydberg 3s State By S.G. Westre, L.D. Ziegler, and P.B. Kelly (With 1 Figure)	218
Part VI Vibrational Dynamics	
Intramolecular Vibrational Redistribution (IVR) of Jet-Cooled Alkylphenols and Alkylanilines as Revealed by Stimulated Emission Ion Dip Spectroscopy By M. Ito and T. Ebata (With 2 Figures)	223
The Influence of a Nearly Free Methyl Rotor on the Dynamics of Vibrational Predissociation and IVR By ZQ. Zhao and C.S. Parmenter	227
Femtosecond Time-Resolved CARS: Time Domain Observation of Molecular Vibrational Dynamics By H. Okamoto and K. Yoshihara (With 2 Figures)	231
Femtosecond Time-Resolved CARS from Acetonitrile and Solvent Effects on the Vibrational Dephasing of the C≡N Stretching Band By R. Inaba, H. Okamoto, K. Yoshihara, and M. Tasumi (With 1 Figure)	235
Vibrational Relaxation of Very Highly Excited Azulene: Collisional Transition Probabilities in the Quasi-Continuous Energy Range By U. Hold, T. Lenzer, K. Luther, and A. Symonds (With 2 Figures)	237
Picosecond Infrared Studies of Intramolecular Vibrational Energy Transfer By S.A. Angel, J.C. Stephenson, and E.J. Heilweil (With 5 Figures)	239
Time-Resolved Infrared Spectroscopy of Organic Molecules By H.J. Bakker and A. Lagendijk (With 3 Figures)	243
SEP-LIF Spectra of Some Molecules and van der Waals Molecules in a Molecular Beam By M. Takayanagi and I. Hanazaki (With 1 Figure)	245
Femtosecond Optical Kerr Study of β -Carotene Solutions By S. Califano, P. Foggi, V.F. Kamalov, R. Righini, and R. Torre (With 1 Figure)	247
Part VII Dynamics in Solids, Aggregates, and Liquid Crystals	
The Effect of Diagonal and Off-Diagonal Disorder on Optical Properties of Molecular Aggregates By D.A. Wiersma, H. Fidder, J. Terpstra, and J. Knoester (With 4 Figures)	251

Interferometric Coherent Raman Spectroscopies with Incoherent Light: Time and Frequency Resolution via Radiation-Matter Oscillations By M.A. Dugan and A.C. Albrecht	291
Part VIII Theoretical Aspects	
Photophysics of Fullerenes: C60 and C70 By T.W. Ebbesen, K. Tanigaki, S. Kuroshima, H. Hiura, and H. Takahashi (With 4 Figures)	284
Critical Speeding-up of the Fluorescence Lifetime near the Structural Phase Transitions By T. Shigenari, K. Abe, Y. Ino, K. Morita, and E. Kojima (With 2 Figures)	282
1D and 2D Time-Resolved FT-IR Studies of Liquid Crystal Reorientation Dynamics By H. Toriumi	280
Time-Resolved Infrared Study of Electric-Field-Induced Reorientation of Nematic Liquid Crystal Molecules By T. Urano, M. Sakamoto, and H. Hamaguchi (With 2 Figures)	278
Dephasing Decay of the Vibrons in $Ar_x(N_2)_{1-x}$ Mixed Crystals By J. De Kinder, E. Goovaerts, A. Bouwen, and D. Schoemaker (With 1 Figure)	276
LO-Phonon Dephasing in Semi-Insulating and n-Type GaAs By F. Vallée, F. Bogani, and C. Flytzanis (With 2 Figures)	272
Quantum Beats of Biphonons in Disordered NH ₄ Cl By F. Vallée (With 1 Figure)	270
The Tunneling Kinetics of NH ₃ D ⁺ Salts By H.L. Strauss, W. Burrows, HG. Cho, and J.E. Weier (With 5 Figures)	266
Femtosecond Time-Resolved Observation of Soft Mode Dynamics in Ferroelectric Crystals By G.P. Wiederrecht, T.P. Dougherty, M.H. Garrett, and K.A. Nelson (With 3 Figures)	262
Ultrafast Relaxation Dynamics of a Single-Crystal Polydiacetylene, PDA-DFMP By S.D. Halle, M. Yoshizawa, H. Matsuda, S. Okada, H. Nakanishi, and T. Kobayashi (With 2 Figures)	260
Ultrafast Geometrical Relaxation Induced by Electron-Phonon Interaction in Conjugated Polymers By T. Kobayashi (With 4 Figures)	256

Simulation of the Ultrafast Optical Response of Water By L.E. Fried and S. Mukamel (With 4 Figures)
Vibrational Wave Packet Dynamics of Diatomic Molecules Under Intense Ultra-Short Laser Pulses By M. Sugawara and Y. Fujimura (With 2 Figures)
Theoretical Treatment of Low-Frequency Motions in Excited State Molecules By J.H. Frederick and J.E. Hadder (With 1 Figure)
Ultrafast Hole Burning in a Strongly-Coupled Localized-Electron-Phonon System By M. Hama and M. Aihara (With 2 Figures)
Time Behavior of Raman Scattering Under Pulsed Light Excitation By T. Kushida and S. Kinoshita (With 1 Figure)
Dynamical Effects on Ultrashort Time-Resolved Nonlinear Coherent Scattering from Molecules in Condensed Phases By Y. Fujimura (With 1 Figure)
Effects of Intermolecular Vibrational Dephasing on Time-Resolved Coherent Anti-Stokes Raman Scattering from Molecules in Liquids By M. Hayashi, M. Sugawara, and Y. Fujimura
Theory of Inhomogeneous Gaussian Broadening of Resonance Raman and Coherent Anti-Stokes Raman Scattering Excitation Profiles for Polyatomic Molecules in Solution By M.G. Zakaraya
Femtosecond Time-Resolved Resonance CARS Spectroscopy: Theory By V.F. Kamalov and Y.P. Svirko (With 1 Figure)
Part IX Innovative Methods/Techniques
Consideration About Optimal Conditions for Backward Scattering Signals in Four-Wave-Mixing Techniques By A. Lau, M. Pfeiffer, and W. Werncke (With 4 Figures)
Molecular Ion Vibrational Spectroscopy by a Time-Resolved REMPI Threshold Photoelectron Technique By M. Takahashi and K. Kimura (With 5 Figures)
Two-Dimensional Infrared (2D IR) Spectroscopy Based on a Time-Resolved IR Measurement By I. Noda, A.E. Dowrey, and C. Marcott (With 3 Figures)

Novel Asynchronous Time-Resolved Fourier Transform IR Spectroscopy By K. Masutani, A. Yokota, Y. Furukawa, and M. Tasumi	
(With 2 Figures)	335
Index of Contributors	337