



## Teizo KITAGAWA

### Structural Chemistry of Allosteric Effects Involved in Heme Proteins

**Birth;** September , 1940, Japanese

**Education;** Ph. D. in Chemistry (1969) from Osaka University

#### Professional

- 1966.4 – 1979.3 Assistant professor, Institute for Protein Research, Osaka Univ.  
1979.4 – 1983.3 Associate Professor, Medical School of Osaka University  
1983.4 – 2000.3 Professor at Institute for Molecular Science  
1985.4 – 1986.3 Adjunct Professor, Tokyo Institute of Technology  
1992.4 – 2005.3 Department head, Institute for Molecular Science  
1999.4 – 2000.3 Professor, Institute for Basic Biology, Okazaki National Institutes  
2000.4 – 2006.3 Professor, Okazaki Institute for Integrative Bioscience, National  
Institutes of Natural Sciences  
2001.4 – 2002.3 Adjunct Professor, Tohoku University  
2003.4 – 2005.3 Director, Okazaki Institute for Integrative Bioscience  
2003.4 – 2005.3 Adjunct Professor, Kyushu University  
2006.3 –  
Emeritus Professor, Institute for Molecular Science, National  
Institutes of Natural Sciences  
2006.4 – Present Fellow, Toyota Physical and Chemical Research Institute  
2007.2 – Present Professor, Picobiology Institute, Graduate School of Life Science,  
University of Hyogo  
2008.4 – present Fellow of the Chemical Society of Japan  
2005.10 – 2008.9 Member of the Science Council of Japan, vice-chairman of  
Chemistry Sub-committee, Chairman of IUPAC sub-committee  
2008.10 – 2011.9 Associate Member of the Science Council of Japan

## Personal Activities

### Honors:

- 2002.3 **The Chemical Society of Japan Award**  
'Investigation of Structure and Dynamics of Heme Proteins by Using Time-resolved Resonance Raman Spectroscopy'
- 1996.5 **Science Award of the Spectroscopic Society of Japan**  
'Investigation of Structural Chemistry of Biomolecules by Using Vibrational Spectroscopy'
- 1988.3 **The Chemical Society of Japan Award for Creative Work**  
'Elucidation of Microscopic Structures of Active Site in Heme Proteins by Using Resonance Raman Spectroscopy'
2012. 2 **Mizushima-Raman Lectureship Award** of JSPS/DST
2012. 7 **Eraldo Antonini Award for Lifetime Contributions to the Understanding of Hemes**, 7<sup>th</sup> International Conference on Porphyrins and Phthalocyanines
2012. 11 **AsBIC Outstanding Achievement Award**, 6<sup>th</sup> Asian Biological Inorganic Chemistry Conference.

### Social Activities and Services for Scientific Societies

#### Editorial Work for Journals

- Journal of Physical Chemistry : Advisory Board (1993-1997).
- Chemical Physics : Advisory Board (1993-).
- Journal of Molecular Liquids: , Editorial Board (1993 - 2009).
- Asian Journal of Physics: Advisory Board (1991-).
- J. Polymer Science, Biospectroscop: Editorial Board (1993-).
- Journal of Raman Spectroscopy: Advisory Board (1995-).
- Journal of Biological Inorganic Chemistry: Advisory Board (1995-1997).
- Journal of Biological Inorganic Chemistry: Editorial Board (1999-2002).
- Journal of Inorganic Biochemistry: Editorial Board (2001-2004).
- Chemistry Letters: Editorial Staff Member (2003-2004).
- Bulletin of Chemical Society of Japan: Advisory Board (2005-).

## **Officers of Scientific Societies and Committee Members**

International Union of Pure and Applied Chemistry: Associate Member of Commission on Biophysical Chemistry (1996.1-1997.1)

Society of Biological Inorganic Chemistry: Council Member (2001.10~2005.9).

Councilor of the Spectroscopic Society of Japan (1987- )

Chairman of Selection Committee of The Chemical Society Award (1999).

Councilor of the Biochemical Society of Japan (1999- )

Director of the Chemical Society of Japan (2002-2003).

Vicepresident of the Chemical Society of Japan (2003-2004)

Fellow of the Chemical Society of Japan (2008- )

Inspector of the Chemical Society of Japan (2009-2010)

Member of the Science Council of Japan (2005.10 – 2008.9)

Vice-chairman of Chemistry Division Subcommittee, Chairman of IUPAC

Subcommittee, and Chairman of Physical chemistry and Biophysical chemistry

Division Subcommittee

Associate Member of the Science Council of Japan (2008.0 - ) Chairman

of Physical chemistry and Biophysical chemistry Division Subcommittee.

Honorary Member of the Spectroscopic Society of Japan (2022.5- )

## **Organizing Committee Members of International Conferences**

International Conference on Raman Spectroscopy, International Steering Committee (1988-1994).

International Conference on Time Resolved Vibrational Spectroscopy, International Organizing Committees (1989-).

11th International Conference on Photobiology, Symposium organizer (1992).

Vth Intl. Conf. on Time-resolved Vibrational Spectroscopy(Tokyo), Local Organizing Committee (1991).

Symposium on Recent Developments in Vibrational Spectroscopy, International Chemical Congress of Pacific Basin Societies (one of organizers).

Co-organization: US-Japan Symposium on “Ligand Binding to Myoglobin and Hemoglobin” Rice University, Houston, March, 1-5 (1997).

Co-organization: US-Japan Symposium on “Proton Coupled Electron Transfer”

Kona, Hawaii, Nov. 11-15 (1998).

Co-organization: Symposium in International Chemical Congress of Pacific Basin Societies “Raman Spectroscopy: Coming Age in the New Millennium”

Hawaii, Dec 14-18 (2000).

Co-organization: 10th International Conference on Time-resolved Vibrational Spectroscopy, Okazaki, May 21-25 (2001).

Organizer: 2002 IMS COE Conference “Dynamical Structures and Molecular Design of Metalloproteins”, Nov. 18-21 (2002).

Organizer: AsBIC-1 “The First Asian Meeting of Bioinorganic Chemistry” Okazaki, March 7-10 (2002).

Chairman of International Steering Committee of “Asian Conference on Biological Inorganic Chemistry”

Chairman of Steering Committee of AsBIC (2002~2008)

## I Books

1. Introduction to Raman Spectroscopy (in Japanese) by T. Kitagawa and An. Tu (1988)
2. Chan's Physical Chemistry (Translation) (by Y. Iwasawa, H. Hamguchi, and T. Kitagawa) (2004)
3. Chan's Physical Chemistry Digest Version (Translation)(by Y. Iwasawa, H. Hamaguchi, and T. Kitagawa) (2006)

## II. Original Papers

1. Miyazawa, T. and T. Kitagawa, *Crystal vibrations, specific heat, and elastic moduli of the polyethylene crystal*. J. Polymer Sci. Ser. B **2**: p. 395-397 1964.
2. Kitagawa, T. and T. Miyazawa, *Inelastic scattering cross section of neutron by crystal vibrations of polyethylene*. J. Chem. Phys. **47**: p. 337-338 1967.
3. Kitagawa, T. and T. Miyazawa, *Cross-section for multi-phonon scattering of neutrons by crystalline polyethylene*. J. Polymer Sci. Ser. B **6**: p. 83-86 1968.
4. Kitagawa, T. and T. Miyazawa, *Energy difference between rotational isomers of methyl ethyl ether*. Bull. Chem. Soc. Jpn. **41**: p. 1976 1968.
5. Kitagawa, T. and T. Miyazawa, *Energy difference between rotational isomers of methyl ethyl ether*. Bull. Chem. Soc. Jpn. **42**: p. 3437-3447 1969.
6. Kitagawa, T. and T. Miyazawa, *Frequency distribution and dispersion curves of crystal vibrations of perdeuterated polyethylene*. Polymer J. **1**: p. 471-479 1970.
7. Kitagawa, T. and T. Miyazawa, *Frequency distribution, specific heat and Young's moduli of orthorhombic polyethylene with skeletal approximation*. Bull. Chem. Soc. Jpn. **43**: p. 372-379 1970.
8. Kitagawa, T., A. Tanaka, and M. Nishii, *End-group orientation in crystalline polyoxymethylene*. J. Polymer Sci. Ser B **9**: p. 579-582 1971.
9. Kitagawa, T., K. Ohno, H. Sugeta, and T. Miyazawa, *Far infrared spectra and internal-rotation potential of ethyl methyl ether*. Bull. Chem. Soc. Jpn. **45**: p. 969-975 1972.
10. Kitagawa, T., K. Kusaki, and T. Miyazawa, *Raman spectra and internal rotation of ethyl methyl ether*. Bull. Chem. Soc. Jpn. **46**: p. 3685-3687 1973.
11. Okabayashi, H., M.Okuyama, T. Kitagawa, and T. Miyazawa, *The Raman spectra and molecular conformations of surfactants in aqueous solution and*

*crystalline state*. Bull. Chem. Soc. Jpn. **47**: p. 1075-1077 1974.

12. Ikeda-Saito, M., T. Kitagawa, T. Iizuka, and Y. Kyogoku, *Resonance Raman scattering from hemoproteins; pH-dependence of Raman spectra of ferrous di-carboxymethyl-methionyl-cytochrome c*. FEBS Lett. **50**: p. 233-235 1975.
13. Kitagawa, T., T. Iizuka, M. Saito, and Y. Kyogoku, *Resonance Raman scattering from hemoproteins: The nature of the bond between the sixth ligand and the heme iron in ferrous low spin derivatives of hemoglobin*. Chem. Lett.: p. 849-852 1975.
14. Kitagawa, T., Y. Kyogoku, T. Iizuka, M. Ikeda-Saito, and T. Yamanaka, *Resonance Raman scattering from hemoproteins: Effects of ligands upon Raman spectra of various c-type cytochromes*. J. Biochem. (Tokyo) **78**: p. 719-728 1975.
15. Kitagawa, T., H. Ogoshi, E. Watanabe, and Z. Yoshida, *Resonance Raman spectra of metalloporphyrins: On the methine-bridge vibrations of ferric octaethylporphyrins and its  $\alpha$ ,  $\beta$ ,  $\gamma$ , and  $\delta$  deuterated derivatives*. Chem. Phys. Lett. **30**: p. 451-457 1975.
16. Kitagawa, T., H. Ogoshi, E. Watanabe, and Z. Yoshida, *Resonance Raman scattering from metalloporphyrins. Metal and ligand dependence of the vibrational frequencies of octaethylporphyrins*. J. Phys. Chem. **79**: p. 2629-2635 1975.
17. Okabayashi, H., M. Okuyama, and T. Kitagawa, *The Raman spectra of surfactants and the concentration dependence of their molecular conformations in aqueous solutions*. Bull. Chem. Soc. Jpn. **48**: p. 2264-2269 1975.
18. Abe, M., T. Kitagawa, and Y. Kyogoku, *Vibrational assignment of resonance Raman lines of Ni(octaethylporphyrin) on the basis of a normal coordinate treatment*, in Chem. Lett. 1976. p. 249-252.
19. Kitagawa, T., M. Abe, Y. Kyogoku, H. Ogoshi, E. Watanabe, and Z. Yoshida, *Resonance Raman spectra of metallo-octaethylporphyrins. Low frequency vibrations of porphyrin and iron-axial ligand stretching modes*. J. Phys. Chem. **80**: p. 1181-1186 1976.
20. Kitagawa, T., Y. Kyogoku, T. Iizuka, and M.I. Saito, *Nature of the iron-ligand bond in ferrous low spin hemoproteins studied by resonance Raman scattering*. J. Am. Chem. Soc. **98**: p. 5169-5173 1976.
21. Ozaki, Y., T. Kitagawa, and Y. Kyogoku, *Raman study of the acid-base transition of ferric myoglobin: Direct evidence for the existence of two molecular species at alkaline pH*. FEBS Lett. **62**: p. 369-372 1976.
22. Ozaki, Y., T. Kitagawa, Y. Kyogoku, H. Shimada, T. Iizuka, and Y. Ishimura, *An anomaly in resonance Raman spectra of cytochrome P-450<sub>cam</sub> in the*

- ferrous high spin state*. J. Biochem. (Tokyo) **80**: p. 1447-1451 1976.
23. Kitagawa, T., M. Abe, Y. Kyogoku, H. Ogoshi, H. Sugimoto, and Z. Yoshida, *Resonance raman spectra of <sup>15</sup>N enriched metallo-octaethylporphyrins. Characterization of the oxidation state marker bands of hemoproteins*. Chem. Phys. Lett. **48**: p. 55-58 1977.
  24. Kitagawa, T., Y. Kyogoku, and Y. Orii, *Resonance Raman spectra of heme a derivatives. Evidence for the reaction of peripheral formyl group with HCN and NaHSO<sub>3</sub>*. Arch. Biochem. Biophys. **181**: p. 228-235 1977.
  25. Kitagawa, T., Y. Ozaki, Y. Kyogoku, and T. Horio, *Resonance Raman study of the pH-dependent and detergent-induced structural alterations in the heme moiety of r. Rubrum cytochrome c'*. Biochim. Biophys. Acta **495**: p. 1-11 1977.
  26. Kitagawa, T., Y. Ozaki, J. Teraoka, Y. Kyogoku, and T. Yamanaka, *The pH dependence of the resonance Raman spectra and structural alterations at heme moieties of various c-type cytochromes*. Biochim. Biophys. Acta **494**: p. 100-114 1977.
  27. Mido, Y., F. Fujita, and T. Kitagawa, *Accordion-like skeletal motions of CH<sub>3</sub>NHCONH(CH<sub>2</sub>)<sub>n</sub>CH<sub>3</sub> (n=1-15)*. Bull. Chem. Soc. Jpn. **50**: p. 1621-1622 1977.
  28. Abe, M., T. Kitagawa, and Y. Kyogoku, *Resonance raman spectra of octaethylporphyrinato-Ni(II) and meso-deuterated and <sup>15</sup>N substituted derivatives. II. A normal coordinate analysis*. J. Chem. Phys. **69**: p. 4526-4534 1978.
  29. Kihara, H., K. Hon-nami, and T. Kitagawa, *Alkaline isomerization of thermoresistant cytochrome c-552 and horse heart cytochrome c studied by absorption and resonance Raman spectra*. Biochim. Biophys. Acta **532**: p. 337-346 1978.
  30. Kitagawa, T., M. Abe, and H. Ogoshi, *Resonance Raman spectra of octaethylporphyrinato-Ni(II) and meso-deuterated and <sup>15</sup>N substituted derivatives. I. Observation and assignments of non-fundamental Raman lines*. J. Chem. Phys. **69**: p. 4516-4526 1978.
  31. Kitagawa, T., T. Azuma, and K. Hamaguchi, *The Raman spectra of Bence-Jones proteins. Disulfide stretching frequencies and dependence of Raman intensity of tryptophan residues upon their environments*. Biopolymers **18**: p. 451-465 1978.
  32. Kitagawa, T. and Y. Orii, *The resonance raman studies of cytochrome oxidase*. J. Biochem. (Tokyo) **84**: p. 1245-1252 1978.
  33. Nishina, Y., T. Kitagawa, K. Shiga, K. Horiike, Y. Matsumura, H. Watari, and T. Yamano, *Resonance Raman spectra of riboflavin and its derivatives in the bound state with egg riboflavin binding proteins*. J. Biochem. (Tokyo) **84**: p.

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34. Okabayashi, H. and T. Kitagawa, *Assignments of the  $\nu_{CH}$ -stretching raman lines of hydrocarbon chains. Raman spectra of normal  $C_{n-1}H_{2n-1}COOH$  ( $n = 3, 4, 6, 8, 10, 12, 14, 16, \text{ and } 18$ ) and their specifically deuterated derivatives.* J. Phys. Chem. **82**: p. 1830-1836 1978.
35. Ozaki, Y., T. Kitagawa, Y. Kyogoku, Y. Imai, C. Hashimoto-Yutsudo, and R. Sato, *Resonance Raman studies of hepatic microsomal cytochrome P-450's: Evidence for strong  $\pi$  basicity of the fifth ligand in the reduced and co complex forms.* Biochemistry **17**: p. 5826-5831 1978.
36. Tatsuno, Y., Y. Saeki, M. Iwaki, T. Yagi, M. Nozaki, T. Kitagawa, and S. Otsuka, *Resonance Raman spectra of protocatechuate 3,4-dioxygenase. Evidence for coordination of tyrosine residue to ferric iron.* J. Am. Chem. Soc. **100**: p. 4614-4615 1978.
37. Kitagawa, T. and K. Nagai, *Quaternary structure-induced photoreduction of haem of haemoglobin.* Nature (London) **281**: p. 503-504 1979.
38. Kitagawa, T., K. Nagai, and M. Tsubaki, *Assignment of the  $Fe-N_{\epsilon}$ (His F8) stretching band in the resonance raman spectra of deoxy-myoglobin.* FEBS Lett. **104**: p. 376-378 1979.
39. Kitagawa, T., Y. Nishina, Y. Kyogoku, T. Yamano, N. Ohishi, A. Takai-Suzuki, and K. Yagi, *Resonance Raman spectra of  $^{13}C$  and  $^{15}N$  labelled riboflavins bound to egg-white flavoprotein.* Biochemistry **18**: p. 1804-1808 1979.
40. Kitagawa, T., Y. Nishina, K. Shiga, H. Watari, Y. Matsumura, and T. Yamano, *Resonance Raman evidence for charge transfer interactions of phenols with FMN of old yellow enzyme.* J. Am. Chem. Soc. **101**: p. 3376-3378 1979.
41. Kitagawa, T. and J. Teraoka, *Resonance Raman spectra of intermediate-spin ferrous porphyrin.* Chem. Phys. Lett. **63**: p. 443-446 1979.
42. Ozaki, Y., T. Kitagawa, and H. Ogoshi, *The resonance Raman spectra of metallo-trans-octaethylchlorins and their  $\gamma$ ,  $\delta$ -deuterated and  $^{15}N$  substituted derivatives.* Inorg. Chem. **18**: p. 1772-1776 1979.
43. Hon-nami, K., H. Kihara, T. Kitagawa, T. Miyazawa, and T. Ohshima, *Proton nuclear-magnetic-resonance and resonance Raman studies of thermophilic cytochrome c-552 from *Thermus thermophilus* Hb8.* Eur. J. Biochem. **110**: p. 217-223 1980.
44. Hori, H. and T. Kitagawa, *Iron-ligand stretching band in the resonance Raman spectra of ferrous iron porphyrin derivatives. Importance as a probe for quaternary structure of hemoglobin.* J. Am. Chem. Soc. **102**: p. 3608-3613 1980.
45. Kitagawa, T., Y. Fukumori, and T. Yamanaka, *Resonance Raman evidence for*



- intramolecular electron transport from flavin to heme in flavocytochrome c and nature of chromophoric interactions.* Biochemistry **19**: p. 5721-5729 1980.
46. Kitagawa, T. and M. Tsuda, *Resonance Raman spectra of acid and alkaline metarhodopsin of octopus.* Biochim. Biophys. Acta **624**: p. 211-217 1980.
  47. Nagai, K., Y. Enoki, and T. Kitagawa, *Influence of quaternary structure on the state of the heme in carp and human met-hemoglobins studied by resonance Raman scattering.* Biochim. Biophys. Acta **624**: p. 304-315 1980.
  48. Nagai, K. and T. Kitagawa, *Difference in Fe(II)-N<sub>ε</sub>(His-f8) stretching frequencies between deoxyhemoglobins in the two alternative quaternary structures.* Proc. Natl. Acad. Sci. U.S.A. **77**: p. 2033-2037 1980.
  49. Nagai, K., T. Kitagawa, and H. Morimoto, *Quaternary structures and low frequency molecular vibrations of hemes of deoxy- and oxyhemoglobins studied by resonance Raman scattering.* J. Mol. Biol. **136**: p. 271-289 1980.
  50. Nagai, K., C. Welborn, D. Dolphin, and T. Kitagawa, *Resonance Raman evidence for cleavage of the Fe-N<sub>ε</sub> (His f8) bond in the α subunit of the T-structure nitrosyl hemoglobin.* Biochemistry **19**: p. 4755-4761 1980.
  51. Nishina, Y., T. Kitagawa, K. Shiga, H. Watari, and T. Yamano, *Resonance Raman study of flavoenzyme-inhibitor charge-transfer interactions: Old yellow enzyme-phenol complexes.* J. Biochem. (Tokyo) **87**: p. 831-839 1980.
  52. Teraoka, J. and T. Kitagawa, *Raman characterization of axial ligands for penta- and hexa-coordinate ferric high- and intermediate-spin octaethylporphyrinato-Fe(III) complexes: Elucidation of unusual resonance Raman spectra of cytochrome c'.* J. Phys. Chem. **84**: p. 1928-1935 1980.
  53. Teraoka, J. and T. Kitagawa, *Resonance Raman study of the heme-linked ionization in reduced horseradish peroxidase.* Biochem. Biophys. Res. Commun. **93**: p. 694-700 1980.
  54. Tsubaki, M., K. Nagai, and T. Kitagawa, *Resonance Raman spectra of myoglobins reconstituted with spirographis and isospirographis hemes and 2,4-diformyl iron protoporphyrin ix: Effect of formyl substitution at heme periphery.* Biochemistry **19**: p. 379-385 1980.
  55. Kimura, S., I. Yamazaki, and T. Kitagawa, *Unusual low-frequency resonance Raman spectra of heme observed for hog intestinal peroxidase and its derivatives.* Biochemistry **20**: p. 4632-4637 1981.
  56. Shimizu, T., T. Kitagawa, F. Mitani, T. Iizuka, and T. Ishimura, *Resonance Raman spectra of adrenal cortex cytochrome P-450<sub>scc</sub>.* Biochim. Biophys. Acta **670**: p. 236-242 1981.
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- Raman line*. J. Biol. Chem. **256**: p. 3969-3977 1981.
58. Kitagawa, T., M.R. Ondrias, D.L. Rousseau, M. Ikeda-Saito, and T. Yonetani, *Evidence for hydrogen bonding of bound dioxygen to the distal histidine of oxycobalt myoglobin and haemoglobin*. Nature (London) **298**: p. 869-871 1982.
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  60. Kitagawa, T., T. Sugiyama, and T. Yamano, *Difference in stability against thermal unfolding between trypsin- and detergent-solubilized cytochrome  $b_5$  and structural changes in the heme vicinity upon the transition: Resonance Raman and absorption study*. Biochemistry **21**: p. 1680-1686 1982.
  61. Okabayashi, H., Y. Yoshida, T. Ikeda, H. Matsuura, and T. Kitagawa,  *$PO_2^-$  symmetric stretching Raman line and molecular aggregation states of barium dialkyl phosphates*. J. Am. Chem. Soc. **104**: p. 5399-5402 1982.
  62. Ondrias, M.R., D.L. Rousseau, T. Kitagawa, M. Ikeda-Saito, T. Inubushi, and T. Yonetani, *Quaternary structure changes in iron-cobalt hybrid hemoglobins detected by resonance Raman scattering*. J. Biol. Chem. **257**: p. 8766-8770 1982.
  63. Teraoka, J., T. Ogura, and T. Kitagawa, *Resonance Raman spectra of the reaction intermediates of horseradish peroxidase catalysis*. J. Am. Chem. Soc. **104**: p. 7354-7356 1982.
  64. Kitagawa, T., S. Hashimoto, J. Teraoka, S. Nakamura, H. Yajima, and T. Hosoya, *Distinct heme-substrate interactions of lactoperoxidase probed by resonance Raman spectroscopy: Difference between animal and plant peroxidases*. Biochemistry **22**: p. 2788-2792 1983.
  65. Nagai, K., T. Kagimoto, A. Hayashi, F. Taketa, and T. Kitagawa, *Resonance Raman studies of hemoglobins M: Evidence for Fe-tyrosine charge transfer interactions in the abnormal subunits of Hb M Boston and Hb M Iwate*. Biochemistry **22**: p. 1305-1311 1983.
  66. Ogura, T., K. Honnami, T. Ohshima, S. Yoshikawa, and T. Kitagawa, *Iron-histidine stretching Raman lines of the  $aa_3$ -type cytochrome oxidase*. J. Am. Chem. Soc. **105**: p. 7781-7783 1983.
  67. Teraoka, J., D. Job, Y. Morita, and T. Kitagawa, *Resonance Raman study of plant tissue peroxidases: Common characteristics in iron coordination environments*. Biochim. Biophys. Acta **747**: p. 10-15 1983.
  68. Hashimoto, S., T. Tatsuno, and T. Kitagawa, *Resonance Raman evidence for the presence of the Fe(IV)=O bond in horseradish peroxidase compound II*.

Proc. Japan Acad. Ser. B **60**: p. 345-348 1984.

69. Kamogawa, K., K. Tajima, K. Hayakawa, and T. Kitagawa, *Raman spectroscopic studies of submillimolar surfactant solutions; concentration dependence of the C-H stretching Raman lines*. J. Phys. Chem. **88**: p. 2494-2497 1984.
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73. Kamogawa, K. and T. Kitagawa, *Solute/solvent and solvent/solvent interactions in methanol solutions: Quantitative separation by Raman difference spectroscopy*. J. Phys. Chem. **89**: p. 1531-1537 1985.
74. Maeda, A., T. Ogurusu, T. Yoshizawa, and T. Kitagawa, *Resonance Raman study on binding of chloride to the chromophore of halorhodopsin*. Biochemistry **24**: p. 2517-2521 1985.
75. Matsukawa, S., K. Mawatari, Y. Yoneyama, and T. Kitagawa, *Correlation between the iron-histidine stretching frequencies and oxygen affinity of hemoglobins; a continuous strain model*. J. Am. Chem. Soc. **107**: p. 1108-1113 1985.
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78. Abe, M., Y. Kyogoku, T. Kitagawa, K. Kawano, N. Ohishi, A. Takai-Suzuki, and K. Yagi, *Vibrational analysis of flavin derivatives. Part I. Infrared spectra and molecular association of lumiflavin and riboflavin derivatives*. Spectrochim. Acta **42A**: p. 1059-1068 1986.
79. Hashimoto, S., R. Nakajima, I. Yamazaki, Y. Tatsuno, and T. Kitagawa, *Oxygen exchange between the Fe(IV)=O heme and bulk water for the A<sub>2</sub> isozyme of horseradish peroxidase*. FEBS Lett. **208**: p. 305-307 1986.

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81. Hashimoto, S., J. Teraoka, T. Inubushi, T. Yonetani, and T. Kitagawa, *Resonance Raman study on cytochrome c peroxidase and its intermediate; presence of the Fe<sup>iv</sup>=O bond in compound es and heme-linked ionization*. J. Biol. Chem. **261**: p. 11110-11118 1986.
82. Kamogawa, K. and T. Kitagawa, *Raman difference spectroscopy of the C-H stretching vibrations: Frequency shifts and excess quantities for acetone/water and acetonitrile/water solutions*. J. Phys. Chem. **90**: p. 1077-1081 1986.
83. Lee, H., M. Abe, R.K. Pandey, H.-K. Leung, K.M. Smith, and T. Kitagawa, *Characterization of low frequency resonance Raman bands of metallo-protoporphyrin ix: Observation of isotope shifts and normal coordinate treatments*. J. Mol. Struct. **146**: p. 329-347 1986.
84. Lee, H. and T. Kitagawa, *Tautomeric equilibrium of salicylidene Schiff base: UV-visible absorption and raman spectroscopic studies*. Bull. Chem. Soc. Jpn. **59**: p. 2897-2898 1986.
85. Maeda, A., T. Ogura, and T. Kitagawa, *Resonance Raman study on proton-dissociated state of bacteriorhodopsin: Stabilization of I-like intermediate having the all-trans chromophore*. Biochemistry **25**: p. 2798-2803 1986.
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