

CURRICULUM VITAE FOR KURT W. ZILM

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PERSONAL DESCRIPTION:

Age - 53, born November 11, 1955 - Des Moines, IA
Married - Velma
Children - Charles, Katherine, Emily, Michael, Lauren, Johnathon

EDUCATION: B.S. in Chemical Technology (combined chemistry/chemical engineering degree): University of Utah, 1976

Ph.D. in Physical Chemistry: University of Utah, 1981
Research Advisor: Prof. David M. Grant

Postdoctoral study in Chemical Physics: University of California at Berkeley, 1982-83
Research Advisor: Prof. Alex Pines.

EMPLOYMENT:

1980-82 - Senior Research Chemist, University of Utah Research Institute
1983-88 - Assistant Prof. of Chemistry, Yale University
1988-90 - Assoc. Prof. of Chemistry, Yale University
1990-93 - tenured Assoc. Prof. of Chemistry, Yale Univ.
1993-present - Full Prof. of Chemistry, Yale Univ.
1994-present - Director, Wm. M. Keck High Field Magnetic Resonance Laboratory
1994-2001, 2005-06, 2008-09 - Dir. of Undergraduate Studies, Dept. of Chem., Yale Univ.
1997-present - Full Professor of Chemistry and Chemical Engineering, Yale Univ.

PROFESSIONAL HONORS AND AWARDS:

National Science Foundation Energy Traineeship, 1976-1979
Eastman Kodak Award for Graduate Research, 1978
IBM Postdoctoral Fellowship 1982-83
Dreyfus Research Award for Newly Appointed Young Faculty in Chemistry, 1983
Bituminous Coal Research Inc. - R. A. Glenn Award, ACS Div. of Fuel Chem., 1986
Morse Faculty Fellowship, 1986
Exxon Education Fund grant for achievements in solid state NMR research, 1987
Franz-Vögt Prize of the Justus-Liebig University in Giessen, FDR, 1987
IR-100 Award for patented design of a time domain zero field NMR spectrometer, 1987
Dreyfus Teacher Scholar Award, 1988
Milton Harris Associate Prof. of Physical Chemistry, 1991-1993
Chair 2003 Magnetic Resonance Gordon Conference
Chair 2006 Experimental NMR Conference
Chair Rocky Mountain Conference on Analytical Chemistry and Spectroscopy 2005-present
Fellow of the American Association for the Advancement of Science, elected 2006
Fellow of the International Union of Pure and Applied Chemists, named 2008
Robert Vaughan Lecturer, 2009

OUTSIDE SERVICE:

1. Panel reviewer for DOE Fossil Energy Univ. Research Prog., 1984, 1993.
2. Symposium organizer "Spin Dynamics" for the 1985 Exp. NMR Conf., Asilomar, CA.
3. Symposium organizer "NMR - Catalysts, Surfaces and New Methods" for the 1985 FACSS Meeting, Philadelphia, PA.
4. Session chair, "Solid State NMR" at the Eastern Analytical Symp. New York, NY, 1988
5. Member of Ed. Board for "Concepts in Magnetic Resonance", 1989-1998.
6. Symposium organizer "New Developments and Applications of Magnetic Resonance and Optical Spectroscopies" for the national meeting of the ACS, N.Y., NY., Aug. 25-30, 1991.
7. Member of Triennial Oversight Review Committee, NSF Chemistry Division, April, 1992.
8. Departmental representative, Council for Chemical Research, 1991-1996.
9. Member of Triennial Oversight Review Committee, NSF Chemistry Division, April, 1995.
10. Triennial review committee, Oak Ridge Natl. Laboratory, March, 1995.
11. Executive Comm. Member, Exp. NMR Conference, 1989-1992, 1998-present.
12. ISMAR (International Society of Magnetic Resonance), election committee, 1996-present, member of ISMAR Council (governing body of the society) 1998-present.
13. Chair 2003 Gordon Conference on Magnetic Resonance in Chemistry and Physics.
14. Canada Foundation for Innovation review panel member, November 2001.
15. NIH Shared Instrumentation SEP for NCCR panel member, June 2002.
16. NSF Major Chemical Instrumentation panel review member, November, 2002.
17. NIH BCB study section member, October 2003.
18. NIH NIBIB site visit team member, November, 2003.
20. NIH Macromolecular Structure-Function special study section member, March 2005.
21. Chair 2006 Experimental NMR Conference
22. Chair 2005, 2006 and 2007 Rocky Mountain Conf. on Analytical Chem. and Spectroscopy
23. Chair NIH S10 Shared Instrumentation study section, June 2006.
24. Invited workshop participant: NSF and NIH Workshop on Instrument Development: Tools

for the New Millennium, June 2008.

25. NIH S10 Shared Instrumentation study section, June 2009.

CONSULTING and INDUSTRIAL EXPERIENCE: Over 30 years of experience in industrial applications of magnetic resonance. Provided firms with technical expertise in use of solids NMR in geochemical, polymer, catalyst, coating and pharmaceutical applications. Developed plans for instrumentation siting and acquisition. Provided advice on deployment of personnel in industrial magnetic resonance laboratories. Acquired and analyzed data for use in patent applications and in patent protection.

- 1) University of Utah Research Institute. Senior research chemist, responsible for conducting contract research for major oil and chemical companies. Kerogen, polyethylene and pharmaceutical analysis by solids NMR. 1980-82.
- 2) Consultant for DuPont in industrial applications of nuclear magnetic resonance. 1988-present.
- 3) Consultant for Olin in industrial applications of nuclear magnetic resonance to polyurethanes. 1990-1995.
- 4) Consultant to Engelhard in applications of solids NMR to catalyst structure and chemistry. Developed data for composition of matter patents. 1995-1998.
- 5) Consultant to Exxon Research and Engineering Corporation in applications of NMR to oil exploration and kerogen characterization. Developed data for patent applications, provided high field NMR services, 1986-present.
- 6) Consultant to Chemagnetics/Varian Instruments in design of solids NMR instrumentation. 1996-1998.
- 7) Consultant and member of Technology Advisory Board to NOVA Chemicals. Responsible for advising general directions of corporate research program, methods to implement new research programs, with emphasis on product development of new polymer products, new catalyst developments, exploitation of new technologies, composition of matter patent issues. 1997-present.
- 8) Consultant to Endo Pharmaceuticals for solid state NMR analysis of drug polymorphs 2001.
- 9) Consultant to AAI Pharma for solution and solid state NMR analysis of pharmaceutical coordination complexes 2003.
- 10) Consultant to Boehringer-Ingelheim 2009 to present.
- 11) Consultant on varied legal work for Andrx, Aptuit, Morgan and Finnegan, Baker-Botts, SSCI, Sandoz.

ADMINISTRATIVE AND TEACHING EXPERIENCE

- 1) Over 25 years experience in teaching chemistry including Freshman Chemistry, Physical Chemistry, Quantum Mechanics, Nuclear Magnetic Resonance and Physical Chemistry Laboratory.
- 2) Revised graduate curriculum in Physical Chemistry. Developed new core graduate courses: "Molecules and Radiation", a combined matrix mechanics/spectroscopy course for physical chemistry or biophysics students, and a graduate level laboratory.
- 3) As Director of Undergraduate Studies (1994-2000) restructured freshman chemistry curriculum. Developed placement procedure now used for entire freshman class; instituted 3 separate freshman chemistry tracks; hired and managed staff of non-ladder faculty for new cur-

riculum; hired and managed sabbatical replacement faculty in undergraduate teaching program.

- 4) Devised new freshman chemistry laboratory (1998-2002) focused on environmental chemistry of a marine ecosystem. Integrated course into existing large freshman chemistry course offering.
- 5) Director of Undergraduate Studies (2009-present), instituted major revision of chemistry major requirements.

PUBLICATIONS:

1. Pugmire, R. J., Grant, D. M., Zilm, K. W., Anderson, L. L., Oblad, A. G., and Wood, R. E., "¹³C Magnetic-Resonance of Coal-Derived Liquids", *Fuel*, 56, 295 (1977).
2. Zilm, K. W., Conlin, R. T., Grant, D. M., and Michl, J., "Low-Temperature Natural-Abundance ¹³C NMR-Spectroscopy of Matrix-Isolated Species: Anisotropy of Shielding Tensor in Ethylene", *Journal of the American Chemical Society*, 100, 8038 (1978).
3. Zilm, K. W., Alderman, D. W., and Grant, D. M., "A High-Speed Magic Angle Spinner", *Journal of Magnetic Resonance*, 30, 563 (1978).
4. Zilm, K. W. and Grant, D. M., "Magic Angle Spinning Without the Magic and Natural Abundance Matrix Isolation ¹³C NMR" *Magnetic Resonance and Related Phenomena*, Ed. by E. Kundla, E. Lippma and T. Saluvere, Springer-Verlag Berlin-Heidelberg-New York, 1979, p.98 Proceedings of XXth Congress AMPERE Tallinn, August 21-26, (1978).
5. Zilm, K. W., Pugmire, R. J., Grant, D. M., Wood, R. E., and Wiser, W. H., "Comparison of the ¹³C NMR-Spectra of Solid Coals and Their Liquids Obtained By Catalytic-Hydrogenation", *Fuel*, 58, 11 (1979).
6. Zilm, K. W., Conlin, R. T., Grant, D. M., and Michl, J., "Low-Temperature ¹³C Magnetic-Resonance of Solids I. Alkenes and Cycloalkenes", *Journal of the American Chemical Society*, 102, 6672 (1980).
7. Zilm, K. W., Grant, D. M., Englert, E., and Straight, R. C., "The Use of Solid ¹³C Nuclear Magnetic Resonance For the Characterization of Cholesterol and Bilirubin Pigment Composition of Human Gallstones", *Biochemical and Biophysical Research Communications*, 93, 857 (1980).
8. Straight, R. C., Zilm, K. W., Englert, E., and Grant, D. M., "The Use of Solid ¹³C Nuclear Magnetic-Resonance For the Characterization of Cholesterol and Bilirubin Pigment Composition of Human Gallstones", *Gastroenterology*, 78, 1271 (1980).
10. Bunker, J. W., Cogswell, D. E., and Zilm, K. W., "Properties of Asphaltenes From Oil Sand Bitumen and the Effect of Asphaltenes on the Conversion of Bitumens Through Hydrolysis", *Erdol & Kohle Erdgas Petrochemie*, 34, 179 (1981).
11. Dalling, D. K., Zilm, K. W., Grant, D. M., Heeschen, W. A., Horton, W. J., and Pugmire, R. J., "A Solution and Solid ¹³C Magnetic-Resonance Study of the Conformation of 9,10-Dihydroanthracene and its 9,10-Methylated Derivatives", *Journal of the American Chemical Society*, 103, 4817 (1981).
12. Zilm, K. W., and Grant, D. M., "¹³C Dipolar Spectroscopy of Small Organic-Molecules in Argon Matrices", *Journal of the American Chemical Society*, 103, 2913 (1981).
13. Zilm, K. W., Pugmire, R. J., Larter, S. R., Allan, J., and Grant, D. M., "C-13 CP-MAS Spectroscopy of Coal Macerals", *Fuel*, 60, 717 (1981).

14. Wilson, M. A., Pugmire, R. J., Zilm, K. W., Goh, K. M., Heng, S., and Grant, D. M., "Cross-Polarization ^{13}C NMR Spectroscopy With Magic Angle Spinning Characterizes Organic-Matter in Whole Soils", *Nature*, 294, 648 (1981).
15. Zilm, K. W., Beeler, A. J., Grant, D. M., Michl, J., Chou, T. C., and Allred, E. L., "C-13 Magnetic-Resonance Dipolar Spectroscopy - Orientation of the Chemical-Shift Tensor in Cyclopropane", *Journal of the American Chemical Society*, 103, 2119 (1981).
16. Wilson, M. A., Pugmire, R. J., Vassallo, A. M., Grant, D. M., Collin, P. J., and Zilm, K. W., "Changes in Aromaticity During Coal-Liquefaction", *Industrial & Engineering Chemistry Product Research and Development*, 21, 477 (1982).
17. Pugmire, R. J.; Zilm, K. W.; Woolfenden, W.W.; Grant, D. M.; Dyrkacz, G. R.; Bloomquist, C. A. A.; Horwitz, E. P., "Carbon-13 Spectra of Macerals Separated from Individual Coals" *Organic Geochemistry*, 4, 79 (1982).
18. Zilm, K. W., and Grant, D. M., "High-Resolution NMR Spectra With J Couplings in Solids", *Journal of Magnetic Resonance*, 48, 524 (1982).
19. Solum, M. S., Zilm, K. W., Michl, J., and Grant, D. M., "Carbon-13 Line Shape Study Of Two-Site Exchange in Solid Dimethyl Sulfone", *Journal of Physical Chemistry*, 87, 2940 (1983).
20. Zilm, K. W., Grant, D. M., Michl, J., Fink, M. J., and West, R., "Electronic-Structure of the Silicon Silicon Double-Bond: ^{29}Si Shielding Anisotropy in Tetramesityldisilene", *Organometallics*, 2, 193 (1983).
21. Alemany, L. B., Grant, D. M., Pugmire, R. J., Alger, T. D., and Zilm, K. W., "Cross Polarization and Magic Angle Sample Spinning NMR-Spectra of Model Organic-Compounds I. Highly Protonated Molecules", *Journal of the American Chemical Society*, 105, 2133 (1983).
22. Alemany, L. B., Grant, D. M., Pugmire, R. J., Alger, T. D., and Zilm, K. W., "Cross Polarization and Magic Angle Sample Spinning NMR Spectra of Model Organic Compounds II. Molecules of Low Or Remote Protonation", *Journal of the American Chemical Society*, 105, 2142 (1983).
23. Duijvestijn, M. J., Vanderlugt, C., Smidt, J., Wind, R. A., Zilm, K. W., and Staplin, D. C., " ^{13}C NMR Spectroscopy in Diamonds Using Dynamic Nuclear Polarization", *Chemical Physics Letters*, 102, 25 (1983).
24. Strub, H., Beeler, A. J., Grant, D. M., Michl, J., Cutts, P. W., and Zilm, K. W., "Low-Temperature ^{13}C Magnetic-Resonance in Solids II. 6π - Electron Ring-Systems - C_7H_7^+ , C_6H_6 , and C_5H_5^- ", *Journal of the American Chemical Society*, 105, 3333 (1983).
25. Weitekamp, D. P.; Bielecki, A.; Zax, D.; Zilm, K. W.; and Pines, A., "Zero-Field NMR" *Physical Review Letters*, 50, 1807 (1983).
26. Bielecki, A., Murdoch, J. B., Weitekamp, D. P., Zax, D. B., Zilm, K. W., Zimmermann, H., and Pines, A., "Fourier-Transform Pure Nuclear-Quadrupole Resonance By Pulsed Field Cycling", *Journal of Chemical Physics*, 80, 2232 (1984).
27. Lee, J. N., Alderman, D. W., Jin, J. Y., Zilm, K. W., Mayne, C. L., Pugmire, R. J., and Grant, D. M., "Cylindrical Spinner and Speed Controller For Magic Angle Spinning Nuclear Magnetic-Resonance", *Review of Scientific Instruments*, 55, 516 (1984).
28. Beeler, A. J., Orendt, A. M., Grant, D. M., Cutts, P. W., Michl, J., Zilm, K. W., Downing, J. W., Facelli, J. C., Schindler, M. S., and Kutzelnigg, W., "Low-Temperature ^{13}C Magnetic-Resonance in Solids III. Linear and Pseudolinear Molecules", *Journal of the American Chemical Society*, 106, 7672 (1984).

29. Zax, D. B., Bielecki, A., Weitekamp, D. P., Zilm, K. W., and Pines, A., "Time Domain Zero Field Magnetic Resonance", *Proceedings of the XXIIInd Congress Ampere on Magnetic Resonance and Related Phenomena Proceedings. Univ. Zurich, Zurich, Switzerland* (1984).
30. Zax, D. B., Bielecki, A., Zilm, K. W., and Pines, A., "Heteronuclear Zero-Field NMR", *Chemical Physics Letters*, *106*, 550 (1984).
31. Zax, D. B., Bielecki, A., Zilm, K. W., Pines, A., and Weitekamp, D. P., "Zero field NMR and NQR", *Journal of Chemical Physics*, *83*, 4877 (1985).
32. Mallouk, T., Hawkins, B.L., Conrad, M. P., Zilm, K. W., Maciel, G. E., and Bartlett, N., "Raman, Infrared and NMR Studies of the Graphite Hydrofluoride $C_xF_{1-\delta}$ (HF) $_{\delta}$ $2 \leq x \leq 5$ ", *Philosophical Transactions of the Royal Society London, A* *314*, 179 (1985).
33. Zilm, K. W. and Webb, G. G., " ^{13}C Proton Shift Correlation Spectroscopy of a Whole Coal", *Fuel*, *65*, 721 (1986).
34. Zilm, K. W., Merrill, R. A., Kummer, M. W., and Kubas, G. J., "Characterization of Transition-Metal Molecular-Hydrogen Complexes By Solid-State Proton NMR", *Journal of the American Chemical Society*, *108*, 7837 (1986).
35. Bielecki, A., Zax, D. B., Zilm, K. W., and Pines, A., "Zero-field NMR and NQR spectrometer", *Review of Scientific Instruments*, *57*, 393 (1986).
36. Zilm, K. W., Lawless, G. A., Merrill, R. M., Millar, J. M., and Webb, G. G., "Nature of the Tin-Tin Double-Bond as Studied By Solid-State and Solution Nuclear Magnetic Resonance", *Journal of the American Chemical Society*, *109*, 7236 (1987).
37. Zilm, K. W., Merrill, R. A., Greenberg, M. M., and Berson, J. A., "The 1st Magic Angle Spinning NMR Spectrum of a Captive Intermediate: Direct Observation of a Singlet Ground-State Biradical, 3,4-Dimethylenefuran", *Journal of the American Chemical Society*, *109*, 1567 (1987).
38. Zilm, K. W., Webb, G. G., Cowley, A. H., Pakulski, M., and Orendt, A., "The Nature of the Phosphorus-Phosphorus Double-Bond as Studied by Solid-State NMR", *Journal of the American Chemical Society*, *110*, 2032 (1988).
39. Zilm, K. W., and Webb, G. G., "Applications of Zero-Field and Two-Dimensional NMR Methods to Fossil-Fuels", *Fuel*, *67*, 707 (1988).
40. Webb, G. G., and Zilm, K. W., "Asynchronous MASSLF Spectroscopy - a Convenient Method For Assigning Solid-State ^{13}C CPMAS Spectra", *Journal of the American Chemical Society*, *111*, 2455 (1989).
41. Duncan, T. M., Zilm, K. W., Hamilton, D. M., and Root, T. W., "Adsorbed States of CO On Dispersed Metals - a High-Resolution Solid-State NMR Study", *Journal of Physical Chemistry*, *93*, 2583 (1989).
42. Zilm, K. W., Heinekey, D. M., Millar, J. M., Payne, N. G., and Demou, P., "Proton Proton-Exchange Couplings in Transition-Metal Polyhydrides", *Journal of the American Chemical Society*, *111*, 3088 (1989).
43. Zilm, K. W., Merrill, R. A., Webb, G. G., Greenberg, M. M., and Berson, J. A., "Two-Dimensional Solid-State NMR of a Captive Intermediate: Structure of the Radical Centers in 3,4-Dimethylenethiophene", *Journal of the American Chemical Society*, *111*, 1533 (1989).

44. Zilm, K. W., Bonneviot, L., Hamilton, D. M., Webb, G. G., and Haller, G. L., "C-13 NMR-Studies of CO Adsorbed on Supported Platinum and Palladium Catalysts Using Magic Angle Sample Spinning", *Journal of Physical Chemistry*, *94*, 1463 (1990).
45. Tycko, R., Dabbagh, G., Duchamp, J. C., and Zilm, K. W., "Carbon-13 Zero-Field NMR In High Field", *Journal of Magnetic Resonance*, *89*, 205 (1990).
46. Duchamp, J. C., Pakulski, M., Cowley, A. H., and Zilm, K. W., "Nature of the Carbon Phosphorus Double-Bond and the Carbon Phosphorus Triple Bond As Studied By Solid-State NMR", *Journal of the American Chemical Society*, *112*, 6803 (1990).
47. Heinekey, D. M., Millar, J. M., Koetzle, T. F., Payne, N. G., and Zilm, K. W., "Structural and Spectroscopic Characterization of Iridium Trihydride Complexes - Evidence For Proton-Proton Exchange Coupling", *Journal of the American Chemical Society*, *112*, 909 (1990).
48. Zilm, K. W., Heinekey, D. M., Millar, J. M., Payne, N. G., Neshyba, S. P., Duchamp, J. C., and Szczyrba, J., "Quantum-Mechanical Exchange of Hydrides in Solution: Proton-Proton Exchange Couplings in Transition-Metal Polyhydrides", *Journal of the American Chemical Society*, *112*, 920 (1990).
49. Zilm, K. W., Bonneviot, L., Haller, G. L., Han, O. H., and Kermarec, M., "¹³C NMR-Spectra of ¹³CO Adsorbed on Silica-Supported Palladium Particles: Particle-Size Dependence of the Surface Diffusion Rate and the ¹³C Knight-Shift", *Journal of Physical Chemistry*, *94*, 8495 (1990).
50. Zilm, K. W.; Millar, J. M., "Solid State and Solution NMR of Non-Classical Transition Metal Polyhydrides" *Advances in Magnetic and Optical Resonance*, *15*, 163-200 (1990).
51. Greenberg, M. M., Blackstock, S. C., Berson, J. A., Merrill, R. A., Duchamp, J. C., and Zilm, K. W. "Structure of the Carrier of the Cross-Polarization Magic Angle Spinning ¹³C Nuclear-Magnetic-Resonance Signal Assigned to 3,4-Dimethylenethiophene - Multiple Position-Labeling and Chemical Trapping in Annealed Glasses" *Journal of the American Chemical Society*, *113*, 2318 (1991).
52. Wu, X. L., and Zilm, K. W., "Heterogeneity of Cross Relaxation in Solid-State NMR", *Journal of Magnetic Resonance*, *93*, 265 (1991).
53. Reynolds, J. H., Berson, J. A., Kumashiro, K. K., Duchamp, J. C., Zilm, K. W., Rubello, A., and Vogel, P., "A Kinetically Stable Singlet-State of 1,2,4,5- Tetramethylenebenzene", *Journal of the American Chemical Society*, *114*, 763 (1992).
54. Inati, S. J., and Zilm, K. W., "Spin Correlations and Symmetrization in the Nuclear Magnetic Resonance of Molecular Systems with Tunneling", *Physical Review Letters*, *68*, 3273 (1992).
55. Wu, X., and Zilm, K. W., "Cross Polarization with High Speed Magic Angle Spinning", *Journal of Magnetic Resonance Series A*, *104*, 154 (1993).
56. Wisniewski, L. L., Mediati, M., Jensen, C. M., and Zilm, K. W., "Mechanism of Hydride Scrambling in a Transition-Metal Dihydrogen Dihydride as Studied by Solid-State Proton NMR", *Journal of the American Chemical Society*, *115*, 7533 (1993).
57. Han, O. H., Lin, C. Y., Sustache, N., McMillan, M., Carruthers, J. D., Zilm, K. W., and Haller, G. L., "Solid State Nuclear Magnetic Resonance Spectroscopic Investigation of Hydrotreating Catalysts and Related Materials", *Applied Catalysis A-General*, *98*, 195 (1993).

58. Han, O. H., Larsen, G., Zilm, K. W., and Haller, G. L., "Methoxy Formation Spillover on Pd/Al₂O₃ Studied By C-13,H-1 NMR", *Studies in Surface Science and Catalysis*, 77, 223 (1993).
59. Maitre, P., Eisenstein, O., Michos, D., Luo, X. L., Siedle, A. R., Wisnieski, L., Zilm, K. W., and Crabtree, R. H., "B₁₁H₁₄⁽⁻⁾ - a Nido Cage With No H··H Interaction", *Journal of the American Chemical Society*, 115, 7747 (1993).
60. Wu, X. L., and Zilm, K. W., "Complete Spectral Editing in CPMAS NMR", *Journal of Magnetic Resonance Series A*, 102, 205 (1993).
61. Augustine, M. P., Zilm, K. W., and Zax, D. B., "Field Dependent Isotropic Shifts in Solid State Nuclear Magnetic Resonance: a Floquet Treatment", *Journal of Chemical Physics*, 98, 9432 (1993).
62. Reynolds, J. H., Berson, J. A., Kumashiro, K. K., Duchamp, J. C., Zilm, K. W., Scaiano, J. C., Berinstain, A. B., Rubello, A., and Vogel, P., "2,3,5,6-Tetrakis(Methylene)-1,4-Cyclohexanediyl (1,2,4,5- Tetramethylenebenzene), a Disjoint Non-Kekule Singlet Hydrocarbon Biradical", *Journal of the American Chemical Society*, 115, 8073 (1993).
63. Cavalieri, J. D., West, R., Duchamp, J. C., and Zilm, K. W., "Unusual ²⁹Si Chemical-Shift Anisotropies in 3-Membered Rings", *Journal of the American Chemical Society*, 115, 3770 (1993).
64. Wu, X. L., and Zilm, K. W., "Methylene-Only Subspectrum in CPMAS NMR", *Journal of Magnetic Resonance Series A*, 104, 119 (1993).
65. Zilm, K. W.; Duchamp, J. C., "Comparisons of Shielding Anisotropies for Different Nuclei and Other Insights Into Shielding From an Experimentalist's Viewpoint" NATO ASI Series C, Vol. 386, pg.315-334 (1993) "*Nuclear Magnetic Shieldings and Molecular Structure*" ed. J. Tossel, Kluwer Academic Pub.
66. West, R., Cavalieri, J. D., Duchamp, J., and Zilm, K. W., "Chemical-Shift Tensors and Chemical Bonding in Cyclic Silanes", *Phosphorus Sulfur and Silicon and the Related Elements*, 93, 213 (1994).
67. Arduengo, A. J., Dixon, D. A., Kumashiro, K. K., Lee, C., Power, W. P., and Zilm, K. W., "Chemical Shielding Tensor of a Carbene", *Journal of the American Chemical Society*, 116, 6361 (1994).
68. Xiaoling, W., Burns, S. T., and Zilm, K. W., "Spectral Editing in CPMAS NMR. Generating Subspectra Based on Proton Multiplicities", *Journal of Magnetic Resonance, Series A*, 111, 29 (1994).
69. Regnier, P., Lasaga, A. C., Berner, R. A., Han, O. H., and Zilm, K. W., "Mechanism of (CO₃)²⁻ Substitution in Carbonate-Fluorapatite - Evidence From FTIR Spectroscopy, C-13 NMR, and Quantum- Mechanical Calculations", *American Mineralogist*, 79, 809 (1994).
70. Kubas, G. J., Nelson, J.E.; Bryan, J.C.; Eckert, J.; Wisniewski, L.; Zilm, K.W. "Isolation of an Extremely Labile Dihydrogen Complex, Cr(CO)₃PPrⁱ₃(H₂), Containing the Shortest Ligated H-H Bond" *Inorganic Chemistry*, 33, 2954-2960 (1994).
71. Zilm, K.W. "Quantum Exchange" *Encyclopedia of Nuclear Magnetic Resonance*, John Wiley and Sons Ltd., 3916-3925(1995).
72. Zilm, K.W. "Spectral Editing in ¹³C Spectra of Hydrocarbon Solids" *Encyclopedia of Nuclear Magnetic Resonance*, John Wiley and Sons Ltd., 4498-4504 (1995).
73. King, W. A., Luo, X. L., Scott, B. L., Kubas, G. J., and Zilm, K. W., "Cationic Manganese(I) Dihydrogen and Dinitrogen Complexes Derived From A Formally 16-Electron

- Complex With A Bis-Agostic Interaction, $[\text{Mn}(\text{CO})(\text{Ph}_2\text{PC}_2\text{H}_4\text{PPh}_2)_2]^+$ ”, *Journal of the American Chemical Society*, *118*, 6782 (1996).
74. Augustine, M. P., and Zilm, K. W., “Observation Of Bulk Susceptibility Effects In High-Resolution Nuclear Magnetic Resonance”, *Journal of Magnetic Resonance Series A*, *123*, 145 (1996).
 75. Augustine, M. P., and Zilm, K. W., “Optical Pumping Magnetic Resonance in High Magnetic Fields: Characterization Of Nuclear Relaxation During Pumping”, *Journal of Chemical Physics*, *105*, 2998 (1996).
 76. Augustine, M. P., and Zilm, K. W., “Optical Pumping Magnetic Resonance in High Magnetic Fields: Characterization of The Optical Properties of Rb-Xe Mixtures”, *Molecular Physics*, *89*, 737 (1996).
 77. Augustine, M. P., and Zilm, K. W., “Optical Pumping Magnetic Resonance in High Magnetic Fields: Measurement of High Field Spin Exchange Cross Sections”, *Chemical Physics Letters*, *280*, 1 (1997).
 78. West, R., Cavalieri, J. D., Buffy, J. J., Fry, C., Zilm, K. W., Duchamp, J. C., Kira, M., Iwamoto, T., Muller, T., and Apeloig, Y., “A Solid State NMR and Theoretical Study of the Chemical Bonding in Disilenes”, *Journal of the American Chemical Society*, *119*, 4972 (1997).
 79. Wiberg, K. B.; Hammer, J. D.; Keith, T.A.; Zilm, K. W. “ ^{13}C NMR Chemical Shifts of Methyl Cation and Anion: A Relationship Between Chemical Shift and Charge” *Tetrahedron Letters*, *38*, 323-326 (1997).
 80. Han, O. H., Larsen, G., Haller, G. L., and Zilm, K. W., “Carbon-13 Nuclear Magnetic Resonance Spectroscopic Studies of ^{13}CO Adsorbed on Platinum Particles in L-Zeolites”, *Bulletin of the Korean Chemical Society*, *19*, 934 (1998).
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 82. Wiberg, K. B., Hammer, J. D., Zilm, K. W., Cheeseman, J. R., and Keith, T. A., “NMR Chemical Shifts. 1. The Role Of Relative Atomic Orbital Phase In Determining The Sign Of The Paramagnetic Terms: ClF , CH_3F , CH_3NH_3^+ , FNH_3^+ , and $\text{HC}\equiv\text{CF}$ ”, *Journal of Physical Chemistry A*, *102*, 8766 (1998).
 83. Wiberg, K.B., J.D. Hammer, T.A. Keith, and K. Zilm, "NMR chemical shifts. 2. Interpretation of the Carbon Chemical Shifts in Monocyclic Aromatic Compounds and Carbenes", *Journal of Physical Chemistry a*, *103*, 21-27 (1999).
 84. Wiberg, K.B., J.D. Hammer, K.W. Zilm, and J.R. Cheeseman, "NMR Chemical Shifts. 3. A Comparison of Acetylene, Allene, and the Higher Cumulenes", *Journal of Organic Chemistry*, *64*, 6394-6400 (1999).
 85. Burns, S.T., X.L. Wu, and K.W. Zilm, "Improvement of Spectral Editing in Solids: A Sequence for Obtaining $^{13}\text{CH} + ^{13}\text{CH}_2$ -only ^{13}C Spectra", *Journal of Magnetic Resonance*, *143*, 352-359 (2000).
 86. McDermott, A., T. Polenova, A. Bockmann, K.W. Zilm, E.K. Paulson, R.W. Martin, and G.T. Montelione, "Partial NMR Assignments for Uniformly (C-13, N-15)-Enriched BPTI in the Solid State", *Journal of Biomolecular NMR*, *16*, 209-219 (2000).
 87. Wiberg, K.B. and K.W. Zilm, "F-19 NMR chemical shifts. 1. Aliphatic fluorides", *Journal of Organic Chemistry*, *66*, 2809-2817 (2001).

88. Lupták, A., Ferré-D'Amaré, A. R., Zhou, K., Zilm, K.W., and Doudna, J.A. "Direct pK_a Measurement of the Active Site Cytosine in a Genomic HDV Ribozyme", *Journal of the American Chemical Society*, *123*, 8447-8452 (2001).
89. Martin, R. W., Paulson, E. K., Zilm, K. W. "Design of a Triple Resonance MAS Probe for High Field Solid State NMR", *Review of Scientific Instruments*, *74*, 1-17 (2003).
90. Morcombe, C. R., Zilm, K. W. "Chemical Shift Referencing in MAS Solid State NMR", *Journal of Magnetic Resonance*, *162*, 173-180 (2003).
91. Martin, R.W., Zilm, K. W. "Protein Nanocrystals and their Characterization by Solid State NMR" *Journal of Magnetic Resonance*, *165*, 162-174 (2003).
92. Gehman, J. D., Paulson, E. K., and Zilm, K. W. "The influence of internuclear spatial distribution and instrument noise on the precision of distances determined by solid state NMR of isotopically enriched proteins" *Journal of Biomolecular NMR*, *27*,235-259 (2003).
93. Paulson, E. K., Morcombe, C. R., Gaponenko, V., Dancheck, B., Byrd, R.A., Zilm, K. W. "High Sensitivity Observation of Dipolar Exchange and NOEs Between Exchangeable Protons in Proteins by 3D Solid State NMR Spectroscopy", *Journal of the American Chemical Society*, *125*,14222-14223 (2003).
94. Paulson, E. K., Morcombe, C. R., Gaponenko, V., Dancheck, B., Byrd, R.A., Zilm, K. W. "Sensitive High Resolution Inverse Detection NMR Spectroscopy of Proteins in the Solid State", *Journal of the American Chemical Society*, *125*, 15831-15836 (2003).
95. Martin, R. W. and Zilm, K. W., "Variable Temperature System Using Vortex Tube Cooling and Fiber Optic Temperature Measurement for Low Temperature Magic Angle Spinning NMR", *Journal of Magnetic Resonance*, *168*, 202-209 (2004).
96. Wiberg, K. B., Hammer, J. D., Zilm, K. W., Keith, T. A., Cheeseman, J. R., Duchamp, J. C., "NMR Chemical Shifts. Substituted Acetylenes", *Journal of Organic Chemistry*, *69*, 1086-1096 (2004).
97. Paulson, E.K. and Zilm, K. W. "Linear Phase Correction of Folded Multidimensional NMR Data by Zero Inter-filling", *Journal of Magnetic Resonance*, *168*, 217-219 (2004).
98. Igumenova, T. I., McDermott, A. E., Zilm, K.W., Martin, R. W., Paulson, E. K., Wand, A. J. "Assignments of Carbon Resonances for Microcrystalline Ubiquitin" *Journal of the American Chemical Society*, *126*, 6720-6727 (2004).
99. Morcombe, C. R., Gaponenko, V., Byrd, R. A., Zilm, K. W. "Diluting Abundant Spins by Isotope Edited Radio Frequency Field Assisted Diffusion" *Journal of the American Chemical Society*, *126*, 7196-7197 (2004).
100. Paulson, E.K., Martin, R. W., and Zilm, K. W. "RF Homogeneity in High Field Solid State NMR Probes", *171*, 314-323, *Journal of Magnetic Resonance*, (2004).
101. Morcombe, E. K., Gaponenko, V., Byrd, R. A., Zilm, K. W. "¹³C CPMAS Spectroscopy of Deuterated Proteins: CP Dynamics, Line Shapes and T₁ Relaxation", *Journal of the American Chemical Society*, *127*, 397-404 (2005).
102. Paulson, E.K. and Zilm, K.W. "External Field Frequency Lock Probe for High Resolution Solid State NMR", *Review of Scientific Instruments*, *76*, article 026104 (2005).
103. Morcombe, C. R., Paulson, E. K., Gaponenko, V., Byrd, R. A., Zilm, K. W. "¹H-¹⁵N Correlation Spectroscopy in Nanocrystalline Proteins", *Journal of Biomolecular NMR*, *31*, 217-230 (2005).

104. Harris, R. K., Becker, E.D., Cabral De Menezes, S. M., Granger, P., Hoffman, R. E., and Zilm, K. W. "Further Conventions For NMR Shielding and Chemical Shifts", *Pure Appl. Chem.*, 80, 59–84 (2008).
105. Fry, E.A., Sengupta, S, Phan,, V.C., Kuang, S. and Kurt W. Zilm, K.W. "CSA Enabled Spin Diffusion Leads to MAS Rate Dependent T₁s at High Field" accepted for publication, *Journal of the American Chemical Society*, (2010).

INVITED LECTURES:

1984

1. "Zero field Nuclear Magnetic Resonance" at the 23rd Eastern Analytical Symposium, November, 1984, New York, NY in symposium "Spectroscopic Advances in the 1980's."
2. "Zero Field and Pulsed Field NMR" at the 11th FACSS annual meeting, September, 1984, Philadelphia, PA in session on "Two-Dimensional NMR Spectroscopy."
3. "Zero Field NMR" at the 5th Delaware NMR Symposium, May, 1984, University of Delaware, Newark, DE.
4. "Zero Field NMR," at Schlumberger-Doll Research Center, Ridgefield, CT., September 1984.

1985

5. "New Solid State NMR Techniques: Applications to Polymers and Catalysis" presented at the General Electric Corporate Research and Development Center, Schenectady, NY., September 1985.
6. "Echo Train NMR" presented at the Dept. of Chemistry, Dartmouth College, Hanover, NH., October 1985.
7. "Second Generation CP/MAS Techniques: Applications and Experimental Aspects" presented at the 27th Rocky Mountain Conference, July, 1985, Denver, CO.
8. "Solid State NMR of Surface Adsorbed Species: Results from Some Model Systems" presented at the 27th Rocky Mountain Conference, July, 1985, Denver, CO.
9. "MAS and Pulse Train NMR of Surface Species and Model Systems" presented at the 12th annual FACSS meeting, October, 1985, Philadelphia, PA.

1986

10. "Zero Field and 2-D NMR Methods: Applications to Fossil Fuels" presented at the 191st National Meeting of the ACS, April, 1986, New York, NY. meeting in symposium on "New Applications of Analytical Techniques to Fossil Fuels."
11. "Echo Trains and Pulse Games in Solids" presented at symposium on new NMR methods at the Experimental NMR Conference, April, 1986, Baltimore, MD.
12. "Magic Angle Spinning and Low Temperature NMR Studies of Adsorbates on Supported Metal Catalysts," presented at the Catalysis Gordon Conference, June 1986, New London, NH.
13. "New NMR Techniques Applied to Fossil Fuel Characterization" presented at the Fossil Fuel Gordon Conference, July, 1986, New Hampton, NH.
14. "Low Temperature Magic Angle Spinning Studies of Small Molecules Adsorbed on Supported Metal Catalysts," presented at the 192nd Natl. Meeting of the ACS, Anaheim, CA., August 1986.
15. "Carbon-13 Solid State NMR of Small Molecules Adsorbed on Supported Metal Catalysts," presented at the 25th Eastern Analytical Symposium, New York, NY., October 1986.

16. "Application of Solid State NMR Techniques to Structural Organic and Inorganic Chemistry" presented at the Dept. of Chemistry, Harvard University, Cambridge, MA., November 1986.

1987

17. "Solid State NMR Techniques on the Horizon," presented at the Pittsburgh Conference, Atlantic City, NJ., March 1987.
18. "Solid State NMR of Intermediates in Matrices and on Surfaces" presented at the Department of Chemistry, Texas A&M University and the Dept. of Chemistry University of Texas at Austin, April 1987.
19. "Solid State NMR Methods Applied to Structural Problems in Organic and Inorganic Chemistry" presented at the Department of Chemistry, University of Chicago, Chicago, IL., April 1987.
20. "Two Dimensional Solid State NMR Methods Applied to Whole Coals and Chemically Modified Coals," presented at the Storch Award Symposium, 193rd National Meeting of the ACS, Denver, CO., April 1987.
21. "Strategies for Solid State NMR of Matrix Isolated Photochemical Intermediates" presented at the Nuclear Magnetic Resonance Gordon Conference, June 1987, Wolfeboro, NH.
22. "Magic Angle Spinning NMR of Matrix Isolated Photochemical Intermediates" presented at the Dept. of Chemistry, University of Massachusetts, Amherst, MA., Sept. 1987.
23. "Solid State NMR of Transition Metal Dihydrogen Complexes and Multiply Bonded Main Group Compounds", presented at the 194th Natl. Meeting of the ACS, New Orleans, LA., Sept. 1987 in symposium on "Applications of Solid State NMR in Inorganic Chemistry".
24. "Solid State NMR in Inorganic Chemistry" presented at Sun Oil, Marcus Hook, PA., Oct. 1987.
25. "13C Solid State NMR of Small Molecules Adsorbed on Supported Metal Catalysts" presented at the Catalysis Club, Wilmington, DE., Oct. 1987.
26. "Matrix Isolation NMR of Photochemical Intermediates", Dow-Bucknell Lecture, Dept. of Chemistry, Bucknell University, Lewisburg, PA., Oct. 1987.
27. "Solid State NMR of Matrix Isolated Photochemical Intermediates" presented at the Dept. of Chemistry, Justus-Liebig University, Giessen, West Germany, Nov. 1987.
28. "13C NMR of Surface Adsorbed Molecules" presented in the Physics and Chemistry of Microelectronics and Surfaces lecture series, Dept. of Physics, University of Stuttgart, West Germany, Nov. 1987.
29. "Solid State NMR of Small Molecules on Supported Metal Catalysts," presented at the meeting of Materials Research Society, Boston, MA., December 1987.

1988

30. "Solving Structural Problems in Organic and Inorganic Chemistry with Solid State NMR" presented at the dedication of the joint Lehigh University-Air Products and Chemicals NMR Facility, Lehigh University, Bethlehem, PA., May 31, 1988.
31. "Two-Dimensional NMR in Solids" presented at the 30th Rocky Mountain Conference, Denver, CO., July 1988.
32. "Applications of Solid State NMR to Problems in Structural Organic and Inorganic Chemistry" presented at the Dept. of Chemistry, Villanova University, Villanova, PA., Sept. 27, 1988.

33. "Solid State NMR Applied to Structural Problems in Organic and Inorganic Chemistry" presented at the Dept. of Chemistry, Carnegie-Mellon University, Pittsburgh, PA., Oct. 1988.

1989

34. "Solid State NMR of Non-Classical Polyhydrides" presented at the symposium on Solid State NMR in honor of Prof. John S. Waugh's 60th birthday, MIT, Cambridge, MA., January 1989.
35. "Quantum Mechanical Exchange of Polyhydrides in Solution" presented at AT&T Bell Laboratories, Murray Hill, NJ., Feb. 22, 1989.
36. "Quantum Mechanical Exchange Couplings in Polyhydrides: An Unexpected Example of Quantal Motion of Atoms at Ambient Temperatures" presented at the symposium on Physical Organic Chemistry in honor of Prof. Josef Michl's 50th birthday, Dept. of Chemistry, University of Texas at Austin, Austin, TX., March 1989.
37. "Novel Effects in the NMR of Atomic Clusters" presented at the 30th Experimental NMR Conference, Asilomar, CA., April 1989.
38. "NMR of CO on Supported Metal Catalysts" presented at the 197th ACS National Meeting, Dallas, TX., April 1989.
39. "Solving Structural Problems in Organic and Inorganic Chemistry Using Solid State NMR" presented at the Molecular Science Research Center, Battelle Pacific Northwest Laboratories, Richland, WA., April 25, 1989.
40. "Quantum Mechanical Exchange and NMR" presented at the 31st Rocky Mountain Conference, Denver, CO., August 1989.
41. "Some Surprising Results in the Relaxation Behavior of the Argonne Premium Coals" presented at the 31st Rocky Mountain Conference, Denver, CO., August 1989.
42. "An Alternative Approach to NMR at Very High Fields: NMR in Inhomogeneous Magnets" presented at the Battelle Pacific Northwest Laboratory Workshop on "High Field NMR and Biological Applications", Richland, WA., August 1989.
43. "Quantum Exchange in NMR" presented at the Department of Chemistry, Rennsalaer Polytechnic Institute, Troy, NY., August 1989.
44. "Quantum Size Effects and the NMR of ¹³CO on Supported Metal Catalysts" presented at the XVI FACSS Meeting, Chicago, IL., Oct. 1989.

1990

45. "Studying Quantum Mechanical Motion in Non-Classical Polyhydrides by NMR" presented at the Dept. of Chemistry, Lehigh University, Bethlehem, PA., Feb. 7, 1990.
46. "Solving Structural Problems in Organic and Inorganic Chemistry by Solid State NMR: From Captive Intermediates to Exchange Coupled Polyhydrides" presented at the Dept. of Chemistry, Washington University, St. Louis, MO., Feb. 15, 1990.
47. "Solving Structural Problems in Organic and Inorganic Chemistry by Solid State NMR: From Captive Intermediates to Exchange Coupled Polyhydrides" presented at the Dept. of Chemistry, University of Colorado at Boulder, Boulder, CO., Feb. 19, 1990.
48. "Solid State NMR Studies of CO and Ethylene Adsorbed on Supported Metal Catalysts" presented at the Dept. of Chemistry, University of Washington, Seattle, Washington, Mar. 7, 1990.
49. "NMR of Matrix Isolated Clusters and Clusters of Protons" presented at the University of Pittsburgh, Pittsburgh, PA., April 1990.

50. "NMR Studies of Nonclassical Polyhydrides: Exchange Couplings and Rotational Tunneling" presented at DuPont de Nemours & Co., Central Research and Development, Wilmington, DE., June 1990.
51. "Cross Polarization Under Very High Speed MAS: Its Not as Simple as We Thought" presented at Exxon Engineering and Research Company, Annandale, NJ., Nov. 5, 1990.
52. "Studies of Spin Dynamics in Solids" presented at the Dept. of Chemistry, Mass. Inst. of Tech., Cambridge, MA., Nov. 16, 1990.
53. "Solid State NMR in Materials Science" presented at the Dept. of Chemistry, University of Indiana, Purdue, Indiana, Dec. 14, 1990.

1991

54. "A Primer in Solid State NMR: From Basics to Recent Advances" presented at Olin Chemicals Research Center, Cheshire, CT., June 28, 1991.
55. "Rotational Tunneling and Quantum Exchange in Transition Metal Polyhydrides as Studied by NMR" presented at the Magnetic Resonance Gordon Conference, Wolfeboro, NH., July, 1991.
56. "Variable Temperature and Field Strength Relaxation in Argonne Premium Coals" presented at the 33rd Rocky Mtn. Conf., Denver, CO., July, 1991.
57. "Solid State NMR Studies of Small Metal Particles in Catalysts and Matrices" presented at the 33rd Rocky Mtn. Conf., Denver, CO., July, 1991.
58. "Quantum Exchange and Rotational Tunneling in Transition Metal Polyhydrides" presented at the symposium on "New Developments and Applications of Magnetic Resonance and Optical Spectroscopies", National meeting of the American Chemical Society, N.Y., NY., Aug. 25-30, 1991.
59. *ibid.*, presented at the Dept. of Chemistry, Mass. Inst. of Tech., Cambridge, MA., Sept. 1991.
60. *ibid.*, presented at the Dept. of Chemistry, Dalhousie University, Halifax, Nova Scotia, November, 1991.

1992

61. "Solid State NMR Studies of Small Metal Particles on Catalysts, in Zeolites and Isolated in Matrices" presented at the Dept. of Chemistry, Florida State University, Tallahassee, Florida, February, 1992.
62. "Quantum Exchange and Rotational Tunneling" presented in symposium "Tunneling in Condensed Matter" at the March National Meeting of the Am. Physical Soc., Indianapolis, IN., March, 1992.
63. *ibid.*, presented at the Dept. of Chemistry, Florida State University, Tallahassee, Fla., May, 1992.
64. "Comparison of Shielding Tensors for Different Nuclei in Isostructural Environments and Other Insights into Chemical Shielding From an Experimentalist's Viewpoint", Nato Adv. Research Workshop, Univ. of Maryland, College Park, MD, July, 1992.
65. "Quantum Exchange and Rotational Tunneling in Transition Metal Polyhydrides" presented at the Dept. of Chemistry, Univ. of California at Berkeley, Sept., 1992.

1993

66. "Quantum Exchange and Rotational Tunneling in Transition Metal Polyhydrides" presented at the Dept. of Chemistry, Columbia Univ., Feb. 1993.

67. "Quantum Exchange and Spin Statistics" presented at the Dept. of Physics, Yale University, April, 1993.
68. "Quantum Exchange" presented at the University of Illinois at Chicago, Nov., 1993.
69. "CPMAS Spectral Editing" presented at the University of Illinois at Chicago, Nov., 1993.

1994

70. "Optically Pumped NMR in High Magnetic Fields" presented at the national March meeting of the Am. Physical Society, Pittsburgh, PA, March 1994.
71. "Complete Spectral Editing in CPMAS Spectroscopy" presented at the 34th Experimental NMR conference, Asilomar CA, March, 1994.
72. "Spectral Editing in Solids: Applications to Organic Geochemistry", presented at Exxon Engineering and Research Corp., May, 1994.
73. "Solid State NMR and Spectral Editing: Applications to Geochemical Problems", presented at the 1994 Eastern Analytical Symposium, Somerset NJ, Nov. 1994

1995

74. "Quantum Exchange and Rotational Tunneling in Transition Metal Polyhydrides" and "NMR in Highly Polarized Samples", Dept. of Chemistry, Cornell Univ.
75. "NMR of Highly Polarized Samples" NMR Gordon Conf., Wolfeboro, NH, July 1995
76. "Solids NMR of Complex Mixtures and Macromolecules" 37th Rocky Mountain Conference, Denver, CO, July 1995.
77. "Solids NMR of Uniformly Labeled Macromolecules" presented at the Eastern Analytical Symposium, Somerset, NJ, Nov. 13, 1995.
78. "Differentiating Oil-Prone and Gas-Prone Source Rocks by Solids NMR" presented at Exxon Research and Engineering Corp., Nov. 1995.
79. "Differentiating Simple Models for Quantum Exchange: What Can We Test Experimentally?" presented at the 2nd International Conference on Hydrogen and Metals, Santa Fe, NM, Dec. 13, 1995.

1996

80. "New Approaches to Teaching Chemistry: Dealing with a Diverse Student Body" presented at the Gordon Conf. on Innovations in Chemical Education, North Hampton, NH, June 1996.
81. "Advances in NMR Instrumentation" presented at DuPont Experimental Station, Wilmington, DE, March 1996.
82. "High Field CPMAS NMR" presented at the 38th Rocky Mountain Conference, Denver, CO, July 1996.
83. "Spectral Editing in CPMAS NMR" presented at the Otsuka Electronics Solid State NMR Workshop, Estes Park, CO, July 1996.
84. "High Field CPMAS NMR: Problems and Prospects" presented at the Eastern Analytical Symposium, Somerset, NJ, Nov. 11, 1996.

1997

85. "New Approaches to Structure Determination by Solid State NMR: Horizons in Structural Biology presented at the Department of Chemistry, California Institute of Technology, Pasadena, CA, May 13, 1997.
86. "Decoupling and Recoupling Spin Dynamics Under High Speed Magic Angle Spinning"

- presented at the Eastern Analytical Symposium, Somerset, NJ, Nov. 14, 1997.
87. "Applications of Al-27, P-31 and V-51 MAS Double Resonance Experiments in Catalysis" to be presented at the 24th annual FACCS meeting, Providence, RI, Nov. 26, 1997.
 88. "Advances in High Speed MAS NMR" presented at the Workshop on Biological Solid-State NMR Spectroscopy, University of Pennsylvania, Philadelphia, PA, June 28-29, 1997.
 89. "Solids NMR of Uniformly C-13 Labeled Macromolecular Building Blocks: Assignment Strategies and Problems at High Fields" presented at the Chicago Area NMR meeting, Argonne National Laboratory, Nov. 1997.
 90. "Solids NMR of Uniformly C-13 Labeled Macromolecular Building Blocks: Assignment Strategies and Problems at High Fields" presented at the Department of Chemistry, University of Nebraska, Lincoln NE, Nov. 1997.

1998

91. "High Field CPMAS NMR: Problems and Prospects", colloquium presented at the Department of Chemistry, University of Nebraska, Lincoln, NE, Feb. 1998.
92. "High Field CPMAS NMR: Problems and Prospects", presented at the Department of Chemistry, SUNY-Brookhaven, Brookhaven, NY, Feb. 1998.
93. "Solids NMR of Uniformly Labeled Macromolecular Building Blocks", presented at 1998 Experimental NMR Conference, Asilomar, CA, Mar. 1998
94. "Solids NMR of Uniformly Labeled Macromolecular Building Blocks", presented at the Department of Chemistry, University of West Virginia, Mar. 1998
95. "Solids NMR of Uniformly Labeled Macromolecular Building Blocks", presented at NOVA Chemicals, Calgary, CA, Sept. 1998.
96. "Solids NMR of Uniformly Labeled Macromolecular Building Blocks", presented at the Department of Chemistry, Purdue University, Oct. 1998
97. "Solids NMR of Uniformly Labeled Macromolecular Building Blocks", presented at the Symposium on Magnetic Resonance, Schlumberger-Doll Research Center, Ridgefield, CT, Nov. 1998.

1999

98. "Solids NMR of Uniformly Labeled Macromolecular Building Blocks", presented at the Dupont Experimental Research Station, Wilmington, DE, Jan. 1999
99. "Towards Multidimensional Solids NMR of Uniformly Labeled Macromolecules" presented at the Department of Chemistry, Colorado State University, Feb. 1999.
100. "Towards Multidimensional Solids NMR of Uniformly Labeled Macromolecules" colloquium presented at the Department of Chemistry, University of Colorado, Feb. 1999.
101. "Multidimensional Solids NMR of Uniformly Labeled Macromolecular Building Blocks and Proteins", presented at Argonne National Laboratory, Chemistry Division Seminar Series, Argonne, IL Mar. 1999
102. "Multidimensional Triple Resonance Solids NMR of Uniformly Labeled Proteins", presented at the Magnetic Resonance Gordon Conference, July 1999, NH.
103. "Multidimensional Triple Resonance Solids NMR of Uniformly Labeled Proteins", presented at the Midwest Magnetic Resonance Conference, October, 1999, Akron, OH.

2000

104. "Challenges in High Field Solids NMR of Uniformly Labeled Proteins" presented at the Laboratory for Molecular Biophysics, Rockefeller University, NY, NY, March 2000.

105. "High Field Magnetic Resonance of Uniformly Labeled Macromolecules" presented at the 42nd Rocky Mountain Conference, Denver CO, July, 2000.
106. "RF Inhomogeneity, CP Dynamics and High Field MAS NMR" presented at the Chemagnetics Solid State NMR Workshop, Estes Park, CO, July 2000.
107. "High Field Solids NMR of Uniformly Labeled Macromolecules" presented at the 2000 International Chemical Congress of Pacific Basin Societies, Honolulu, Hawaii, December 14-19, 2000.

2001

109. "Towards Solids NMR Structure Determination of Ligand-Receptor Complexes" Department of Molecular Pharmacology, Physiology & Biotechnology, Brown University, Providence RI, January 2001.
110. "Solids NMR Methods for Determining Structure in Macromolecular Assemblies" the Picower Institute, Stonybrook NY, February 2001.
111. "Solids NMR Meets Liquids NMR" Washington Area NMR Group, NIH, Bethesda MD, May 2001.
112. "Principles of CPMAS NMR" and "High Field CPMAS NMR Applications", invited lectures presented at the Waterloo NMR Summer School, Univ. of Waterloo, Waterloo, ON, CA, June 2001.

2002

113. "High Resolution NMR of Solid and Semi-Solid Macromolecules", presented at the Department of Chemistry, University of Utah, Salt Lake City, UT, March 2002.
114. "New Approaches to Obtaining Structural Information from Large Molecules: High Resolution NMR of Solid and Semi-Solid Macromolecules", presented at the Department of Chemistry, University of Alberta, Edmonton, Alberta, May 2002.
115. "High Field Solids NMR of Proteins and Nucleic Acids: Spectral Assignment and Distance Constraints" International Conference on Analytical Sciences and Spectroscopy, Toronto, Ontario, May 2002.

2003

116. "NMR of Macromolecules as Solids and Semi-Solids: New Approaches to Molecular Structure and Chemistry", presented at the Department of Chemistry, New York University, New York City, NY, April 14, 2003.
117. "High Field Solids NMR of Proteins and Nucleic Acids", presented at the 45th Rocky Mountain Conference, Denver, Colorado, July 2003.
118. "High Field H-1, C-13 and N-15, NMR of Nanocrystalline Macromolecules", presented at the Third Alpine NMR Conference, Chamonix, France, September, 2003.
119. "Probing Macromolecular Structure with Solid State NMR: Spin Exchange, NOEs, Resonance Assignments and Water", presented at the Department of Chemistry, University of Illinois at Chicago, Chicago, Illinois, November, 2003.

2004

120. "Probing Macromolecular Structure in Nanocrystalline Proteins with Solid State NMR: Spin Exchange, NOEs, Resonance Assignments and Water", presented at the 5th Biennial Structural Biology Symposium on Membranes: A Challenge for Protein Magnetic Resonance, Tallahassee FL, January, 2004.

121. "The State of the Art in Solids NMR of Biopolymers: Strategies for Obtaining Resonance Assignments and Distance Constraints", presented at DuPont Central Research and Development, February, 2004.
122. "Probing Macromolecular Structure with Solid State NMR: Spin Exchange, NOEs, Resonance Assignments and Water", to be presented at the University of Connecticut Medical Center, Farmington, Connecticut, February, 2004.
123. "Probing Macromolecular Structure with Solid State NMR: Spin Exchange, NOEs, Resonance Assignments and Water", presented at the Department of Chemistry, MIT, Cambridge, MA., February, 2004.
124. "Probing Macromolecular Structure with Solid State NMR: Spin Exchange, NOEs, Resonance Assignments and Water", presented at the Department of Chemistry, University of California at Davis, Davis, California, April, 2004.
125. "Probing Macromolecular Structure and Chemistry in Nanocrystalline Proteins", presented at the 48th Experimental NMR Conference, Asilomar, California, April 2004.
126. "Making Solids NMR Look like Liquids NMR", Varian NMR workshop, Stanford University, Palo Alto, California, April 2004.
127. "Probing Macromolecular Structure in Nanocrystalline Proteins with Solid State NMR: Spin Exchange, NOEs, Resonance Assignments and Water", presented at the Canadian Society of Chemistry national meeting, London, Ontario, June 2004.
128. "High Resolution Solid State NMR: A Powerful Tool for Detecting Crystallinity and Distinguishing Polymorphs", presented at Transform Pharmaceuticals, Massachusetts, June 2004.
129. "Solid State NMR in Deuterated Proteins", presented at the 46th Rocky Mountain Conference, Denver, Colorado, August 2004.
130. "MAS NMR of Nanocrystalline Proteins", presented at the Small Molecules are Still Hot (SMASH) NMR meeting, Breckenridge, CO, September 2004.
131. "Physical Chemistry of Proteins by Solid State NMR Nanocrystallography: Spin Exchange, NOEs, the Glass Transition and Water", presented at Glaxo Smith-Kline, King of Prussia, PA, September 2004.
132. "High Resolution Solid State NMR in Extensively Deuterated Proteins", presented at the 15th Triennial Conference of the International Society of Magnetic Resonance (ISMAR), Ponte Vedra Beach, FL, October 2004.

2005

133. "Solid State NMR Nanocrystallography", presented at the Department of Chemistry, University of Maryland, College Park, MD, February 8 2005.
134. "Physical Chemistry of Proteins by Solid State NMR Nanocrystallography: Spin Exchange, NOEs, the Glass Transition and Water", presented at the Department of Chemistry, Brandeis University, Boston, MA, February 28, 2005.
135. "Adventures in the Chemistry Curriculum and Outreach Education", presented at the Department of Chemistry, Brandeis University, Boston, MA, March 1, 2005.
136. "Probing Physical Chemistry in Proteins by Solid State NMR Nanocrystallography", presented at the Washington University NMR Discussion Group, St. Louis, MO, February 2005.
137. "High Resolution Solid State NMR in Extensively Deuterated Proteins", presented at the National Cancer Institute, Frederick, MD, March 2005.

138. "Physical Chemistry of Proteins by Solid State NMR Nanocrystallography", presented at the University of Michigan, Ann Arbor, MI, March 2005.
139. "NMR Nanocrystallography: Resonance Assignment and Structure Determination of Extensively Deuterated Proteins in the Solid State", presented at the 46th Experimental NMR Conference, Providence, RI, April 2005.
140. "Solid State NMR Nanocrystallography: a Window into the Physical Chemistry of Proteins", presented at the department of Chemistry, University of Washington, April 2005.
141. "Solid State Proton NMR Protein Nanocrystallography", NMR symposium, Forschungsinstitut für Molekular Pharmakologie, Berlin, Germany, May 23, 2005.
142. "Physical Chemistry and Structure of Proteins as Studied by Solid State NMR Nanocrystallography", presented at the Magnetic Resonance in Chemistry and Physics Gordon Conference, New London, CT, June 2005.
143. "Solid State NMR Nanocrystallography of Deuterated Protein", presented at the 4th Alpine Solid State NMR Conference, Chamonix, France, September 2005.
144. "Structure and Dynamics by Solid State NMR in an Extensively Deuterated Protein", Eastern Analytical Symposium, Somerset, NJ, November 2005.
145. "Probing Physical Chemistry in Proteins by Solid State NMR Nanocrystallography", presented at PACIFICHEM2005, Honolulu, HI, December 2005.

2006

146. "Solid State NMR Nanocrystallography: A Spectroscopic Window into the Physical Chemistry of Large Molecules", Department of Chemistry, University of Utah, Salt Lake City, UT, February 2006.
147. "Solid State NMR Nanocrystallography: A Window into the Physical Chemistry and Structures of Large Molecules", Department of Chemistry, Michigan State University, East Lansing, MI, March 2006.
148. "High Field Solid State NMR of Proteins: Structure and Beyond" Workshop on High Field Solid State NMR, College of William and Mary, Williamsburg, VA, March 2006.
149. "Solid State ^1H NMR Nanocrystallography: A Window into the Physical Chemistry of Proteins" PittConn 2006, Orlando, FL, March 2006.
150. "Methyl Groups and Water in the Solid State NMR of Nanocrystalline Proteins", EUROMAR, York, England, July 2006.

2007

151. "Solid State NMR Nanocrystallography: A Spectroscopic Window into the Physical Chemistry of Proteins", Department of Chemistry, Ohio State University, Columbus OH, February 2007.
152. "Spin Exchange and Cross Relaxation in the Solid State NMR of Proteins", Experimental NMR Conference, Daytona, FL, April 2007.
153. "Methyl Groups and Water in the Solid State NMR of Nanocrystalline Proteins", Rocky Mountain Conference on Analytical Chemistry, Breckenridge, CO, July 2007
154. "Solid State NMR Nanocrystallography: A Spectroscopic Window into the Physical Chemistry of Large Molecules", Department of Chemistry, Virginia Tech University, September 2007.

155. "Structure Determination, Methyl Groups, Water and Cross Relaxation in the Solid State NMR of Proteins", Eastern Analytical Symposium, Somerset NJ, November 2007.

2008

156. "Structure and Dynamics of Proteins and their Associated Water as Probed by Solid State NMR", at symposium, NMR: A Tool for Biology, Institute Pasteur, Paris, January 2008.

157. "Structure Determination, Methyl Groups, Water and Cross Relaxation in the Solid State NMR of Proteins", Department of Chemistry, University of Virginia, March 2008.

158. "Strategies to Improve Sensitivity in Solids NMR of Proteins", 50th Rocky Mountain Conference on Analytical Chemistry, Breckenridge, CO, July 2008.

159. "Structure and Dynamics of Proteins and their Associated Water as Probed by Solid State NMR", Department of Chemistry, MIT, Boston, MA, October 2008.

2009

160. Perspectives on Science: "Magnets, Molecules and Radio Waves: Imaging Molecules, Cells and the Human Body with Magnetic Resonance", April 17, 2009

161. "NMR Nanocrystallography: Structure, Water and Molecular Dynamics in Proteins as Studied by Solid State NMR", UC Davis NMR symposium, Davis, CA, March 2009.

162. "Solid State in Complex Systems" the Robert Vaughan memorial lecture, Rocky Mountain Conference on Analytical Chemistry, July 2009.

2010

163. "NMR Nanocrystallography: Structure, Water and Molecular Dynamics in Proteins as Studied by Solid State NMR", Department of Chemistry, Dartmouth, Hanover, NH January 2010.

164. "NMR Nanocrystallography: Structure Water and Molecular Dynamics in Proteins Studied by Solid State NMR", Merck, Rahway, NJ.

165. "A Simple Analytic Formalism Accounts for ^{13}C and ^{15}N T_1 Relaxation of Solid Proteins and Peptides Under MAS", presented at the 51st ENC, Daytona Beach, FL, April 2010

166. "Measuring Amplitudes and Correlation Times of Motions in Proteins by Solid State NMR", PacifiChem 2010, Honolulu, HI, December 2010.