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## EDUCATION

1990-1995     **Harvard University**     Cambridge, MA  
Ph.D. in Chemistry, June 1995.  
Thesis advisor: Professor David J. Singel

1985-1990     **University of Wisconsin**     Madison, WI  
B.S. in Physics, graduated with distinction, May 1990.  
Advisor: Professor Thatcher E. Root

## POSTDOCTORAL TRAINING

2002-2008     **Massachusetts General Hospital**     Charlestown, MA  
Postdoctoral Research Fellow, Department of Radiology  
Advisors: Professors Bruce R. Rosen, A. Gregory Sorensen,  
and Jerome L. Ackerman

1995-2002     **Massachusetts Institute of Technology**     Cambridge, MA  
Postdoctoral Fellow, Francis Bitter Magnet Laboratory  
Advisor: Professor Robert G. Griffin

## ACADEMIC APPOINTMENTS

2008-     Instructor in Radiology, Harvard Medical School     Boston, MA

2008-     Assistant in Neuroscience, Department of Radiology,  
Massachusetts General Hospital     Boston, MA

## RESEARCH EXPERIENCE

*Magnetic Resonance Imaging (MGH, 2002-present)*

- MR molecular imaging of Alzheimer's Disease biomarkers
- MRI studies of tumor response to anti-angiogenic therapies in a mouse brain tumor model.
- Development of Off-Resonance and Chemical Exchange Saturation Transfer Imaging methods.
- *In vivo* MR imaging of gene expression using novel iron-oxide nanoparticle contrast agents.
- <sup>31</sup>P NMR studies of the effects of muscle metabolism on ventilatory control.
- High field (4.7-9.4 T) mouse cardiac imaging.
- Development of novel RF coils for intravascular imaging of atherosclerotic plaques.

*Pulsed and CW Dynamic Nuclear Polarization NMR (MIT, 1995-2002)*

- Development of high frequency (140 and 250 GHz) pulsed- and CW-Dynamic Nuclear Polarization techniques for achieving signal enhancements in solid-state NMR.

*High Frequency Electron Paramagnetic Resonance (EPR) Spectroscopy (MIT, 1995-2002)*

- EPR studies of enzyme catalysis involving amino acid radicals in photosystem II (PS-II) and ribonucleotide reductase (RNR).
- Analysis of HF-EPR spectra of biradical spin labeled peptides to obtain distance and orientation information.
- Development of a 140 GHz pulsed EPR/ENDOR spectrometer and a 250 GHz pulsed- and CW-EPR spectrometer.

*Density Functional Molecular Orbital Calculations (MIT, 1995-2002)*

- Calculations of the electronic structure, electron g-values, and hyperfine couplings of tyrosyl and allyl radicals implicated in playing important catalytic roles in PS-II and RNR.

*Electron Spin Echo Envelope Modulation (ESEEM) Spectroscopy (Harvard, 1990-1995)*

- Studies of the structure and function of the G protein p21<sup>Ras</sup>, mutants of which have been implicated in ~30 % of human cancers, and its interactions with GTPase activating protein (GAP).
- ESEEM studies of the electronic and molecular structure of Ni(I) analogues of the active site of carbon monoxide dehydrogenase.
- Theoretical *ab initio* and experimental EPR and ESEEM studies of the electronic structure of [Al(dpt)<sub>3</sub>]<sup>-</sup>.

*Pulsed Field Gradient Spin-Echo (PFGSE) NMR (University of Wisconsin, 1989-1990)*

- Studied the use of, shaped, bipolar field gradients in NMR PFGSE experiments to eliminate errors in the determination of diffusion constants caused by eddy currents induced in the magnet due to the pulsed field gradients.

**TEACHING EXPERIENCE**

- 2001      Guest Lecturer, Spatial Aspects of Nuclear Magnetic Resonance Spectroscopy (22.562)  
Department of Nuclear Engineering, Massachusetts Institute of Technology
- 2001      Guest Lecturer, Principles of Nuclear Magnetic Resonance Spectroscopy (5.80)  
Department of Chemistry, Massachusetts Institute of Technology
- 2000      MIT Undergraduate Research Project Supervisor  
Author: Benedicte Elena  
Thesis title: Dynamic Nuclear Polarization at 9 T applied to Solid State Nuclear  
Magnetic Resonance
- 1994-1995    Teaching Fellow, Statistical Thermodynamics  
Department of Chemistry, Harvard University.
- 1993-1994    Teaching Fellow, Physical Chemistry

Department of Chemistry, Harvard University.

1990-1991 Teaching Fellow, Introduction to the Principles of Chemistry  
Department of Chemistry, Harvard University.

### AWARDS AND HONORS

2007-2012 NIH K25 Mentored Career Development Award, MGH (1-K25-AG029415-01A1)  
2005-2006 NIH NCI Training Grant, MGH (5-T32-CA009502-19)  
1997-1999 NIH Postdoctoral Fellowship, MIT (1-F32-GM18790-02)  
1991-1993 NIH Biophysics Training Grant, Harvard University  
1990 Honorable Mention, NSF Pre-Doctoral Fellowship  
1990 Graduated with Distinction, University of Wisconsin-Madison  
1989 Albert Augustus Radtke Scholarship, University of Wisconsin-Madison  
1987 Phi Beta Kappa, University of Wisconsin-Madison

### PUBLICATIONS

1. Characterization of the active site of p21 ras by electron spin-echo envelope modulation spectroscopy with selective labeling; Comparison between GDP and GTP forms. C.J. Halkides, C.T. Farrar, R.G. Larsen, A.G. Redfield, and D.J. Singel. *Biochemistry* **33**(13), 4019-4035 (1994).
2. Characterization of optical centers in Mn:Ba<sub>3</sub>(VO<sub>4</sub>)<sub>2</sub> by spin-echo EPR spectroscopy. M.H. Whitmore, C.T. Farrar, D.J. Singel, B. Buysee, J. Coremans, and J. Schmidt. *OSA Proc. on Adv. Solid-State Lasers* **20**, 219-221 (1994).
3. Electronic structure of the tris-(1,3-diphenyltriazenido)aluminum radical anion: A theoretical and experimental EPR and ESEEM study. C.T. Farrar, J.T. Leman, S.C. Larsen, J. Braddock-Wilking, D.J. Singel, and A.R. Barron. *J. Am. Chem. Soc.* **117**, 1746-1753 (1995).
4. Radical anion complexes of tris-(1,3-diphenyltriazenido)aluminum. J. Braddock-Wilking, J.T. Leman, C.T. Farrar, S.C. Larsen, D.J. Singel, and A.R. Barron. *J. Am. Chem. Soc.* **117**, 1736-1736-1745 (1995).
5. The active site of p21 ras: Conformational changes induced by the binding of nucleotides. C.J. Halkides, C.T. Farrar, A.G. Redfield, and D.J. Singel. *Biolog. Str. & Dynamics*, Vol. 1, R.H. Sarma & M.H. Sarma, Eds., Adenine Press, Guilderland, New York (1995).
6. High frequency (139.5 GHz) electron paramagnetic resonance spectroscopy of the GTP form of p21 ras with selective <sup>17</sup>O-labeling of threonine. C.J. Halkides, B.F. Bellew, G.J. Gerfen, C.T. Farrar, P.H. Carter, B. Ruoll, D.A. Evans, R.G. Griffin, and D.J. Singel. *Biochemistry* **35**(37), 12194-12200 (1996).
7. Electronic structure of the Y<sub>D</sub> tyrosyl radical in photosystem II: A high frequency EPR spectroscopic and density functional theoretical study. C. T. Farrar, G. J. Gerfen, R. G. Griffin, Dee Ann Force, and R. David Britt. *J. Phys. Chem. B* **101**, 6634-6641 (1997).

8. The frozen solution structure of p21 ras determined by ESEEM spectroscopy reveals weak coordination of Thr35 to the active site metal ion. C.T. Farrar, C.J. Halkides, and D.J. Singel. *Structure* **5**(8), 1055-1066 (1997).
9. Characterization of a substrate derived radical detected during the inactivation of ribonucleotide reductase from Escherichia coli by 2'-fluoromethylene-2'-deoxycytidine 5'-diphosphate. G.J. Gerfen, W.A. van der Donk, G. Yu, J.R. McCarthy, E.T. Jarvi, D.P. Matthews, C.T. Farrar, R.G. Griffin, and J. Stubbe. *J. Am. Chem. Soc.* **120**(16), 3823-3835 (1998).
10. The effects of cryoprotectants on the structure and activity of p21 ras: Implications for electron spin-echo envelope modulation spectroscopy. C.J. Halkides, C.T. Farrar, and D.J. Singel. *J. Magn. Reson.* **134**, 142-153 (1998).
11. The use of a 250 GHz gyrotron in a DNP/EPR spectrometer. K.E. Kreisler, C.T. Farrar, R.G. Griffin, and R.J. Temkin, *Proc. 23rd Intl. Conf. Infrared and Millimeter Waves*, 357-358 (1998).
12. Pulsed electron nuclear double resonance (ENDOR) at 140 GHz. M.L. Bennati, C.T. Farrar, J.A. Bryant, S.J. Inati, V. Weis, G.J. Gerfen, P. Riggs-Gelasco, J. Stubbe, and R.G. Griffin. *J. Magn. Reson.* **138**, 232-243 (1999).
13. High frequency dynamic nuclear polarization in the nuclear rotating frame. C.T. Farrar, D.A. Hall, G.J. Gerfen, M. Rosay, and R.G. Griffin. *J. Magn. Reson.* **144**, 134-141 (2000).
14. Structural changes induced in p21<sup>Ras</sup> upon GAP-334 complexation as probed by ESEEM spectroscopy and molecular dynamics simulation. C.T. Farrar, J. Ma, D.J. Singel, and C.J. Halkides. *Structure* **8**(12), 1279-1287 (2000).
15. Electron spin resonance of TOAC labeled peptides: Folding transitions and high frequency spectroscopy. J.C. McNulty, J.L. Silapie, M. Carnevali, C.T. Farrar, R.G. Griffin, F. Formaggio, M. Crisma, C. Toniolo, and G.L. Millhauser. *Biopolymers (Peptide Science)* **55**, 479-485 (2000).
16. Mechanism of dynamic nuclear polarization at high magnetic fields. C.T. Farrar, D.A. Hall, G.J. Gerfen, S.J. Inati, and R.G. Griffin. *J. Chem. Phys.* **114**, 4922-4933 (2001).
17. Dynamic nuclear polarization at 9 Tesla using a novel 250 GHz gyrotron microwave source. V.S. Bajaj, C.T. Farrar, M.K. Hornstein, I. Mastovsky, J. Viereg, J. Bryant, B. Elena, K.E. Kreisler, R.J. Temkin, and R.G. Griffin. *J. Magn. Reson.* **160**, 85-90 (2003).
18. Cylindrical meanderline radiofrequency coil for intravascular magnetic resonance studies of atherosclerotic plaque. C.T. Farrar, V.J. Wedeen, and J.L. Ackerman. *Magn. Reson. Med.* **53**, 226-230 (2005).
19. In vivo imaging of siRNA delivery and silencing in tumors. Z. Medarova, W. Pham, C.T. Farrar, V. Petkova, and A. Moore. *Nature Med.* **13**, 372-377 (2007).
20. Effects of a nucleoside reverse transcriptase inhibitor, stavudine, on glucose disposal and mitochondrial function in muscle of healthy adults. A. Fleischman, S. Johnsen, D.M. Systrom, M.

Hrovat, C.T. Farrar, W. Frontera, K. Fitch, B.J. Thomas, M. Torriani, H.C.F. Côté, and S.K. Grinspoon. *Am. J. Physiol. Endocrinol. Metab.* **292**, E1666-E1673 (2007).

21. MR contrast probes that trace gene transcripts for cerebral ischemia in live animals. C.H. Liu, S. Huang, J. Cui, Y.R. Kim, C.T. Farrar, M.A. Moskowitz, B.R. Rosen, and P.K. Liu. *FASEB* **21**, 3004-3015 (2007).
22. Corrections for artifacts in chemical exchange saturation transfer (CEST) imaging from B0 and B1 field errors. P.Z. Sun, C.T. Farrar, and A.G. Sorensen. *Magn. Reson. Med.* **58**, 1207-1215 (2007).
23. Impact of field strength and iron-oxide nanoparticle concentration on the linearity and diagnostic accuracy of off-resonance imaging. C.T. Farrar, G. Dai, M. Novikov, A. Rosenzweig, R. Weissleder, B.R. Rosen, and D.E. Sosnovik. *NMR Biomed* **21**, 453-463 (2008).
24. Influence of molecular parameters and increasing magnetic field strength on relaxivity of T1 contrast agents. P. Caravan, C.T. Farrar, L. Frullano, and R. Uppal. *Contrast Media Molec Imag* **4**, 89-100 (2009).
25. Edema control by cediranib, a VEGF targeted kinase inhibitor, prolongs survival despite persistent brain tumor growth in mice. W.S. Kamoun,\* C.D. Ley,\* C.T. Farrar,\* A.M. Duyverman, J. Lahdenranta, D.A. Lacorre, T.T. Batchelor, E. Di Tomaso, D.G. Duda, L.L. Munn, D. Fukumura, A.G. Sorensen, and R.K. Jain. *J Clin Oncol* **27**, 2542-2552 (2009).

\* these authors contributed equally

26. Target-specific contrast agents for magnetic resonance microscopy. M.L. Blackwell, C.T. Farrar, B. Fischl, and B.R. Rosen. *NeuroImage* **46**, 382-393 (2009).
27. In vivo validation of MRI vessel caliber index (VCI) measurement methods with intravital optical microscopy in a U87 mouse brain tumor model. C.T. Farrar, W. Kamoun, C.D. Ley, Y.R. Kim, G. Dai, B.R. Rosen, E. Di Tomasso, R.K. Jain, and A.G. Sorensen. *Neuro-Oncology* (accepted for publication, 2009).

## PRESENTATIONS

1. ESEEM of  $^{17}\text{O}$  Nuclei in Metal-Ligand Complexes. 15<sup>th</sup> International EPR Symposium, Rocky Mountain ACS Conference, Denver, CO (1992). Poster.
2. Multifrequency ESEEM and EPR Studies of Radical Anion Complexes of  $\text{Al}(\text{PhNNNPh})_3$ . 16<sup>th</sup> International EPR Symposium, Rocky Mountain ACS Conference, Denver, CO (1993). Oral presentation.
3. Electronic Structure of  $\text{Al}(\text{PhNNNPh})_3$  Radical Anion: An Experimental and Theoretical Study. MIT Magnetic Resonance Seminar Series, Cambridge, MA (1994). Oral presentation.
4. Dynamic Nuclear Polarization in the Nuclear Rotating Frame. Symposium on NMR, Rocky Mountain ACS Conference, Denver, CO (1997). Poster.

5. Mechanistic Studies of High-Frequency Dynamic Nuclear Polarization: 140 GHz Pulsed EPR and ELDOR Investigations of Electron Cross Relaxation. Symposium on NMR, Rocky Mountain ACS Conference, Denver, CO (1997). Poster.
6. 139.5 GHz Pulsed EPR and Double Resonance. International Experts' Workshop on the Present and Future of HF-EPR Instrumentation, Champaign-Urbana, IL (1998). Oral presentation.
7. Development of High Frequency Pulsed EPR and ENDOR for Protein Structure Studies. Metals in Biology, Gordon Conference, Ventura, CA (1999). Oral presentation.
8. High Frequency EPR of Biradical MTS and TOAC Spin-Labeled Peptides: Analysis of Dipolar and Exchange Interactions. 22<sup>nd</sup> International EPR Symposium, Rocky Mountain ACS Conference, Denver, CO (1999). Poster.
9. High Frequency EPR and ENDOR Studies of the Hydrogen Bonding Environment of the Y<sub>Z</sub> Tyrosyl Radical of Photosystem II. 22<sup>nd</sup> International EPR Symposium, Rocky Mountain ACS Conference, Denver, CO (1999). Poster.
10. Dynamic Nuclear Polarization at 9 Tesla and Beyond. 41<sup>st</sup> Experimental NMR Conference (ENC), Asilomar, CA (2000). Oral presentation.
11. Dynamic Nuclear Polarization at 9 Tesla and Beyond. Symposium on NMR, Rocky Mountain ACS Conference, Broomfield, CO (2000). Oral presentation.
12. Mechanism of Dynamic Nuclear Polarization in High Magnetic Field. Gordon Research Conference on Magnetic Resonance, Bristol, RI (2001). Oral presentation.
13. The Cylindrical Meanderline Radio Frequency Coil for Intravascular Magnetic Resonance Studies of Atherosclerotic Plaque. 5<sup>th</sup> Interventional MRI Symposium, Cambridge, MA (2004). Poster.
14. Cylindrical Meanderline Intravascular MR Coils. 13<sup>th</sup> ISMRM Meeting, Miami, FL (2005). Poster. Honorable mention poster award.
15. A Dual Histology Stain/MRI Contrast Agent for Molecular Imaging of the Brain. 13<sup>th</sup> ISMRM Meeting, Miami, FL (2005). Poster.
16. Off-Resonance Spectroscopic Imaging of Iron Oxide Nanoparticles at Dilute Concentrations and High Field Strengths. 14<sup>th</sup> ISMRM Meeting, Seattle, WA (2006). Poster.
17. Skeletal muscle hydrogen ion concentration stimulates ventilatory drive through direct neural pathways as shown by <sup>31</sup>P MRS. 14<sup>th</sup> ISMRM Meeting, Seattle, WA (2006). Poster.
18. Off-Resonance Imaging of Superparamagnetic Iron-Oxide Nanoparticles in Infarcted Mouse Myocardium at Dilute Concentrations and High Magnetic Field Strengths. 10<sup>th</sup> SCMR Scientific Meeting, Rome, Italy (2007). Poster.

19. Impact of Field Strength and Iron-Oxide Nanoparticle Concentration on the Linearity and Diagnostic Accuracy of Off-Resonance Imaging. 6<sup>th</sup> Annual Molecular Imaging Conference, Providence, Rhode Island (2007). Oral presentation.
20. In vivo 2-photon microscopy validation of MRI vessel caliber index (VCI) measurement methods in a U87 mouse brain tumor model. 16<sup>th</sup> ISMRM Meeting, Toronto, ON (2008). Poster.
21. Edema control by anti-VEGF therapy prolongs survival despite persistent tumor growth in mice. 17<sup>th</sup> ISMRM Meeting, Honolulu, HI (2009). Oral presentation.
22. Characterization of a novel RNA aptamer probe for imaging amyloid plaques and oligomeric A $\beta$ . Society for Neuroscience Meeting, Chicago, IL (2009). Poster.