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Research Interests

- Alkali metals and noble gases for precision measurements, biomagnetism, and navigation

Positions

- Consultant, SRI International, Menlo Park, CA; Apr. 2020-Present
  - DARPA Program Support, Clearance: S

- Physicist, Twinleaf LLC, Princeton, NJ; Jan. 2018-Present
  - DARPA AMBIIENT (Atomic Magnetometer for Biological Imaging In Earth's Native Terrain): first unshielded magnetoencephalography using atomic sensors
  - Research small, low-power atomic magnetometers, develop table-top particle physics experiments, and hyperpolarized noble gases in miniature cells
  - DARPA N3 (Next-Generation Non-surgical Neurotechnology)

- Postdoctoral Research Associate, Associate Research Scholar, Lecturer, Dept. Guest, Department of Physics, Princeton University, Princeton, NJ; Apr. 2014 –Dec. 2019. PI: Mike Romalis
  - DARPA C-SCAN (Chip-Scale Combinatorial Atomic Navigator): noble-gas comagnetometry for a miniature NMR gyro, first to develop mm-sized ^{3}He-^{129}Xe-^{87}Rb cells with long noble gas coherence times
  - Long-term fundamental efforts include spin-gravity searches under an NSF grant, first to detect J-coupling between noble gas nuclei
  - Lecturer for general physics using Investigative Science Learning Environment (ISLE)

- Teaching + Research Assistant, Ph.D. Student, and Postdoctoral Research Associate, Department of Physics and Astronomy, University of Utah, Salt Lake City, UT; 2005-2007, 2009-2014.
  Project PIs: Brian Saam, Christoph Boehme, Mikhail Raikh, J. Lupton
  - Researched gaseous, liquid, and solid noble-gas spin relaxation mechanisms
  - Studied organic semiconductors for spintronic devices
  - Mentored undergraduates and high-school students
  - TA and course marshal, maintained WebAssign/BlackBoard for entry-level courses

- Adjunct Professor, Life and Natural Sciences Department, Owens Community College, Toledo, OH; 2009
  - General astronomy class, calculus-based applied physics class

- Teaching Assistant and Ph.D. Student, Department of Mathematics and Statistics, Bowling Green State University, Bowling Green, OH; 2007-2009
  - Teaching assistant for business calculus classes
  - Researched Runge-Kutta smoothing techniques

- Electrical Apprentice, L & B Electric, Grand Rapids, OH; 2006-2009
  - Assist the design and implementation of control systems

Education

- Ph.D., M.Sc., Physics – The University of Utah, 2005-2007;2009-2013, Salt Lake City, UT USA
  Dissertation Title: *^{129}Xe Relaxation and Rabi Oscillations*. Adviser: Brian Saam

- Ph.D. Program, Applied Mathematics – Bowling Green State University, 2007-2009, Bowling Green, OH USA. Adviser: Tong Sun (Masters All but thesis)

- B.Sc., Mathematics, Physics – Bowling Green State University, 2002-2005**,** Bowling Green, OH USA. Honors Title: *The Multi-Fractal Nature of Dynamical Systems*. Adviser: Haowen Xi

Publications

13. V. G. Lucivero, W. Lee, M. V. Romalis, M. E. Limes, E. L. Foley, T. W. Kornack, *A femtotesla quantum-noise-limited pulsed gradiometer at finite fields. In preparation*

12. M. E. Limes, N. Dural , M. V. Romalis, E. L. Foley, T. W. Kornack, A. Nelson, L. R. Grisham, *Long spin-1/2 coherence times in mm-sized anodically bonded ^{3}He-^{129}Xe-^{87}Rb cells. In preparation*

11. M. E. Limes, E. L. Foley, T. W. Kornack, S. Caliga, S. McBride, A. Braun, W. Lee, V. G. Lucivero, M. V. Romalis, *Portable magnetometry for detection of biomagnetism in ambient environments.* Phys. Rev. Applied *Letter* **14**, 011002 (2020) *Editors' Suggestion*
    Portable Sensor Detects Biomagnetic Signals in Noisy Outdoor Environments by Ian Randall, Physics World

10. M. E. Limes, N. Dural, M. V. Romalis, E. L. Foley, T. W. Kornack, A. Nelson, L. R. Grisham, J. Vaara, *Dipolar and scalar ^{3}He-^{129}Xe frequency shifts in stemless cells*. Phys. Rev. A **100**, 010501 (R) (2019)

9. M. E. Limes, D. Sheng, and M. V. Romalis, *^{3}He-^{129}Xe comagnetometry with ^{87}Rb detection and decoupling*, Phys. Rev. Lett. **120**, 033401 (2018).
    Editor's Suggestion, Featured in Physics, Viewpoint: https://physics.aps.org/articles/v11/5

8. M. E. Limes, Z. L. Ma, E. G. Sorte, and B. Saam, *Robust solid ^{129}Xe longitudinal relaxation times*, Phys. Rev. B **94**, 094309 (2016).

7. D. P. Waters, G. Joshi, M. Kavand, M. E. Limes, H. Malissa, P. L. Burn, J. M. Lupton, and C. Boehme, *The spin-Dicke effect in OLED magnetoresistance*, Nature Physics **11**, 910-914 (2015).

6. K. J. van Schooten, D. L. Baird, M. E. Limes, J. M. Lupton, and C. Boehme, *Probing carrier-pair spin-spin interactions in a conjugated polymer by detuning of electrically detected spin-beating*, Nature Communications **6**, 6688 (2015).

5. E. F. Thenell, M. E. Limes, E. G. Sorte, Z. V. Vardeny, and B. Saam, *Nuclear relaxation measurements in organic semiconducting polymers for application to organic spintronics*, Phys. Rev. B **91**, 045205 (2015).

4. M. E. Limes, J. Wang, W. J. Baker, S.-Y. Lee, B. Saam, and C. Boehme, *Numerical study of spin-dependent transition rates within pairs of dipolar and exchange coupled spins with s=1/2 during magnetic resonant excitation*, Phys. Rev. B **87**, 165204 (2013).

3. R. Glenn, M. E. Limes, B. Saam, C. Boehme, and M. E. Raikh, *Analytical study of spin-dependent transition rates within pairs of dipolar and strongly exchange coupled spins with s=1/2 during magnetic resonant excitation*, Phys. Rev. B. **87**, 165205 (2013).

2. R. Glenn, M. E. Limes, B. Pankovich, B. Saam, and M. E. Raikh, *Magnetic resonance in slowly modulated longitudinal field: Modified shape of the Rabi oscillations*, Phys. Rev. B. **87**, 155128 (2013).

1. L. P. Fulcher, R. C. Scherer, A. Melnykov, V. Gateva, and M. E. Limes, *Negative Coulomb damping, limit cycles, and self-oscillation of the vocal folds*, Am. J. Phys. **74**, 386 (2006).

Presentations

29. M. E. Limes, E. L. Foley, T. W. Kornack, S. Caliga, S. McBride, A. Braun, W. Lee, V. G. Lucivero, M. V. Romalis, *A portable ^{87}Rb gradiometer operating in Earth's field*, Contributed Talk
2020 APS DAMOP Meeting, 05/2020, Portland, OR (Online)

28. M. E. Limes, E. Foley, T. Kornack, *Pulsed Intrinsic Gradiometer operating in Earth's field*, Poster
2019 Workshop on Optically Pumped Magnetometers, 08/2019, Mainz, Germany

27. W. Lee, V.G. Lucivero, M. E. Limes, E. Foley, T. Kornack, M. V. Romalis, *Heading error analysis of a pulsed ^{87}Rb magnetometer at geomagnetic fields*, Poster
2019 APS DAMOP Meeting, 05/2019, Milwaukee, WI

26. V.G. Lucivero, W. Lee, M. V. Romalis, M. E. Limes, E. Foley, T. Kornack, *A femtotesla quantum-noise-limited pulsed gradiometer at Earth's magnetic fields*, Poster
2019 APS DAMOP Meeting, 05/2019, Milwaukee, WI

25. V.G. Lucivero, W. Lee, M. V. Romalis, M. E. Limes, E. Foley, T. Kornack *A femtotesla quantum-noise-limited pulsed gradiometer at finite fields*, Conference Paper,
https://doi.org/10.1364/QIM.2019.T3C.3
Quantum Information and Measurement (QIM) V: Quantum Technologies, 04/2019, Rome, Italy

24. A. Braun, S. McBride, S. Caliga, T. Kornack, E. Foley, M. E. Limes, V. G. Lucivero, W. Lee, M. V. Romalis, *Pulsed Intrinsic Gradiometer for Magnetometry in Earth's Native Terrain (PIGMENT)*
2019 DARPA AMBIIENT Meeting, 01/2019, Anaheim, CA

23. M. E. Limes, T. Kornack, E. Foley, *High-sensitivity pulsed magnetometer*, Contributed talk
2018 Workshop on Optically Pumped Magnetometers, 08/2018, Philadelphia, PA

22. T. Kornack, E. Foley, L. Grisham, D. Newby, M. E. Limes, *Applications of Twinleaf microfabricated alkali vapor cells*, Contributed talk
2018 Workshop on Optically Pumped Magnetometers, 08/2018, Philadelphia, PA

21. K. Zhao, A. Almasi, M. E. Limes, M. V. Romalis, *Suppressing Rubidium back-polarization in nuclear spin comagnetometer by radiation trapping assisted depolarization pumping*, Poster
2018 APS DAMOP meeting, 05/2018, Ft. Lauderdale, FL

20. M. E. Limes, N. Dural, M. V. Romalis, E. L. Foley, T. W. Kornack, A. Nelson, L. R. Grisham *Dipolar and scalar ^{3}He and ^{129}Xe frequency shifts in mm-sized cells*, Contributed Talk
    2018 APS DAMOP meeting, 05/2018, Ft. Lauderdale, FL

19. A. Braun, S. McBride, S. Caliga, T. Kornack, E. Foley, M. E. Limes, M. V. Romalis, *Pulsed Intrinsic Gradiometer for Magnetometry in Earth's Native Terrain (PIGMENT)*
    2018 DARPA AMBIIENT kickoff meeting, 03/2018, Washington DC

18. M. E. Limes, M. V. Romalis, *^{3}He-^{129}Xe Comagnetometery with ^{87}Rb Pulse-train Detection & Decoupling*, Contributed Talk
    2017 APS DAMOP meeting, 06/2017, Sacramento, CA

17. M. E. Limes, *Optical Detection of a Nuclear-spin Gyro*, Colloquium
    Miami University, 02/2017, Oxford, OH

16. M. E. Limes, D. Sheng, M. V. Romalis, *A ^{3}He-^{129}Xe co-magnetometer with ^{87}Rb magnetometry*, Poster
    2016 APS DAMOP meeting, 05/2016, Providence, RI

15. M. V. Romalis, M. E. Limes, D. Sheng, A. Kabcenell, N. Dural, T. Kornack, J. Foley, D. Newby, N, Ford, M. Rizzo, A. Nelson, D. Murray, *^{3}He-^{129}Xe Nuclear Spin Gyro*, Poster
    2016 Spring DARPA microPNT Program Review, 10/2015, San Diego, CA

14. M. E. Limes, D. Sheng, M. V. Romalis, *Progress on a ^{3}He-^{129}Xe co-magnetometer*, Poster
    2015 APS DAMOP meeting, 06/2015, Columbus, OH

13. M. V. Romalis, M. E. Limes, D. Sheng, A. Kabcenell, N. Dural, T. Kornack, J. Foley, *^{3}He-^{129}Xe Nuclear Spin Gyro*, Poster
    2015 Spring DARPA microPNT Program Review, 04/2015, Pittsburg, PA

12. M. V. Romalis, M. E. Limes, D. Sheng, A. Kabcenell, N. Dural, T. Kornack, J. Foley, *^{3}He-^{129}Xe Nuclear Spin Gyro*, Poster
    2014 Fall DARPA microPNT Program Review, 11/2014, San Antonio, TX

11. Z. L. Ma, K. Jeong, E. Houghtby, T. Paskvan, M. E. Limes, and B. Saam, *Noble gas polarimetry using Rb EPR frequency shifts*, Poster
    2014 APS DAMOP meeting, 06/2014, Madison, WI

10. M. E. Limes, *^{129}Xe Relaxation and Rabi Oscillations*
    Pines Lab Seminar, 12/2013, UC Berkeley, CA

9. E. Thenell, M. E. Limes, E. G. Sorte, and B. Saam, *Relaxation measurements in organic semiconducting polymers for applications to organic spintronics*, Poster
    2013 Experimental Nuclear Magnetic Resonance Conference, 04/2013, Asilomar, CA

8. M. E. Limes, R. Glenn, B. Pankovich, M. E. Raikh, and B. Saam, *Low-frequency modulation of the longitudinal field: modified Rabi envelopes*, Poster
    2013 Experimental Nuclear Magnetic Resonance Conference, 04/2013, Asilomar, CA

7. M. E. Limes, J. Wang, W. J. Baker, S.-Y. Lee, B. Saam, and C. Boehme, *Numerical study of spin-dependent transition rates within pairs of dipolar and exchange coupled spins with s=1/2 during magnetic resonant excitation*, Contributed Talk
   2013 APS March Meeting, 03/2013, Baltimore, MD

6. M. E. Limes, Z. L. Ma, and B. Saam, *Longitudinal relaxation of solid ^{129}Xe,* Poster
   2012 Rocky Mountain Conference on Magnetic Resonance, Solid State NMR Symposium 06/2012, Copper Mountain, CO

5. M. E. Limes, J. Wang, W. J. Baker, S.-Y. Lee, B. Saam, and C. Boehme, *Numerical study of spin-dependent electronic transition rates between two dipolar and exchange coupled paramagnetic (S=1/2) states during coherent excitation by magnetic resonance*, Poster
   2012 Rocky Mountain Conference on Magnetic Resonance, EPR Symposium, 06/2012, Copper Mountain, CO.

4. M. E. Limes, Z. L. Ma, E. G. Sorte, H. Emerson, L. Hales, B. Thapa, O. Jeong, T. van Hook, and B. Saam, *Crystallite morphology and longitudinal relaxation in solid ^{129}Xe*, Poster
   2012 XeMat Conference, 05/2012, Dublin, Ireland

3. M. E. Limes, Z. L. Ma, and B. Saam, *Altered states of solid xenon*, Poster
   2012 DAMOP Meeting, 05/2012, Orange County, CA

2. M. E. Limes and B. Saam, *Relaxation of low-field gas-phase ^{129}Xe*, Contributed Talk
   2010 APS/Four Corners Meeting, 10/2010, Ogden, UT

1. M. Randles, M. E. Limes, E. Ondieki, and H. Rajaei, *Distributed simulation of particle physics*, Poster, 2005 Spring Symposium on Undergraduate Research, 04/2005, Bowling Green, OH

Honors/Academic Service

- James Robert and Gretchen Overman Undergraduate Physics Scholarship, 2004
- Phi Beta Kappa Society, Xi of Ohio, 2005
- Kappa Mu Epsilon National Mathematics Honors Society, Ohio Alpha, 2005
- Physics Graduate Student Advisory Council President, 2010
- J. Irvin and Norma K. Swigart Outstanding Graduate Student, 2013
- Referee: Physical Review B, IEEE Photonics Technology Letters, Journal of Magnetic Resonance, IEEE Sensors, Physical Review Letters, Physical Review Applied, Physical Review A, Optics Express, Chinese Optics Letters