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Research Interests

- Quantum sensing: Real-time data analysis and field-deployment
- Alkali metals and noble gases for precision measurements, biomagnetism, and navigation

Positions

- Associate Professor, Joint Appointment, Virginia Tech National Security Institute (VTNSI) and the Bradley Department of Electrical and Computer Engineering, Virginia Tech, Blacksburg, VA; July 2024 –Present
 - Tenure-track Quantum Systems Initiative, Spectrum Dominance Division of VTNSI
 - Research small, low-power atomic magnetometers and hyperpolarized noble gas sensors, with a focus on long-term stability and novel cell fabrication
- Physicist, Twinleaf LLC, Plainsboro, NJ; Jan. 2018-Jan. 2024
 - All relevant projects managed by SRI, in collaboration with the Romalis group at Princeton University
 - DARPA AMBIIENT (Atomic Magnetometer for Biological Imaging In Earth's Native Terrain): first demo of unshielded magnetoencephalography using atomic sensors
 - DARPA QUIVER
- 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 ^3He - ^{129}Xe - ^{87}Rb cells with long noble gas coherence times
 - Continued novel vapor cell fabrication research, including anodically bonded optical pumping cells
 - 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 mechanism, studied spin-exchange optical pumping
 - Optical pumping of various alkali metal vapors at wide variety of working magnetic fields, and novel vapor cell fabrication, including specialized coatings
 - 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

- Teaching Assistant and Ph.D. Student, Department of Mathematics and Statistics, Bowling Green State University, Bowling Green, OH; 2007-2009
- Electrical Apprentice, L & B Electric, Grand Rapids, OH; 2006-2009

Education

- Ph.D., M.Sc., Physics – The University of Utah, 2005-2007;2009-2013, Salt Lake City, UT USA
Dissertation Title: *¹²⁹Xe 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

1. T. Wang, W. Lee, M. V. Romalis, M. E. Limes, E. L. Foley, T. W. Kornack, *Pulsed ⁸⁷Rb vector magnetometer using a fast rotating field*. In preparation
2. 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 ³He-¹²⁹Xe-⁸⁷Rb cells*. In preparation
3. V. G. Lucivero, W. Lee, T. W. Kornack, M. E. Limes, E. L. Foley, M. V. Romalis, *Femtotesla nearly quantum-noise-limited gradiometer at Earth-scale fields*. Phys. Rev. Applied Letter **18**, L021001 (2022)
4. W. Lee, V. G. Lucivero , M. V. Romalis, M. E. Limes, E. L. Foley, T. W. Kornack, *Heading errors in an all-optical pulsed-pump ⁸⁷Rb magnetometer in geomagnetic fields*. Phys. Rev. A **103**, 063103 (2021) *Editors' Suggestion*
5. A. Jaufenthaler , T. Kornack, V. Lebedev, M. E. Limes, R. Korber, M. Liebl, D. Baumgarten, *Pulsed optically pumped magnetometers: Addressing dead time and bandwidth for unshielded magnetorelaxometry of magnetic nanoparticles*. Sensors **21**(4), 1212 (2021)
6. 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
7. M. E. Limes, N. Dural, M. V. Romalis, E. L. Foley, T. W. Kornack, A. Nelson, L. R. Grisham, J. Vaara, *Dipolar and scalar ³He-¹²⁹Xe frequency shifts in stemless cells*. Phys. Rev. A **100**, 010501 (R) (2019)
8. M. E. Limes, D. Sheng, and M. V. Romalis, *³He-¹²⁹Xe comagnetometry with ⁸⁷Rb detection and decoupling*, Phys. Rev. Lett. **120**, 033401 (2018). *Editors' Suggestion, Featured in Physics, Viewpoint*: <https://physics.aps.org/articles/v11/5>

9. 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).
10. 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).
11. 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).
12. 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).
13. 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).
14. 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).
15. 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).
16. 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).

Selected Presentations

- 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)
- M. E. Limes, N. Dural, M. V. Romalis, E. L. Foley, T. W. Kornack, A. Nelson, L. R. Grisham *Dipolar and scalar ^3He and ^{129}Xe frequency shifts in mm-sized cells*, Contributed Talk
2018 APS DAMOP meeting, 05/2018, Ft. Lauderdale, FL
- M. E. Limes, *Optical Detection of a Nuclear-spin Gyro*, Colloquium
Miami University, 02/2017, Oxford, OH
- M. E. Limes, D. Sheng, M. V. Romalis, *A ^3He - ^{129}Xe co-magnetometer with ^{87}Rb magnetometry*,
2016 APS DAMOP meeting, 05/2016, Providence, RI
- M. E. Limes, D. Sheng, M. V. Romalis, *Progress on a ^3He - ^{129}Xe co-magnetometer*, 2015 APS
DAMOP meeting, 06/2015, Columbus, OH
- M. E. Limes, *^{129}Xe Relaxation and Rabi Oscillations*
Pines Lab Seminar, 12/2013, UC Berkeley, CA

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

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*, *IEEE Transactions on Instrumentation and Measurement*, *Physical Review X*