

Zheng-Tian Lu 卢征天 (July, 2012)

Argonne National Laboratory
Physics Division, Building 203
9700 South Cass Avenue
Argonne, Illinois 60439, USA

Phone: (630) 252-0583
Email: lu@anl.gov
Web: www.phy.anl.gov/mep/atta/

Research interests

Ultrasensitive trace-isotope analysis;
Low-energy search for physics beyond the Standard Model;
Laser spectroscopy of atoms with exotic nuclei.

Academic Degrees

Ph.D., 1994, University of California at Berkeley;
M.S., 1991, The University of Chicago;
B.S., 1987, University of Science and Technology of China.

Employment history

2007 – Present,	Senior Physicist,	Argonne National Laboratory;
2004 – Present,	Professor (part-time),	The University of Chicago;
2000 – 2007,	Physicist,	Argonne National Laboratory;
1997 – 2000,	Assistant Physicist,	Argonne National Laboratory;
1994 – 1997,	Research Associate,	JILA, University of Colorado.

Honors

Francis M. Pipkin Award, American Physical Society (2009);
Fellow, American Physical Society (2006);
Guest Professor, University of Science and Technology of China (2005 – present);
U. S. Presidential Early Career Award for Scientists and Engineers (2000);
U. S. DOE Office of Science Early Career Scientist and Engineer Award (2000).

Selected Professional Service and Association

Organizer, Int. Workshop on Tracer Applications of Noble Gas Radionuclides, Argonne National Lab, June 2012;
Co-convenor (on EDM), Fundamental Physics at the Intensity Frontier Workshop, Washington DC, November 2011;
Member, U.S. Nuclear Science Advisory Committee (NSAC), March 2011 – present;
Member, NSAC Sub-Committee on Neutron Physics, April – September 2011;
Member, AMO Review Panel, National Science Foundation, Washington DC, January 2011;
Member, Program Committee of APS Division of Atomic, Molecular and Optical Physics, 2009 – 2011;
Co-organizer, Int. Workshop on Particle's EDM and Implications, Shanghai Jiao Tong Univ., Shanghai, June 2010;
Co-organizer / Scientific Secretary, The 6th Joint Meeting of Chinese Physicists Worldwide, Lanzhou, August 2009;
Member, Chinese Physical Society, 2008 – Present;
Member-at-Large, Topical Group on Precision Measurement and Fundamental Constants, APS, 2008 – 2011;
Member and Councilor-at-Large, Overseas Chinese Physics Association, 2007 – 2009;
Member, Committee on Membership, American Physical Society, 2005 – 2007;
Member, American Physical Society, 1990 – Present; Fellow of APS, 2006 – Present;
Member, Geochemical Society, 2004 – Present;
Member, American Geophysical Union, 2004 – Present.

Research Projects

Testing time-reversal symmetry in atoms and nuclei

We are searching for a permanent electric-dipole moment (EDM) of the ^{225}Ra ($t_{1/2} = 15$ d) atom. A positive finding would signify the violation of time-reversal symmetry (T) and, indirectly, the violation of charge-parity symmetry (CP). While the CKM mechanism in the Standard Model gives rise to a negligible EDM, extensions to the Standard Model such as Supersymmetry generally predict a relatively large EDM within reach. Therefore, this experiment provides an outstanding opportunity to search for new physics beyond the Standard Model. The ^{225}Ra nucleus is an especially good case because of octupole deformation, which leads to large enhancements of the T-violating Schiff moment. The overall scheme is to cool and trap ^{225}Ra atoms in a magneto-optical trap (MOT), transfer the trapped ^{225}Ra atoms to an optical dipole trap (ODT), and perform EDM measurements. We have succeeded in realizing laser trapping and cooling of ^{225}Ra atoms, both in MOT and ODT. At present, we are developing the techniques and apparatus needed for the EDM measurements.

- C.-Y. Xu *et al.*, Phys. Rev. Lett. **107**, 093001 (2011);
- J.R. Guest *et al.*, Phys. Rev. Lett. **98**, 093001 (2007);
- AIP Physics News Update, [Number 812](#) (2007).

Radio-krypton dating

Due to its simple production and transport processes in the terrestrial environment, the long-lived noble-gas isotope ^{81}Kr is the ideal tracer for old water and ice in the age range of 10^5 - 10^6 years, a range beyond the reach of ^{14}C . ^{81}Kr -dating, a concept pursued in the past four decades by numerous laboratories employing a variety of techniques, is now available for the first time to the earth science community at large. This is made possible by our earlier invention of the Atom Trap Trace Analysis method and, in particular, by our recent development of ATTA-3, an efficient and selective atom counter capable of measuring both $^{81}\text{Kr}/\text{Kr}$ and $^{85}\text{Kr}/\text{Kr}$ ratios of environmental samples in the range of 10^{-14} - 10^{-10} . In addition, ATTA-3 has been used to detect ^{39}Ar in environmental samples at the 10^{-16} isotopic abundance level. It represents the state-of-the-art instrument for routine analysis of these rare noble gas tracers for a wide range of earth science applications.

- W. Jiang *et al.*, Geochim. Cosmochim. Acta **91**, 1-6 (2012);
- W. Jiang *et al.*, Phys. Rev. Lett. **106**, 103001 (2011);
- C.Y. Chen *et al.*, Science **286**, 1139 (1999);
- ["A Rare Isotope Helps Track an Ancient Water Source"](#), The New York Times, Science Section, November 21, 2011.

Studying exotic nuclear structure

Helium-8 (^8He) is the most neutron-rich matter that can be synthesized on earth: it consists of two protons and six neutrons, and remains stable for an average of 0.2 seconds. Because of its intriguing properties, ^8He has the potential to reveal new aspects of the fundamental forces among the constituent nucleons. We have recently succeeded in laser trapping and cooling this exotic helium isotope and have performed precision laser spectroscopy on individual trapped atoms. Based on atomic frequency differences measured along the isotope chain $^3\text{He} - ^4\text{He} - ^6\text{He} - ^8\text{He}$, the nuclear charge radius of ^8He has been determined for the first time. The result can now be compared with the values predicted by a number of nuclear structure calculations and is testing their ability to characterize this loosely-bound halo nucleus.

- P. Mueller *et al.*, Phys. Rev. Lett. **99**, 252501 (2007);
- L.-B. Wang *et al.*, Phys. Rev. Lett. **93**, 142501 (2004);
- AIP Physics News Update, [Number 851](#) (2007).

Publications

Invited Publications:

Atom Trap Trace Analysis of Rare Noble Gas Isotopes

Z.-T. Lu and P. Mueller

Advances in Atomic, Molecular, and Optical Physics, Vol. **58**, 173-205 (2010)

Simple Atom, Extreme Nucleus – Laser Trapping and Probing of Exotic Helium Isotopes

L.-B. Wang, Z.-T. Lu, and P. Mueller

物理 (“Physics”, published by Chinese Physical Society) **38**, 339 (2009)

Precision spectroscopy of the helium atom (a review article)

S-M Hu, Z.-T. Lu, and Z-C Yan

Frontiers of Physics in China **4**, 165 (2009)

Simple Atom, Extreme Nucleus – Laser Trapping and Probing of ^6He and ^8He

Z.-T. Lu and P. Mueller

Nuclear Physics News **19**, 28-32 (2009)

Atom Trap, Krypton-81, and Saharan Water

Z.-T. Lu

Nuclear Physics News **18**, 37-40 (2008)

Search for a Permanent Electric Dipole Moment in Atoms

Z.-T. Lu

A report to the National Natural Science Foundation of China (2008)

Halo Nuclei in Laser Light

G. W. F. Drake, Z.-T. Lu, W. Noertershaeuser, and Z.-C. Yan

Lecture Notes in Physics **745**, 131-153 (2008)

Atom Trap, krypton-81, and the groundwater underneath the Sahara Desert

X. Du and Z.-T. Lu

物理 (“Physics”, published by Chinese Physical Society) **34**, 408 (2005)

Searches for stable strangelets in ordinary matter: overview and a recent example

Z.-T. Lu, R. J. Holt, P. Müller, T. P. O’Connor, J. P. Schiffer, L.-B. Wang

Nuclear Physics **A754**, 361c (2005)

Tracing Noble Gas Radionuclides in the Environment

P. Collon, W. Kutschera and Z.-T. Lu

Annual Review of Nuclear and Particle Science **54**, 39 (2004)

Laser-Based Methods for Ultrasensitive Trace-Isotope Analyses (*Feature review article*)

Z.-T. Lu and K.D.A. Wendt

Review of Scientific Instruments **74**, 1169 (2003)

Atom Trap Trace Analysis

Z.-T. Lu

McGraw-Hill 2002 Yearbook of Science and Technologies (2002)

From Helium-6 to Krypton-81

Z.-T. Lu

Art and Symmetry in Experimental Physics, Festschrift for Eugene D. Commins

AIP Conference Proceedings 596 (2001)

Atom Trap Trace Analysis

Z.-T. Lu, K. Bailey, C.Y. Chen, X. Du, Y.-M. Li, T.P. O'Connor, L. Young
Atomic Physic 17, edited by E. Arimondo, P. DeNatale and M. Inguscio (AIP, 2001)

An Efficient Vapor Cell Magneto-Optical Trap of ^{221}Fr atoms

Z.-T. Lu, K.L. Corwin, K.R. Vogel, C.E. Wieman, T.P. Dinneen, J. Maddi and H. Gould
Laser Spectroscopy XIII, edited by Z. Wang, Z. Zhang, Y. Wang (World Scientific, 1997)

Contributed Publications:

An atom counter for measuring ^{81}Kr and ^{85}Kr in environmental samples

W. Jiang, K. Bailey, Z.-T. Lu, P. Mueller, T.P. O'Connor, C.-F. Cheng, S.-M. Hu, R. Purtschert, N.C. Sturchio, Y.R. Sun, W. D. Williams, and G.-M. Yang
Geochimica et Cosmochimica Acta, **91**, 1-6 (2012)

Optical excitation and decay dynamics of ytterbium atoms embedded in a solid neon matrix

C.-Y. Xu, S.-M. Hu, J. Singh, K. Bailey, Z.-T. Lu, P. Mueller, T.P. O'Connor, and U. Welp
Physical Review Letters **107**, 093001 (2011)

Ar-39 detection at 10^{-16} isotopic abundance level with atom trap trace analysis

W. Jiang, W.D. Williams, K. Bailey, A.M. Davis, S.-M. Hu, Z.-T. Lu, T.P. O'Connor, R. Purtschert, N.C. Sturchio, Y.R. Sun, and P. Mueller
Physical Review Letters **106**, 103001 (2011)

A spectroscopic study of the cycling transition $4s[3/2] - 4p[5/2]$ at 811.8 nm in ^{39}Ar : hyperfine structure and isotope shift

W. Williams, Z.-T. Lu, K. Rudinger, C.-Y. Xu, R. Yokochi, and P. Mueller
Physical Review **A83**, 012512 (2011)

Lifetime of the $6s5d\ ^1D_2$ atomic state of radium

W.L. Trimble, I.A. Sulai, I. Ahmad, K. Bailey, B. Graner, J.P. Greene, R.J. Holt, W. Korsch, Z.-T. Lu, P. Mueller, and T.P. O'Connor
Physical Review **A80**, 054501 (2009)

The role of carrier gases in the production of metastable argon atoms in an RF discharge

K. Rudinger, Z.-T. Lu, and P. Mueller
Review of Scientific Instruments **80**, 036105 (2009)

Hyperfine Suppression of $2\ ^3S_1 - 3\ ^3P_1$ Transitions in ^3He

I.A. Sulai, Qixue Wu, M. Bishof, G.W.F. Drake, Z.-T. Lu, P. Mueller, and R. Santra
Physical Review Letters **101**, 173001 (2008)

Nuclear charge radius of ^8He

P. Mueller, I.A. Sulai, A.C.C. Villari, J.A. Alcantara-Nunez, R. Alves-Conde, K. Bailey, G.W.F. Drake, M. Dubois, C. Eleon, G. Gaubert, R.J. Holt, R.V.F. Janssens, N. Lecesne, Z.-T. Lu, T.P. O'Connor, M.-G. Saint-Laurent, J.-C. Thomas, L.-B. Wang
Physical Review Letters **99**, 252501 (2007)

Laser-trapping of Ra-225 and Ra-226 with repumping by room-temperature blackbody radiation

J.R. Guest, N.D. Scielzo, I. Ahmad, K. Bailey, J. P. Greene, R.J. Holt, Z.-T. Lu, T.P. O'Connor, and D.H. Potterveld
Physical Review Letters **98**, 093001 (2007)

A thermal beam of metastable krypton atoms produced by optical excitation

Y. Ding, S.-M. Hu, K. Bailey, A. M. Davis, R. W. Dunford, Z.-T. Lu, T. P. O'Connor, L. Young
Review of Scientific Instruments **78**, 023103 (2007)

Beam of metastable krypton atoms extracted from a microwave-driven discharge

Y. Ding, K. Bailey, A. M. Davis, S.-M. Hu, [Z.-T. Lu](#), and T. P. O'Connor

Review of Scientific Instruments **77**, 126105 (2006)

Measurement of the lifetimes of the lowest 3P_1 state of neutral Ba and Ra

N.D. Scielzo, J.R. Guest, E.C. Schulte, I. Ahmad, K. Bailey, D.L. Bowers, R.J. Holt, Z.-T. Lu, T.P. O'Connor, and D.H. Potterveld

Physical Review A **73**, 010501 (2006)

Fine structure of the $1s3p\ ^3P_J$ level in atomic ^4He : theory and experiment

P. Mueller, L.-B. Wang, G.W.F. Drake, K. Bailey, [Z.-T. Lu](#), T.P. O'Connor

Physical Review Letters **94**, 133001 (2005)

Cosmogenic, radiogenic, and stable isotopic constraints on groundwater residence time in the Nubian Aquifer, Western Desert of Egypt

L.J. Patterson, N.C. Sturchio, B.M. Kennedy, M.C. van Soest, M. Sultan, Z.-T. Lu, B. Lehmann, R. Purtschert, Z. El Alfy, B. El Kaliouby, Y. Dawood, A. Abdallah

Geochemistry Geophysics Geosystems **6**, Q01005 (2005)

Laser spectroscopic determination of the ^6He nuclear charge radius

L.-B. Wang, P. Mueller, K. Bailey, G.W.F. Drake, J.P. Greene, D. Henderson, R.J. Holt, R.V.F. Janssens, C.L. Jiang, [Z.-T. Lu](#), T.P. O'Connor, R.C. Pardo, K.E. Rehm, J.P. Schiffer, and X.D. Tang

Physical Review Letters **93**, 142501 (2004)

An atom trap system for practical ^{81}Kr -dating

X. Du, K. Bailey, [Z.-T. Lu](#), P. Mueller, T.P. O'Connor, L. Young

Review of Scientific Instruments **75**, 3224 (2004)

One million year old groundwater in the Sahara revealed by krypton-81 and chlorine-36

N. C. Sturchio, X. Du, R. Purtschert, B. E. Lehmann, M. Sultan, L. J. Patterson, [Z.-T. Lu](#), P. Mueller, K. Bailey, T. P. O'Connor, L. Young, R. Lorenzo, B. M. Kennedy, M. van Soest, Z. El Alfy, B. El Kaliouby, Y. Dawood, and A. M. A. Abdallah

Geophysical Research Letters **31**, L05503 (2004)

Counting individual ^{41}Ca atoms with a Magneto-Optical Trap

I. D. Moore, K. Bailey, J. Greene, [Z.-T. Lu](#), P. Mueller, T. P. O'Connor, Ch. Geppert, K. D. A. Wendt, L. Young

Physical Review Letters **92**, 153002 (2004)

Search for anomalously heavy isotopes of helium in the Earth's atmosphere

P. Mueller, L.-B. Wang, R. J. Holt, [Z.-T. Lu](#), T. P. O'Connor, and J. P. Schiffer

Physical Review Letters **92**, 022501 (2004)

A new method of measuring ^{81}Kr and ^{85}Kr abundances in environmental samples

X. Du, R. Purtschert, K. Bailey, B. E. Lehmann, R. Lorenzo, [Z.-T. Lu](#), P. Mueller, T. P. O'Connor, N.C. Sturchio, and L. Young

Geophysical Research Letters **30**, 2068 (2003).

Laser spectroscopic measurement of helium isotope ratios

L.-B. Wang, P. Mueller, R. Holt, [Z.-T. Lu](#), T.P. O'Connor, Y. Sano, N.C. Sturchio

Geophysical Research Letters **30**, 1592 (2003)

Towards ultrahigh sensitivity analysis of ^{41}Ca

I.D. Moore, K. Bailey, [Z.-T. Lu](#), P. Mueller, T.P. O'Connor, L. Young

Nuclear Instruments and Methods in Physical Research **B204**, 701 (2003)

Towards measuring the charge radius of ${}^6\text{He}$ and ${}^8\text{He}$

P. Mueller, L.-B. Wang, K. Bailey, G.W.F. Drake, X. Du, J. Greene, A.M. Heinz, R.J. Holt, D. Henderson, R.V. Janssens, C.-L. Jiang, C. Law, Z.-T. Lu, I.D. Moore, T.P. O'Connor, R.C. Pardo, M. Paul, T. Pennington, K.E. Rehm, J.P. Schiffer

Nuclear Instruments and Methods in Physical Research **B204**, 536 (2003)

A Beam of Metastable Krypton Atoms Extracted from an RF-Driven Discharge

C.Y. Chen, K. Bailey, X. Du, Y.M. Li, Z.-T. Lu, T.P. O'Connor, L. Young, G. Winkler

Review of Scientific Instruments **72**, 271 (2001)

ATTA -- a new method of ultrasensitive isotope trace analysis

K. Bailey, C.Y. Chen, X. Du, Y.M. Li, Z.-T. Lu, T.P. O'Connor, L. Young

Nuclear Instruments and Methods in Physics Research **B172**, 224 (2000)

Atom Trap Trace Analysis

K. Bailey, C.Y. Chen, X. Du, Y.M. Li, Z.-T. Lu, T.P. O'Connor, L. Young

Hyperfine Interactions **127**, 515 (2000)

Ultrasensitive isotope trace analyses with a magneto-optical trap

C.Y. Chen, Y.M. Li, K. Bailey, T.P. O'Connor, L. Young, Z.-T. Lu

Science **286**, 1139 (1999)

Frequency-stabilized diode laser with the Zeeman shift in an atomic vapor

K.L. Corwin, Z.-T. Lu, C.F. Hand, R.J. Epstein, and C.E. Wieman

Applied Optics, **37**, 3295 (1998)

Efficient collection of ${}^{221}\text{Fr}$ atoms into a vapor cell magneto-optical trap

Z.-T. Lu, K.L. Corwin, K.R. Vogel, C.E. Wieman, T.P. Dinneen, J. Maddi and H. Gould

Physical Review Letters, **79**, 994 (1997)

Low-velocity intense source of atoms from a magneto-optical trap

Z.-T. Lu, K.L. Corwin, M.J. Renn, M.H. Anderson, E.A. Cornell, and C.E. Wieman

Physical Review Letters, **77**, 3331 (1996)

Comparison of the cold-collision losses for laser-trapped sodium in different ground-state hyperfine sublevels

S.-Q. Shang, Z.-T. Lu and S.J. Freedman

Physical Review A, **50**, R4449 (1994)

Laser trapping of short-lived radioactive isotopes

Z.-T. Lu, C.J. Bowers, S.J. Freedman, B.K. Fujikawa, J.L. Mortara, S-Q. Shang, K.P. Coulter, and L. Young

Physical Review Letters, **72**, 3792 (1994)

Patents:

System and a Method for Frequency-Stabilizing a Diode Laser

K.L. Corwin, Z.-T. Lu, C.F. Hand, R.J. Epstein, C.E. Wieman

U.S. Patent Number 6,009,111 (December 28, 1999)

Invited Talks, Seminars, Colloquia (last five years)

2008

Simple atom, Extreme Nucleus: Laser Trapping and Probing of Helium-8

Physics Department Colloquium, University of Chicago, February 2008;
Atomic Physics Seminar, Stanford University, April 2008;
Physics Department Colloquium, Rensselaer Polytechnic Institute, April 2008;
Seminar, JILA, University of Colorado, May 2008;
Third International Symposium on Cold Atom Physics, Wuhan, China, July 2008;
PREX workshop, Jefferson Laboratory, August 2008;
Physics Department Colloquium, Columbia University, October 2008;
Physics Department Colloquium, Yale University, October 2008.

Atom Trap, Krypton-81, and Saharan Water

Physics Department Colloquium, University of Washington, May 2008.

Laser trapping and probing of radioactive atoms and its applications

HUGS2008 Summer School, Thomas Jefferson National Accelerator Facility, June 2008;
Michigan Quantum Summer School, University of Michigan, June 2008;
Summer School on Experimental Cold Atomic and Molecular Physics, Chinese Academy of Science, Wuhan, China, July 2008;

2009

Simple atom, Extreme Nucleus: Laser Trapping and Probing of Helium-8

Nuclear Physics Seminar, University of Wisconsin at Madison, April 2009;
Physics Department Colloquium, University of Texas at Austin, April 2009;
American Physical Society April Meeting, Denver, May 2009.

My research work at Argonne

Seminar, JILA, University of Colorado, May 2009.

Atom Trap Trace Analysis

Free Electron Laser Photon Science Workshop, Jefferson Laboratory, July 2009;
The 6th Joint Meeting of Chinese Physicists Worldwide, Lanzhou, China, August 2009;
Computations in Science Seminar, University of Chicago, Chicago, October 2009.

Laser Trapping of radium for an electric dipole moment measurement

Ultracold Group II Atoms Workshop, College Park, Maryland, September 2009.

Search for an electric dipole moment of radium-225

Workshop on Applications of High Intensity Proton Accelerator, Fermilab, Batavia, October 2009.

How can an atom tell us the direction of time?

Model Class, University of Chicago, Chicago, October 2009.

2010

Search for the Nuclear Schiff Moment of Radium-225

International Workshop on Particle's EDM and Implications, Shanghai Jiao Tong University, Shanghai, China, June 13-17, 2010;
4th International Symposium on Lepton Moments, Cape Cod, MA, July 19-22, 2010.

Testing Time-Reversal Symmetry: Search for the electric dipole moment of radium-225

Graduate Student Symposium, The 41st Annual Meeting of the Division of Atomic Molecular and Optical Physics, American Physical Society, Houston, TX, May 25-29, 2010;
Seminar, Hefei National Laboratory on Physical Science at the Microscale, Hefei, China, June 10, 2010.

Simple atom, Extreme Nucleus: Laser Trapping and Probing of Helium-8
Physics Department Colloquium, Texas A&M, December 2, 2010.

2011

Ultrasensitive Trace Isotope Detection: 81Kr, 85Kr, 39Ar

Seminar, Hydrology Section, International Atomic Energy Agency, Vienna, Austria, January 2011;

Ar-39 Detection at the Part-per-quadrillion Level with Atom Trap Trace Analysis

Seminar, VERA, University of Vienna, Vienna, Austria, January 2011;

Seminar, Niels Bohr Institute, Copenhagen, Denmark, January 2011.

Atom Trap Trace Analysis

42nd Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics (DAMOP), Atlanta, GA, June 14-17, 2011;

Seminar, Center for Cold Matter, Imperial College London, London, UK, August, 2011;

Rutherford Centennial Conference on Nuclear Physics, Manchester, UK, August 8-12, 2011;

Development in Noble Gas Understanding and Expertise (DINGUE), Paris, France, August 12-13, 2011;

Physics Colloquium, University of Arizona, October 2011;

Nuclear Science Division Colloquium, Lawrence Berkeley National Laboratory, October 2011;

Physics Colloquium, Brookhaven National Laboratory, November 2011;

Geochemistry Seminar, Lamont Doherty Earth Observatory, November 2011;

JLab Physics Seminar, Jefferson Laboratory, Virginia, December 2011.

Development of an Atom-Trap Detector to Analyze Rare Isotopes of Noble Gas

DOE-NP Applications of Nuclear Science & Technology Exchange Meeting, Washington, DC, August 22-23, 2011.

2012

Atom Trap, Krypton-81, and Global Groundwater

Plenary Talk, American Physical Society Spring Meeting, Atlanta, April 2012;

Physics/Theory Colloquium, Los Alamos National Laboratory, March 2012;

Seminar, Hefei National Laboratory for Science at the Microscale, May 2012;

44th Conference of the European Group on Atomic Systems, July 2012;

81Kr-Dating is Now Available

General Assembly of European Geoscience Union, Vienna, Austria, April 2012.

Atom Trap Trace Analysis

International Workshop on Tracer Applications of Noble Gas Radionuclides, Argonne, June 2012.

Precision Measurements in Atomic/Nuclear Physics

Physics of Precision Measurements, Wuhan Institute of Mathematics and Physics, Chinese Academy of Science, Wuhan, April 2012.

An Overview of EDM Searches

High Energy Physics Seminar, University of Chicago, February 2012;

Physics Division Seminar, Argonne National Laboratory, April 2012.