

# Timothy James (TJ) Ulrich II

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## CONTACT INFORMATION

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## RESEARCH INTERESTS

Applied Condensed Matter Physics: Investigating the physical phenomena of nonlinear elasticity (e.g., elastic wave mixing, modulus softening, slow dynamics and hysteresis). Developing experimental tools and techniques using Time Reversal (TR) and Nonlinear Elastic Wave Spectroscopy (NEWS) (e.g., Nondestructive Evaluation, Geophysics, Medicine). Acoustic signal processing. Superconducting magnetic levitation nonlinear oscillators.

## EDUCATION

**University of Nevada, Reno, NV**

Ph.D. *Physics*

- Dissertation: *Thermally induced nonlinear elastic response in Berea sandstone*
- Graduation date: August 2004
- Advisors: Dr. Katherine R. McCall

M.S. *Physics*

- Thesis: *Experimental determination of the elastic properties of rocks using Resonant Ultrasound Spectroscopy*
- Graduation date: December 2000
- Advisors: Dr. Katherine R. McCall

B.S., *Materials Science & Engineering*, 1997

## HONORS AND AWARDS

2008 Los Alamos Achievement Award (technological advances in acoustic imaging)  
2008 Research featured in LANL Science & Technology Magazine: *1663* (august issue)  
2008 Los Alamos Spot Award (outstanding performance and presentation in a scientific review)  
2007, 2006, 2005 Invited Scholar (Centre National de Recherche Scientifique, Univ. of Paris VI)  
2002 Outstanding Student Paper Award (American Geophysical Union Fall Meeting)  
2002 PASS 2002 scholarship recipient (National Center for Physical Acoustics)  
2001 NASA Space Grant Fellowship (NASA Space Grant Consortium)  
1998 – 2001 Mackenzie Scholarship for Physics  
1998 – 1999 Regents Scholar Award  
1998 – 1999 Elected to Graduate Student Council (College of Arts & Science Representative)  
1990 – 1993 Symphonic Band Scholarship  
1990 – 1991 Presidential Scholarship

## PROFESSIONAL EXPERIENCE

**Los Alamos National Laboratory**

*Technical Staff Member (Scientist Level 2)*

**March, 2008 – present**

- Developing applications for stockpile stewardship using nonlinear elasticity experimental techniques.
- Developing superconducting seismic sensor using magnetic levitation.
- Supervising post-docs and students in laboratory studies.

*Post-Doc*

**March, 2005 – February 2008**

- Developed Time Reversed Acoustics (TRA) system (hardware and software).
- Developed ultrasonic signal processing techniques for imaging using TRA.
- Explored the application of Time Reversal (TR) and Nonlinear Elastic Wave Spectroscopy (NEWS) for use in Nondestructive Evaluation (NDE).
- Assisted in maintenance and repair of the Los Alamos Seismic Network.

**University of Paris VI – Medical School, Paris, France**

*Invited Scholar*

**Fall 2005, 2006 & 2007**

- Applied experimental nonlinear elasticity techniques for medical purposes (e.g., acoustic detection of osteoporosis, monitoring fatigue damage in human cortical bone, determining bone implant placement quality).
- Worked with graduate students teaching and developing experimental techniques.

**University of Nevada, Reno**

*Post-Doc*

**August 2004 – March 2005**

- Designed and taught one third of the *Computational Physics* course for beginning graduate and advanced undergraduate students.
- Assisted in departmental teaching responsibilities by acting as a substitute instructor (both short and long term).
- Directed graduate and undergraduate students in research using Resonant Ultrasound Spectroscopy (RUS) to measure phase changes in f-electron metals.

*Graduate Research Assistant*

**June 1998 – August 2004**

- Designed and constructed a temperature control chamber (operating range: 77-500 K) in which to conduct acoustic resonance experiments on cm scale samples of various materials (e.g., rocks, single crystals, metal alloys, etc.).
- Created a computer hardware and software system to control the above systems using LabVIEW.
- Supervised undergraduate research projects.

*Graduate Teaching Assistant*

**August 1998 – May 2001**

- Taught Physics labs for science and non-science majors (average 3 labs/semester, 16 students/lab).
- Conducted demonstrations for the science/engineering majors introductory physics course (classical mechanics, 100+ students/course).

**Desert Research Institute**

*Research Assistant*

**February 1997 – June 1998**

- Analyzed ice crystal data for the NASA FIRE II cloud physics project.
- Created and maintained the DRI NASA FIRE II website containing cloud physics ice crystal data.

**Chromalloy Nevada**

*Engineering Laboratory Assistant*

**July 1995 – December 1995**

- Prepared GE aircraft turbine engine parts for remanufacturing (slurry, plasma and ceramic coatings).
- Performed metallurgical quality control tests on remanufactured turbine parts.

SKILLS &  
LANGUAGES

- *Computer:* Matlab, LabVIEW (with Real-Time & FPGA), Comsol Multiphysics, Origin, C/C++, FORTRAN 90/95, L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>, Linux, Windows & Mac proficient.
- *Spoken/Written:* English (native speaker/U.S. citizen), French (functional).
- *Laboratory:* Instrumentation development, Resonant Ultrasound Spectroscopy, nonlinear acoustic/elastic wave-propagation, Time Reversed Acoustics, temperature control systems, cryogenic systems, high vacuum systems, Scanning Electron Microscopy, assorted metallurgical techniques.

PROFESSIONAL  
AFFILIATIONS

American Physical Society  
American Geophysical Union  
American Association for the Advancement of Science

Acoustical Society of America  
Sigma Pi Sigma

RESEARCH  
COLLABORATIONS &  
CONTACTS

**Los Alamos National Lab** (Geophysics, Nonlinear acoustics, Nondestructive Evaluation):  
*Paul Johnson, James TenCate, Robert Guyer, Brian Anderson, Michele Griffa, Carene Larmat, Pierre-Yves Le Bas.*

**University of Paris** (Medical acoustics, Biomaterials, Biomechanics, Time Reversal):  
*Pascal Laugier, Maryline Talmant, David Mitton, Marie Muller, Arnaud Derode.*

**University of Nevada, Reno** (Materials Physics, Geophysics, Metallurgical Engineering):  
*Katherine McCall, Robert Guyer, Tim Darling, Aaron Covington, Dhanesh Chandra.*

**Stevens Institute of Technology** (Nonlinear Acoustics):  
*Alexander Sutin.*

**Polytechnic Institute of Torino** (Nonlinear Acoustics, FE/FD Modeling):  
*Marco Scalerandi, Pierre-Paolo DelSanto, Antonio Gliozzi.*

**Catholic University of Leuven** (Nonlinear Acoustics, Nondestructive Evaluation):  
*Koen van den Abeele.*

**North Carolina State University** (Granular Media):  
*Karen Daniels.*

**Imperial College** (Nondestructive Evaluation, Time Reversal, Imaging):  
*Francesco Simonetti.*

PUBLICATIONS

BOOK CHAPTER:

Muller, M., **Ulrich, T.**, Johnson, P., and Laugier, P., Assessment of damage in cortical bone using nonlinear acoustic techniques, *Vibrations and Acoustics in Biomedical Applications*, ASME Press, in press. **\*\*invited**

JOURNAL PUBLICATIONS:

**Ulrich, T.**, Van Den Abeele, K., Le Bas, P.-Y., Griffa, M., Anderson, B.E., Guyer, R.A., Three component time reversal: focusing vector components using a scalar source., *manuscript in review*.

Delsanto, P-P., Gliozzi, A., and **Ulrich, T.**, Elastic response to temperature of granular media: an analysis based on the phenomenological universality, *manuscript in review*.

Anderson, B.E., **Ulrich, T.**, Griffa, M., Scalerandi, M., and Gliozzi, A., Experimentally identifying masked sources applying time reversal with the selective source reduction method, *J. Applied Phys.*, in press (2008).

**Ulrich, T.**, Sutin, A.M., Claytor, T., Papin, P., Le Bas, P.-Y., and TenCate, J., Time reversed elastic nonlinearity diagnostic applied to investigating diffusion bonds, *Applied Phys. Lett.*, **93** (15), (2008).

**Ulrich, T.**, Griffa, M., and Anderson, B., Symmetry-based imaging condition in time reversed acoustics, *J. Applied Phys.*, **104** (6), (2008).

Scalerandi, M. Gliozzi, A., Griffa, M., Anderson, B.E., and **Ulrich, T.**, Selective source reduction to identify masked sources using time reversed acoustics, *J. Phys. D: Appl. Phys.* **41** (2008).

Griffa, M., Guyer, R.A., **Ulrich, T.**, Anderson, B.E., and Johnson, P.A., Investigation of the robustness of Time Reversal Acoustics in solid media through the reconstruction of temporally symmetric sources, *J. Phys. D: Appl. Phys.* **41** (2008).

**Ulrich, T.**, Sutin, A.M., Guyer, R.A., and Johnson, P.A., Time Reversal and Nonlinear Elastic Wave Spectroscopy (TR NEWS) Techniques, *Int. J. Nonlinear Mech.*, **43** (2008).

Anderson, B.E., Griffa, M., Larmat, C., **Ulrich, T.**, and Johnson, P.A., Time Reversal, *Acoustics Today*, **4** (1), (2008).

**Ulrich, T.**, Johnson, P., Muller, M., Mitton, D., Talmant, M., Laugier, P., Application of nonlinear dynamics to progressive fatigue damage in human cortical bone, *Applied Phys. Lett.*, **91**, 21 (2007). \* also selected for inclusion in the Dec. 1, 2007 issue of the **Virtual Journal of Biological Physics Research** ([www.vjbio.org](http://www.vjbio.org)).

**Ulrich, T.**, Johnson, P.A., and Guyer, R.A., Interaction dynamics of elastic waves with a complex nonlinear scatterer through the use of a time reversal mirror, *Phys. Rev. Lett.*, **98**, 104301 (2007).

**Ulrich, T.**, Johnson, P.A., and Sutin, A.M., Imaging nonlinear scatterers applying the time reversal mirror, *J. Acoust. Soc. Am.*, **119**, 1514-1518 (2006).

**Ulrich, T.**, McCall, K.R., and Guyer, R.A., Determination of elastic moduli of rock samples using resonant ultrasound spectroscopy, *J. Acoust. Soc. Am.*, (2002).

**Ulrich, T.** and Darling, T.W., Observation of anomalous elastic behavior in rock at low temperatures, *Geophys. Rev. Lett.*, (2001).

#### REVIEWS, REPORTS & PROCEEDINGS

**Ulrich, T.**, Saleh, T., Claytor, T., Papin, P., and TenCate, J., Investigation of diffusion bond strength using the Time Reversed Elastic Nonlinearity Diagnostic, *LANL internal report*, (2007).

Anderson, B.E., Scalerandi, M., Gliozzi, A., Griffa, M., **Ulrich, T.**, and Johnson, P.A., Selective source reduction to identify masked sources using time reversed acoustics (TRA), *Reviews of Progress in Quantitative Non-Destructive Evaluation*, (2007).

TenCate, J., **Ulrich, T.**, Sutin, A., and Johnson, P., Nonlinear elastic techniques for investigating diffusion bond strength, *LANL internal report: LA-UR-06-7670*, (2006).

**Ulrich, T.**, Johnson, P.A., and Sutin, A.M., Imaging and characterizing damage using time reversed acoustics, *Reviews of Progress in Quantitative Nondestructive Evaluation*, (2006).

**Ulrich, T.**, Broken symmetry in the elastic response to temperature of consolidated granular media, *Proceeding of the 17th International Symposium on Nonlinear Acoustics*, American Institute of Physics, (2006). **\*\*invited**

**Ulrich, T.**, Chandra, D., and Imam, A., Elastic constant measurements of Ti 6-2-1-1 using resonant ultrasound spectroscopy, *Ti-2003 Science and Technology*, Vol. 3, (2003).

#### PRESENTATIONS

##### ORAL:

Advances in time reversal nonlinear elastic wave spectroscopy (TR NEWS) for application to nonlinear non-destructive evaluation, imaging and source complexity. P. Johnson, T. Ulrich, B.E. Anderson, 19th International Congress on Acoustics, Madrid, Spain, September 2007. **\*\*invited**

Monitoring fatigue damage in cortical bone using Nonlinear Elastic Wave Spectroscopy. T. Ulrich, P. Johnson, M. Muller, P. Laugier, M. Talmant, D. Mitton, 19th International Congress on Acoustics, Madrid, Spain, September 2007. **\*\*invited**

Improving focal determination in time reversed acoustic signals, T. Ulrich, B.E. Anderson, P. Johnson, Quantitative Non-Destructive Evaluation 2007, Golden, CO, July 2007.

Experimental Time Reversal in solids, T. Ulrich, B.E. Anderson, P. Johnson, 12th International Workshop on Nonlinear Elastic Materials, Ajaccio, France, June 2007.

The Time Reversal Mirror (TRM) and nondestructive evaluation, T. Ulrich, B.E. Anderson, P. Johnson, A.M. Sutin, R.A. Guyer, Acoustical Society of America Spring Meeting, Salt Lake City, UT, June, 2007.

Imaging and characterizing damage using time reversed acoustics, T. Ulrich, P.A. Johnson, A.M. Sutin, Quantitative Non-Destructive Evaluation 2006, Portland, OR, July 2006.

Nonlinear dynamics of cracks and time reversed acoustic imaging, T. Ulrich, P.A. Johnson, R.A. Guyer, Quantitative Non-Destructive Evaluation 2006, Portland, OR, July 2006.

Time reversed acoustics and nondestructive evaluation, T. Ulrich, Los Alamos National Laboratory Engineering Institute summer school, June 2006. **\*\*invited**

Nonlinear dynamics and time reversed elastic nonlinearity diagnostics, T. Ulrich, P. Johnson, R. Guyer, A. Sutin, 11th International Workshop on Nonlinear Elastic Materials, Sorrento, Italy, June 2006.

Investigating fatigue damage in nickel based superalloys using nonlinear resonant ultrasound spectroscopy, T. Saleh, P. Johnson, J. Tencate, T. Ulrich, A. Sutin, 11th International Workshop on Nonlinear Elastic Materials, Sorrento, Italy, June 2006.

Reciprocity, nonlinearity and time reversal, T. Ulrich, P. Johnson, R. Guyer, A. Sutin, 10th International Workshop on Nonlinear Elastic Materials, Taormina, Italy, July 2005.

Elasticity as a function of grain size in polycrystalline copper, G. Kaplan, G. Mishra, T.J. Ulrich, K.R. McCall, 10th International Workshop on Nonlinear Elastic Materials, Taormina, Italy, July 2005.

Broken symmetry in the elastic response to temperature of consolidated granular media, T.J. Ulrich, K.R. McCall, R.A. Guyer, 17th International Symposium on Nonlinear Acoustics, Penn State University, July 2005. **\*\*invited**

Thermally induced nonlinear elastic response in Berea sandstone, T.J. Ulrich, K.R. McCall, R.A. Guyer, 9th International Workshop on Nonlinear Elastic Materials, Karlskrona, Sweden, June 2004.

Temperature dependant elastic behavior and thermal equilibrium of granular materials, 8th International Workshop on Mesoscopic Nonlinear Elastic Materials, Santa Fe, NM, July 2003.

Elastic constant measurements of Ti and Ti alloys using resonant ultrasound spectroscopy, T.J. Ulrich, Dhanesh Chandra, Imam Ashraf, Ti-2003, World conference on Titanium, Hamburg, Germany, July 2003.

Low temperature elastic behavior of rocks, T.J. Ulrich, K.R. McCall, R.A. Guyer, Fall meeting of the American Geophysical Union, San Francisco, CA, December 2002. **\*\*invited**

Further investigation into the elastic behavior of rocks below room temperature, 7th International Workshop on Mesoscopic Nonlinear Elastic Materials, Riva Del Garda, Italy, August 2002.

Nonlinear effects and the temperature dependence of the second-order elastic constants of rocks, T.W. Darling, T.J. Ulrich, 6th International Workshop on Mesoscopic Nonlinear Elastic Materials, Leuven, Belgium, June 2001.

RUS on rocks, T.J. Ulrich, K.R. McCall, 4th annual conference on nonlinear mesoscopic elasticity, Institute of Geophysics and Planetary Physics, Los Alamos National Laboratory, 1999.

POSTERS:

Displacement Field Reciprocity, Nonlinearity, and Time Reversal: An Experimental Exploration, T. Ulrich, R. Guyer, Fall Meeting of the American Geophysical Union, San Francisco, CA, December 2005.

Elasticity as a function of grain size in polycrystalline copper, G. Kaplan, G. Mishra, TJ Ulrich, and K.R. McCall, March Meeting of the American Physical Society, March 2005.

Optical studies of f-electron metals under high pressure, E. Emmons, T. Cowan, S. Duvvuri, G. Kaplan, R. Kraus, N. LeGalloudec, K. McCall, G. Mishra, J. Thompson, T.J. Ulrich, and A. Covington, March Meeting of the American Physical Society, March 2005.

Identifying phase transitions and kinetics in Cerium metal using resonant ultrasound spectroscopy, G. Mishra, G. Kaplan, TJ Ulrich, and K.R. McCall, March Meeting of the American Physical Society, March 2005.

Anomalous thermal relaxation induced by the granular composition of berea sandstone, TJ Ulrich, K.R. McCall, and R.A. Guyer, Fall Meeting of the American Geophysical Union, San Francisco, CA, December 2003.

Anomalous elastic behavior of rocks below room temperature, TJ Ulrich, T.W. Darling, and K.R. McCall, Fall Meeting of the American Geophysical Union, San Francisco, CA, December 2001.

Slow Dynamics and Nonlinearity in Rocks: Response to Changes of Humidity J A TenCate, T W Darling, T J Ulrich, T J Shankland, Fall meeting of the American Geophysical Union, December, 2000.

Optimizing success with resonant ultrasound spectroscopy on rock samples, TJ Ulrich, I. Santos and K.R. McCall, Fall Meeting of the American Geophysical Union, San Francisco, CA, December 1999, and Fall Meeting of the Geological Society of America, Reno, NV October 2000.

Application of resonant ultrasound spectroscopy (RUS) to determine the elastic properties of rock samples, TJ Ulrich, K.R. McCall, P.A. Johnson, T.W. Darling, and A. Migliori, Fall meeting of the American Geophysical Union, San Francisco, CA, December 1998.

Summary of in situ observations of cirrus microphysics during FIRE II: instrumental response, W.P. Arnott, TJ Ulrich, R. Cole, J. Hallett and M.R. Poellot, American Meteorological Society Conference on cloud Physics, Everett, WA, August 1998.

PERSONAL  
INTERESTS

Mountain Biking  
Skiing  
Rock Climbing  
Swing Dancing  
Music  
International Travel