Paul S. Julienne

Joint Quantum Institute, National Institute of Standards and Technology (NIST) and the University of Maryland, 100 Bureau Drive Stop 8423, Gaithersburg, MD 20899-8423

(a) Professional preparation

Wofford College, Chemistry (1965)
University of North Carolina at Chapel Hill, Chemical Physics, Ph. D. (1969)
National Bureau of Standards (NBS), NRC postdoctoral research associate, 1969-1971
National Bureau of Standards (NBS), postdoctoral research associate, 1971-1973

(b) Appointments

Joint Quantum Institute Fellow, University of Maryland and NIST, 2007-present
NIST Fellow, 2003-present
NIST, Group Leader, Quantum Processes Group, Atomic Physics Division, 1995-2003
NIST/NBS, staff, 1974-1995
Naval Research Laboratory, staff, 1973-1974

(c) Publications

A select set of relevant publications (Over 220 publications total with more than 1000 citations in 2011 and an h-factor of 50 through 2011).

S. Ospelkaus, K.-K. Ni, D. Wang, M. H. G. de Miranda, B. Neyenhuis, G. Quéméner, P. S. Julienne, J. L. Bohn, D. S. Jin and J. Ye, "Quantum-State Controlled Reactions of Ultracold KRb Molecules," Science 327, 853-857 (2010). (arXiv:0912.3854)

Z. Idziaszek and P. S. Julienne, "Universal rate constants for reactive collisions of ultracold molecules," Phys. Rev. Lett 104, 113202 (2010). (arXiv:0912.0307)

C. Chin, R. Grimm, P. S. Julienne, and E. Tiesinga, "Feshbach Resonances in Ultracold Gases," Rev. Mod. Phys. 82, 1225-1286 (2010). (arXiv:0812:1486)

"Ultracold molecules from ultracold atoms: a case study with the KRb molecule," P. S. Julienne, Faraday Discuss. 142, 361-388 (2009). (arXiv:0812:1233)

"A High Phase-Space-Density Gas of Polar Molecules," K.-K. Ni, S. Ospelkaus, M. H. G. de Miranda, A. Pe'er, B. Neyenhuis, J. J. Zirbel, S. Kotochigova, P. S. Julienne, D. S. Jin, J. Ye, Science 322, 231-235 (2008).

"Ultracold photoassociation spectroscopy: long-range molecules and atomic scattering," K. Jones, E. Tiesinga, P. D. Lett, and P. S. Julienne, Rev. Mod. Phys. **78**, 483 (2006).

(d) Honors

* 1992, Department of Commerce Silver Medal
* 1998, Department of Commerce Gold Medal
* 2004, Davisson-Germer Prize of the American Physical Society,

Citation: For his pioneering studies of the theory of ultracold atomic collisions, and its applications to precision metrology and quantum gas dynamics.

* 2004, NIST Samuel Wesley Stratton Award for outstanding scientific or engineering achievements in support of NIST objectives.

Citation: For world leading theoretical physics research in collisions fundamental to the laser cooling of atoms and Bose-Einstein condensation

* 2005, Washington Academy of Sciences Annual Award for Work of Merit and Distinction in the Physical Sciences

Citation: For pioneering studies of the theory of ultracold atomic collisions and its numerous applications that continue to impact forefront research from Bose-Einstein condensation to atomic clocks.

* 2007, Meritorious Presidential Rank Award.

These awards recognize exceptional long-term accomplishments in public service by career senior government executives or scientists. Award winners are nominated by their agency heads, evaluated by boards of private citizens, and approved by the President.

(e) Committees

* 1994-1998, National Research Council Committee on Atomic, Molecular, and Optical Science (CAMOS)
* 2005-2007, Advisory Board for the Harvard-Smithsonian Institute for Atomic and Molecular Physics (ITAMP).
* 2007-2010, American Physical Society Divisional Councilor, representing the Division of Atomic, Molecular, and Optical Physics (DAMOP).

(f) Research interests:

My general area of interest has been in theoretical molecular spectroscopy and atomic collision processes, in particular, in the application of theoretical techniques to obtain a better understanding of basic atomic and molecular phenomena. Most of this work has been directed at understanding experimental observations or to make predictions that can be tested by new experiments. Work in the 1970's involved applications to atmospheric and astrophysical problems. From the late 1970s through the 1980s, applications centered on issues relating to the development of high-energy lasers and collisions in light fields. For the last 25 years, since the development of laser cooling in the mid 1980s, I have concentrated on phenomena associated with ultracold trapped atoms. Current research is directed in two areas. The first is the formation and properties of ultracold molecules. This includes the development of simplified quantitative models for understanding and calculating the properties of magnetically tunable Feshbach resonances, which have been very successfully used to make cold molecules and to control atom interactions in quantum degenerate atomic gases or optical lattices. This work is being extended to calculating the properties of optically tunable resonances. The second area involves the study of closed shell S-state atoms such as Ca, Sr, and Yb. These species can be laser cooled, have both bosonic and fermionic isotopes, and have good prospects for use in ultraprecise optical clocks, as new kinds of quantum degenerate gases or lattices, or for quantum information applications.

PUBLICATION LIST

Paul S. Julienne

1. Julienne, P. S., and Gary, L. P., "Trapped electrons in ice," Molecular Crystals **5**, 135(1968).

2. Julienne, P. S., and Choi, Sang-Il, "Impurity states in a linear molecular Crystal," J. Chem. Phys. **49**, 3704 (1968).

3. Julienne, P. S., and Choi, Sang-Il, Electronic states of a disordered polymer,", J. Chem. Phys. **53**, 2726 (1970).

4. Julienne, P. S., "Predissociation of the H_2 $D^1\Pi_u$ state," Chem. Phys. Lett. **8**, 27 (1971).

5. Waynant, R. W., Ali, A. W., and Julienne, P. S., "Experimental observations and calculated band strengths for the D_2 Lyman band laser," J. Appl.Phys. **42**, 3406 (1971).

6. Julienne, P. S., Neumann, D., and Krauss, M., "Calculation of the temperature dependence for absorption of CO_2 in the 1720-1200 Å region," J. Atmos. Sci. **28**, 833 (1971).

7. Julienne, P. S., Krauss, M., and Donn, B., "Formation of OH through inverse predissociation," Astrophys J. **170**, 65 (1971).

8. Julienne, P. S., Krauss, M., and Wahl, A. C., "Hartree-Fock energy curves for the $X^2\Pi$ and $^2\Sigma^+$ states of HF ," Chem. Phys. Lett. **11**, 16 (1971).

9. Marchetti, M., Julienne, P. S., and Krauss, M., "Vibrational and electronic oscillator strengths of LiO," J. Res. NBS **76A**, 665 (1972).

10. Julienne, P. S., and Krauss, M., "Excitation of O_2 $^1\Delta_g$ by electron impact," J. Res. NBS **76A**, 661 (1972).

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14. Julienne, P. S., Davis, J., and Oran, E. S., "Oxygen recombination in the tropical nightglow," J. Geophys. Res. **79**, 2540 (1974).

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72. Band, Y. B., and Julienne, P. S., "Molecular Population Transfer, Alignment and Orientation using Chirped Pulse Absorption," J. Chem. Phys. **97**, 9107 (1992).

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Ionization Collisions in a Sodium Magneto-optic Trap," Phys. Rev. Lett.**76**, 2033 (1996).

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Molecule and a Determination of the Atomic 3P Lifetime, Euro. Phys. Lett. **35**, 85 (1996).

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Invited Talks, 1997

1. “Atomic Interactions and Bose-Einstein Condensation,” Physics Colloquium, University of Toledo, Toledo, OH, January 1997.

2. “Collisional Stability of Dual Bose-Einstein Condensates,” ARO-ONR Workshop on Atom Lasers, Optical Sciences Center, University of Arizona, Tuscon, AZ, January, 1997.

3. “Atomic Interactions and Bose-Einstein Condensation,” Physics Seminar, Ben-Gurion University, Beer-Sheva, Israel, February, 1997.

4. “Atomic Interactions and Bose-Einstein Condensation,” Physics Seminar, Oersted Institute, Copenhagen University, Copenhagen, Denmark, March, 1997.

5. “Atomic Interactions and Bose-Einstein Condensation,” Workshop on Bose-Einstein Condensation,” University of Helsinki, Helsinki, Finland, March, 1997.

6. “Photoassociation Spectroscopy: Progress in Theory for a New Precision Measurement Tool,” Symposium on New Challenges in Precision Atomic Physics, DAMOP Meeting, American Physical Society, April, 1997.

7. “Atomic Collisions and Bose-Einstein Condensation,” Joint University of Connecticut, Wesleyean University, and Yale University Physics Chemical Physics Colliquium Series, Storrs, CT, April, 1997.

8. “High Precision Molecular Spectra by Photoassociation of Ultracold Trapped Atoms,” International Symposium on Molecular Spectroscopy, Ohio State University, Columbus, OH, June 1997.

9. “Theory of Ultracold Atomic Collisions,” International Conference on Electron and Atomic Collisions, Vienna, Austria, July, 1997.

10. “Atomic Interactions and Bose-Einstein Condensation,” Gordon Conference on Electronic Spectra, Queens College, Oxford, England, September, 1997.

11. “Quantitative Collision Rates for Ultracold Collisions,” Gaseous Electronics Conference, Madison, WI, October, 1997.

12. “Atomic interactions and Bose-Einstein Condensation,” Physics Colloquium, Temple University, Philadelphia, PA, November, 1997

13. “Photoassociation Spectroscopy and Bose-Einstein Condensation,” Workshop on Collisions of Cold, Trapped Atoms, JILA, Boulder, CO, November, 1997.

Invited Talks, 1998

1. Collisions of Cooled and Trapped atoms: 3 lectures, "Introduction to Cold Collisions: Basic concepts," "Photo-induced collisions," "Collisions and Bose-Einstein Condensation", School on Nonlinear and Quantum Optics, 1998, Sao Carlos, Brazil, January 5-16, 1998.

2. "Progress in Cold Collision Studies for Bose-Einstein Condensation," Mini-workshop on Bose-Einstein Condensation, Niels Bohr Institute, Copenhagen, Denmark, January 24, 1998.

3. " Collisions in a Cold Atomic Gas," Euroconference on Slow Collisions between Laser Manipulated Systems," Rust, Austria, April 1-5, 1998.

4. "Cold Molecule Formation in Bose-Einstein Condensates and Optical Lattices," Center for Advanced Studies Workshop on Quantum Control of Atomic Motion II, University of New Mexico, Albuquerque, New Mexico, June 1-2, 1998

5. "Atomic Collisions in the Quantum Limit," Symposium honoring Bill Phillips, NIST, June 17-19, 1998.

6 "Lineshape Issues in Cold Atomic Collisions." International Conference on Spectral Line Shapes, Pennsylvania State University, State College, PA, June 22-26, 1998.

7. "Atoms, Molecules, Bose-Einstein Condensates, and Light ," Gordon Conference on Atomic and Molecular Interactions, New London, NH, June 28-July 3, 1998

8. "Ultracold Atomic Collisions," International Conference on Atomic Physics, Windsor, Ontario, Canada, Aug. 3-7, 1998.

9. "Atoms, Light, and Bose-Einstein Condensates: the Story of Cooling and Trapping," Physics Seminar, George Mason University, Fairfax, Virginia, Oct. 9, 1998.

10. "Cold Atomic Collisions: 9 lectures," Master Class on Laser Cooling, Cold Collisions, and Bose-Einstein Condensation, Niels Bohr Institute, Copenhagen, Denmark, Dec. 2-9, 1998.

Invited Talks, 1999

1. "Photoassociation Spectroscopy: Past, Present, and Future," Workshop on Formation of Cold Molecules," Les Houches, France, March 1-5, 1999.

2. "Atoms, Light, and Bose-Einstein Condensates: the Success of Cooling and Trapping," Physics Colloquium, Univerisy of Maryland Baltimore County, April 9, 1999.

3. "Atomic Collisions in Optical Lattices," Southwestern Quantum Information Network Workshop, Alburqueque, NM, April 30-May 1, 1999.

4. “Cold Collisions in Traps: Condensates, Resonances, and Molecules,”, ITAMP Workshop on Cold Molecules, Harvard-Smithsonian Center for Astrophysics, July 1-3, 1999.

5. “Collisions and the Dynamics of Cold Atomic Gases,” International Conference on the Dynamics of Molecular Collisions, Split Rock, PA, July 18-22, 1999

6. “Coherence and Dynamics of Matter Waves from Bose-Einstein Condensate Sources,” Grodon Coference on Quantum Control of Matter, Plymouth, NH, Aug. 1-5, 1999.

7. “Photoassociation Spectroscopy: Past, Present, and Future,” Workshop on Collisions in Laser Fields, Torun, Poland, Sept. 1-3, 1999.

8. “Condensates, Collisions, and Quantum Control,” Physics Seminar, Yale Univeristy, New Haven, CT, Nov. 6, 1999.

Invited talks, 2000

1. “Scattering resonances and the formation of cold molecules,” Division of Atomic, Molecular, and Optical Physics Annual Meeting, Storrs, CT, June 16, 2000.

2. “Nonlinear phenomena in Bose-Einstein condensate wavepacket dynamics,” Gordon Conference on Multiphoton Processes, Tilton, NH, June 22, 2000.

3. “Survey of molecule formation processes from ultracold atoms,” American Chemical Society National Meeting, Symposium on Low Temperature Spectroscopy and Dynamics, Washington, DC, August 22, 2000.

4. “Group II Atoms: A Cornucopia of Cold Collision Physics,” Workshop on Group II Atoms, Institute for Theoretical Atomic and Molecular Physics, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, Sept. 9, 2000.

5. “Threshold Resonances: a key to cold collision phenomena,” Physics Seminar, State University of New York, Stony Brook, NY, September 25, 2000.

6. “Threshold Resonances: a key to cold collision phenomena,” Department of Energy Basic Energy Sciences Annual Meeting on Atomic, Molecular, and Optical Physics, Warrenton, VA, September 28, 2000.

Invited Talks, 2001

1. “Threshold resonances: A key to cold collision physics”, Physics Seminar, University of Texas at Austin, Austin, TX, March 2001.

2. “Threshold resonances: A key to cold collision physics”, Seminar, Center for Ultracold Atoms, Harvard/MIT, Cambridge, MA, May 2001.

3. “Threshold resonances: A key to cold collision physics”, International Conference on Laser Spectroscopy, Snowbird, UT, June 2001.

4. “Collisions of Cold Group II Atoms,” Workshop on Cold Atoms and Ultra-precise Atomic Clocks, Sandjberg, Denmark, September 2001.

Invited Talks, 2002

1. "Quantum encounters of the cold kind," Physics Seminar, European Laboratory for Nonlinear Spectroscopy, Florence, Italy, February, 2002.

2. "Theory of photoassociation at ultra low temperatures," Workshop on Cold Molecules, Les Houches, France, march 2002.

3. " Quantum encounters of the cold kind," Physics Colloquium, Old Dominion University, Norfolk, VA, April 2002.

4. "Collisions, Condensates, and Optical Lattices," Conference on Cold Atoms in Traps, Sandbjerg, Denmark, April 2002.

5. "Collisions, Condensates, and Optical Lattices," Nordic Institute for Theoretical Physics, Copenhagen, Denmark, April 2002.

6. "Collisions, Condensates, and Optical Lattices," Physics Seminar, Institute for Quantum Optics, University of Hannover, Hannover, Germany, April 2002.

7. "Threshold resonances: a key to cold collision physics," Workshop on Cold Molecules, University of Durham, Durham, UK, September 2002.

8. "Quantum encounters of the cold kind," Seminar, University of Maryland, College Park, Md, , October, 2002.

9. “Cold collision basics: Threshold phenomena”, tutorial lecture, Institute for Experimental Physics, University of Innsbruck, Innsbruck, Austria, November, 2002.

10. “Quantum Encounters of the Cold Kind,” Physics Seminar, University of Innsbruck, Innsbruck, Austria, November, 2002.

11. “Photoassociation in a Bose-Einstein condensate”, tutorial lecture, Institute for Experimental Physics, University of Innsbruck, Innsbruck, Austria, November, 2002.

Invited talks, 2003

1. "Time-dependent Feshbach Resonance Ramps and Molecules in a BEC," QIBEC Seminar, NIST, January, 2003.

2. "Quantum Encounters of the Cold Kind: Fundamentals of Cold Collision Physics," Tutorial Lecture, Student Symposium, DAMOP, Boulder, May, 2003.

3. "Making Cold Molecules by tunable Scattering Resonances," Quantum Challenges Colloquium, Warsaw, Poland, Spetember, 2003

4. "High intensity Photoasociation Spectra," Workshop on Cold Alkaline Earth Atoms, Copenhagen, Denmark, September, 2003.

Invited Talks 2004

1. "Making Ultracold Molecules" Joint Institute for Coherent Quantum Phenomena Workshop, U. Maryland, January, 2004

2. "Making cold molecules using tunable scattering resonances", March APS Meeting, Montreal, March 22, 2004

3. "Making cold molecules using tunable scattering resonances", Conference on Bose-Einstein Condensation: from Atoms to Molecules, University of Durham, UK, March, 2004

4. "Making cold molecules using tunable scattering resonances", Plenary Prize Session, DAMOP, Tucson, AZ, May, 2004

5. "Making cold molecules using tunable scattering resonances", Symposium on Ultracold Molecules, American Chemical Society National Meeting, Philadelphia, August, 2004.

Invited Talks 2005

1. "Tunable scattering resonances: What are they like?" Conference on Mesoscopic Phenomena in Ultracold Matter: From Single Atoms to Coherent Ensembles, Dresden, Germany, October 2004.

2. "The molecular physics of bound and unbound Feshbach resonance states," Workshop on Ultracold Molecules, Telluride, CO, July 2005.

3. “Quantum Encounters of the Cold Kind,” Telluride Public Town Talk, Telluride, CO, July 2005.

4. “What you really want to know about Feshbach resonances,”, NIST QIBEC Seminar, July 2005.

5. “Properties of Bound and Unbound Feshbach Resonance States,” Seminar, Institute for Experimental Physics, University of Innsbruck, Innsbruck, Austria, August 2005.

6. “Feshbach Resonances and the Formation of Polar Molecules,” Workshop on Quantum Computing with Polar Molecules, Arlington, VA, Sept. 2005.

7. “Scattering resonances and molecules in ultracold atomic gases,” James Franck Institute, University of Chicago, Chicago, IL, October, 2005.

8. “Scattering resonances and molecules in ultracold atomic gases,” Atomic Physics Seminar, NIST, Nov. 2005.

Invited Talks 2006

1. “Scattering resonances and molecules in ultracold atomic gases,” James Franck Institute, University of Chicago, Chicago, IL, October, 2005.

2. “Scattering resonances and molecules in ultracold atomic gases,” Atomic Physics Seminar, NIST, Nov. 2005.

3. “Scattering resonances and molecules in ultracold atomic gases,” Physics Seminar, Ohio State University, Columbus, Ohio, Feb. 2006.

4. “Resonant control of collisions in atomic gases,” Center for Advanced Studies Seminar, University of New Mexico, Albuquerque, New Mexico, March, 2006.

5. Three lectures at the ICAP Summer School, Innsbruck, Austria, July 10-14, 2006, on “Cold atomic and molecular collisions:” (1) “Basics,” (2) ”Feshbach resonances, ” (3) ”Photoassociation.”

6. “Simple theoretical models for resonant cold atom interactions”, International Conference on Atomic Physics (ICAP), Innsbruck.

7. “Resonant control of cold atom collisions,” Physics seminar, University of Durham, Durham, UK, July 2006.

8. “Cold molecular collisions: challenges and opportunities”, Wilhelm und Else Heraeus-Seminar on Cold Molecules, Bad Honnef, Germany, October 2007.

Invited Talks 2007

1. "Mass tuning of scattering lengths", NIST QIBEC seminar, March 2007.

2. "Some Perspectives on Ultracold Atomic and Molecular Interactions and their Control," KITP Conference on Correlated States in Degenerate Atomic Gases, April 25, 2007.

3. "Ultracold Alkali Metal Atoms and Dimers: A Quantum Paradise," 62nd International Symposium on Molecular Spectroscopy, Columbus, OH, June 22, 2007

4. "Photoassociation of alkaline earth and related species," Coherent Control of Ultracold Molecular Processes, University of British Columbia, Vancouver, CA, August 1-4, 2007

5. "Ultracold Atomic Physics: A Quantum Paradise," University of Louisville Physics Colloquium, Sept. 14, 2007

6. "From Clocks to Molecules: Some New Trends in Ultra-cold Physics.", Atomic Physics Division Seminar, NIST, Dec. 18, 2007.

Invited Talks, 2008

1. "New Opportunities in ultra-cold physics with Sr and Yb atoms," Physics Seminar, Rice University, Houston, May 2, 2008.

2. "Ultracold lattices of molecular dipoles," Coherence and Correlations in Nanosystems, Ustron, Poland, Sept. 6, 2008.

3. "Some new directions in ultracold physics," Nicholas Copernicus University, Torun, Poland, Sept. 11, 2008.

4. "Ultracold molecules in gases and lattices,", Joint Quantum Institute Seminar, University of Maryland, Oct. 20, 2008.

Invited Talks, 2009

1. "Ultracold polar molecules: a case study with KRb," Harvard/Smithsonian Joint Atomic Physics Colloquium, Boston, MA, April 1, 2009.

2. "Ultracold molecules from ultracold atoms: a case study with KRb,", Faraday Discussions 142 Cold and Ultracold Molecules, University of Durham, Durham, UK, April 17, 2009.

3. "Understanding Feshbach molecules with long range quantum defect theory," EuroQUAM Satellite Meeting on Cold Molecules, University of Durham, UK, April 18, 2009.

4. “Understanding ultracold polar molecules,” DAMOP Focus Session on Cold Molecules, University of Virginia, May 23, 2009.

5. “Understanding ultracold atomic and molecular collisions”, Workshop on Cold Atoms and Molecules: Collisions, Field Effects, and Applications, Univeriity of Kyoto, Kyoto, Japan, June 25, 2009.

6. “The Quantum Defect Viewpoint of Atomic and Molecular Collisions”, Colorado Cold Molecule Workshop, Boulder, CO, July 17, 2009.

Invited Talks, 2010

1. “Universal reaction rates for ultracold molecular collisions,” Physics of Quantum Electronics Conference, Snowbird, UT, January 4, 2010.

2. “Reaction rates for ultracold molecular collisions,” NIST QIBEC Seminar, Jan. 20, 2010.

3. “Simple models for ultracold molecular collisions,” APS March Meeting, Focus Session on Cold Molecules II, March 17, 2010.

4. “Towards a theory of ultracold molecular collisions,” International Workshop on Coherence in Ultracold Molecular Physics, University of British Columbia, Vancouver, CA, May 23, 2010.

5. “Ultracold Polar Molecules in Gases and Lattices”, Quantum Technologies Conference: Manipulating photons, atoms, and molecules Torun, Poland, September 1, 2010.

6. “Ultracold Polar Molecules in Gases and Lattices”, Correlations and coherence at Different Scales, Ustron, Poland, Sept. 4, 2010.

7. Ultracold Molecules in Gases and Lattices: the Next Frontier,” EuroQUAM 2010 Cold Quantum Matter: Achievements and Prospects, Ischgl, Austria, Sept. 13, 2010.

8 “Cold Collisions of Atoms, Molecules, and Ions,” 2010 European Conference on Trapped Ions County Durham, UK, September 21, 2010.

Invited Talks 2011

1. “Towards simple theories for polar molecule collisions,” Macroscopic Quantum Control Conference on Ultracold Atoms and Molcules, University of Tokyo, Japan, January 24-26, 2011.

2. “Universal and non-universal collisions of ultracold molecules in gases and lattices,” International Workshop on Coherence and Decoherence at Ultracold Temperatures, Institute for Advanced Study, Technical University of Munich, Sept. 6-9, 2011.

3. “Universal and non-universal collisions of ultracold molecules in gases and lattices,” Fundamental Science with Ultracold Molecules, ITAMP Topical Group, Oct. 3-7, 2011.

4. “New Frontiers with ultracold molecules,” Physics Colloquium, University of Maryland Baltimore County, October 19, 2011.

5. “Universal and non-universal collisions of ultracold molecules in gases and lattices,” International Workshop on Ultracold Molecules, national Institute of Theoretical Physics, Stellenbosch, South Africa, Nov. 7-11, 2011.