

Curriculum vitae

Rafael Garcia

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BACKGROUND

1. EDUCATION:

- 1995-1999 Penn State University, University Park, PA; Ph.D. in Physics.
Thesis: "Fluctuation-Induced Forces in Helium Films"
Thesis Advisor: Dr. Moses H. W. Chan
- 1992-1995 Penn State University, University Park, PA; M.S. in Physics.
- 1984-1988 Cornell University, Ithaca, NY;
B.A. with Distinction in All Subjects;
Dual Major in Chemistry and Biology.

2. WORK EXPERIENCE:

- 2003-present Assistant Professor, Physics Dept., Worcester Polytechnic Institute
- 1999-2003 Physics Post-Doctoral Researcher, Penn State University
- 1992-99 Physics Graduate Teaching and Research Assistant, Penn State University
- 1988-92 Assistant Chemist, Elf Atochem North America
- 1986-88 Undergrad Research Assistant, Boyce Thompson Institute for Plant Research

SCHOLARSHIP

3(a). PEER-REVIEWED PUBLICATIONS: (Number of citations indicated at the beginning within parentheses)

1. (1) R. Garcia, E. Subashi, and M. Fukuto, "Thin-Thick Coexistence Behavior of 8CB Liquid Crystalline Films on Silicon," *Phys. Rev. Lett.* 100, 197801 (2008).
2. (0) R. Garcia, K. Osborne, and E. Subashi, "Addition/Correction: Validity of the "Sharp-Kink Approximation" for Water and Other Fluids," *J. Phys. Chem B* 112, 8199 (2009).
3. (1) R. Garcia, K. Osborne, and E. Subashi, "Validity of the "Sharp-Kink Approximation" for Water and Other Fluids," *J. Phys. Chem B* 112, 8114 (2008).
4. (11) A. Ganshin, S. Scheidemantel, R. Garcia and M. H. W. Chan, "Critical Casimir force in He-4 films: Confirmation of Finite-size Scaling," *Phys. Rev. Lett.* 97 075301 (2006).
5. (27) M. Hieda, R. Garcia, M. Dixon, T. Daniel, D. Allara, and M. H. W. Chan, "Ultrasensitive Quartz Crystal Microbalance with Porous Gold Electrodes," *Appl. Phys. Lett.*, 84, 628 (2004).

6. (0) R. Garcia, T. Wilson, J. Ma, O. Vilches, and M. H. W. Chan, "Layer-by-Layer Growth of Helium and Hydrogen on Gold," *J. Low Temp. Phys.* 134, 567 (2004).
7. (1) R. Garcia, S. Jordan, J. Lazzaretti, and M. H. W. Chan, "Quartz Microbalance Study of Thick He-4 Films near the Superfluid Transition," *J. Low Temp. Phys.* 134, 527 (2004).
8. (2) R. Garcia, S. Sheidemantel, K. Knorr and M. H. W. Chan, "Critical Adsorption in a Well-defined Geometry," *Phys. Rev. E.* 68, 056111 (2003).
9. (0) R. Garcia and M. H. W. Chan, "Boundary Conditions and Critical Casimir Forces in Helium," *Physica B* 329, 238 (2003).
10. (30) R. Garcia and M. H. W. Chan, "Critical Casimir Force near the 3He- 4He Tricritical Point," *Phys. Rev. Lett.* 88, 086101 (2002).
11. (7) R. Garcia and M. H. W. Chan, "Preliminary Measurement of the Critical Casimir Effect near the Tricritical Point of He-3-He-4 Mixture Films," *J. Low Temp. Phys.* 121, 55 (2000).
12. (9) R. Garcia and M. H. W. Chan, "Critical Casimir Effect in Dilute He-3-He-4 Mixture Films," *Physica B* 280, 55 (2000).
13. (67) R. Garcia and M. H. W. Chan, "Critical Fluctuation-Induced Thinning of 4He Films near the Superfluid Transition," *Phys. Rev. Lett.* 83, 1187 (1999).
14. (70) J. Levy, V. Nikitin, J. M. Kikkawa, A. Cohen, N. Samarth, R. Garcia, and D. D. Awschalom, "Spatiotemporal Near-Field Spin Microscopy in Patterned Magnetic Heterostructures," *Phys. Rev. Lett.* 76, 1948-1951 (1996).
15. (87) S. A. Crooker, D. A. Tulchinsky, J. Levy, D. D. Awschalom, R. Garcia, and N. Samarth, "Enhanced Spin Interactions in Digital Magnetic Heterostructures," *Phys. Rev. Lett.* 75, 505-508 (1995).

3(b). NON-PEER-REVIEWED PUBLICATIONS: (Number of citations indicated at the beginning within parentheses)

1. (0) R. Garcia, A. Zozulya, J. Stickney, "MATLAB codes for teaching quantum physics: Part 1," LANL Physics Archives, <http://arxiv.org/abs/0704.1622> (2007). Downloaded 16 times.

4(a). SCHOLARSHIP IN PROGRESS

1. Experimental measurement of Casimir forces near the Nematic to Smectic transition in liquid crystalline films
2. Investigation of quenched random disorder effects on 2 dimensional phase transitions
3. Investigation of confinement effects on the surface tension, viscosity and surface ordering of liquid crystalline films
4. Investigation of the temperature dependence of the contact angle of liquids on solid surfaces, examining the validity of current predictions that water at sufficiently high temperature will wet even a hydrophobic surface.
5. Investigation of wetting transitions in films of binary liquid mixtures which may be caused by Casimir forces
6. Attended Liquid Crystal Gordon Conference at Colby-Sawyer College in New Hampshire, to present our measurements of the Nematic-to-Smectic transition in 8CB films adsorbed on silicon June 14-19, 2009.
7. Currently preparing two publications on the Nematic-to-Smectic transition in 8CB to be submitted this fall.

4(b). LABORATORY REQUIREMENTS FOR RESEACH

A fully functioning laboratory is in place at the Worcester Polytechnic Institute, which is suitable for these studies. It was set up with startup funds of \$120, 000 (of which so far \$100,000 has been spent), plus \$40,000 from a Petroleum Research Fund (PRF) Grant, and \$140,000 from an NSF Major Research Instrumentation Grant.

The projects may also be found at my website:

<http://www.wpi.edu/~garcia/WTL.html>

5. GRANTS-awarded or pending

1. **“NSF MRI: Acquisition of a Modulated Differential Scanning Calorimeter and Spectroscopic Ellipsometer for Characterizing Complex Fluids,” \$233,194.00, with H. Susan Zhou, Terri Camesano, Jose Arguello, and G. Iannachione, Awarded 2008.**
2. **“PRF: Experiments for Improved Understanding of the Wetting of Polar Liquids,” \$40,000, 2006 , Awarded.**
3. **“MRI: Acquisition of an Atomic Force Microscope for Bioengineering and Life Science Research Across Multiple Scales: Molecules, Polymers, Microbes, and Cells”, 2008, Pending2009.**

6(a). PROFESSIONAL PRESENTATIONS (Invited):

1. “Experimental Observation of Casimir Forces in Tricritical and Liquid Crystalline Films,” Rafael Garcia, KITP Program: The Theory and Practice of Fluctuation-Induced Interactions, University of California Santa Barbara, Nov 04, 2008. <http://online.kitp.ucsb.edu/online/fluctuate08/garcia/>
2. “Wetting transitions and forces in adsorbed films: new phenomena and surprising results,” Rafael Garcia, Boston University Physics Dept. Condensed-Matter Seminar, March 2008.
3. “Surprising phase diagram of thin 8CB liquid crystal films on Silicon,” Rafael Garcia, Ergys Subashi, Masa Fukuto, Condensed Matter Physics and Materials Science Dept. Seminar, Brookhaven National Lab, July 2007.
4. “Casimir Forces and the Wetting of Thin Films,” Rafael Garcia, Condensed Matter Physics and Materials Science Dept. Seminar, Brookhaven National Lab, April 2006.
5. “Casimir Forces and the Wetting of Thin Films,” Wesleyan University Physics Dept. Colloquium, Sept. 2005.
6. “Casimir Forces and the Wetting of Liquids on Solid Surfaces,” Rafael Garcia, University of Massachusetts at Lowell Physics Dept. Colloquium, Sept. 2005.
7. “Casimir Forces and the Wetting of Thin Films,” Rafael Garcia, Clark University Physics Dept. Colloquium, October 2004
8. “Critical Casimir Force in Superfluid Helium Films,” March Meeting of the American Physical Society, Montreal, CA, March 2004.
9. “What We Still Don’t Know About Critical Casimir Forces,” Rafael Garcia, Symposium on Quantum Fluids and Solids, University of New Mexico, Albuquerque, NM, August 2003.
10. “Experimental Observation of Critical Casimir Forces,” Rafael Garcia and Moses Chan, NASA/JPL Workshop for Fundamental Physics in Space, May, 2002.
11. “Critical Casimir Effect near the Tricritical Point,” Rafael Garcia, European Physical Society, Brighton, UK, April, 2002.

12. "Critical Casimir Effect near the Tricritical Point," Symposium on Quantum Fluids and Solids, University of Minnesota, Minneapolis, MN, June, 2000.
13. "Critical Casimir Effect in ^3He - ^4He Mixture Films," International Conference on Low Temperature Physics (LT22), Helsinki, Finland, August 1999.
14. "Fluctuation-Induced Forces near the Superfluid Transition in Helium," Centennial Meeting of the American Physical Society, Atlanta, GA, March 1999.
15. "Fluctuation Induced forces in Helium Films," Low Temperature Physics Seminar, Physics Dept., Cornell Univ., February 1999.

6(b). PROFESSIONAL PRESENTATIONS (Contributed):

16. "Quartz Crystal Microbalance Measurement of Adsorption Potential Well-depths," Ryan Foltz and R. Garcia, March Meeting Contributed Talk, N17.00014 (2007).
17. "Absence of Uniform Nematic Phase for Thin 8CB Films, Ergys Subashi and R. Garcia, March Meeting Contributed Talk, N30.00002 (2007).
18. "Wetting Behavior of Nitrous Oxide Near its Critical Point," R. Weiler, M. Waegell, and R. Garcia, March Meeting Contributed Talk, H3.0002 (2006).
19. "Water as a Wetting Agent for Liquid Crystal Films," E. Subashi and R. Garcia, March Meeting Contributed Talk, W21.0009 (2006).
20. "Observing a Wetting Transition for Water," S. Segawa, R. Weiler and R. Garcia, March Meeting Contributed Talk, Abstract J39.0009 (2005).
21. "Dewetting Mechanism of Thin Liquid Crystal Films," E. Subashi and R. Garcia, 24th New England Complex Fluids Workshop, Talk #11, Brandeis University (2005).

6(c). PROFESSIONAL PRESENTATIONS (INVITED BUT NOT RESEARCH-RELATED):

1. Bancroft Middle School, Worcester MA: "On Latin, Physics and Wikipedia," March 2008.
2. "Galileo Fruit Drop Extravaganza," with Declan DePaor, Stephan Koehler and G. Iannacchione, October, 2007.
3. WPI Philosophy Club: "Objectivism and Quantum Mechanics," April 2007.

TEACHING

7(a). TEACHING HONORS AND AWARDS

My formal teaching roles have varied from being recitation instructor for some of the bigger freshman courses to being totally in charge of freshman and higher level courses, including a junior-level laboratory/writing course (PH 2651) taken by most physics majors at WPI. My student evaluations were good, generally in the range of 3.4 to 4.3 on a scale of 1-5 with 5 being excellent and 4.01 being the "universal mean" for all courses at WPI.

At WPI, a great emphasis is also placed on all students completing a senior thesis, which is called an MQP (Master Qualifying Project). See section 8(a) for a full listing of these projects.

Due to my successful advising of students in their projects I was awarded the Provost's MQP award three times: in 2005, 2006, and 2008. A recent project project "Modeling RF Excitation of a CO₂ Laser," by Daniel LaTorella (2009) was honored with Textron Corporation Chairman's Award for Innovation.

7 (b). COURSES TAUGHT AT WPI:

PH 1110 – Introductory Calculus-based Mechanics, Recitation Instructor
PH 1120 – Introductory Calculus-based Electromagnetism, Recitation Instructor
PH 1130 – Introductory Calculus-based 20th Century Physics, Recitation Instructor and Lecturer in Charge
PH 1140 – Introductory Calculus-based Oscillations and Waves, Recitation
PH 2201 – Intermediate Mechanics, Lecturer
PH 3401 – Quantum Mechanics 1, Lecturer
PH 2651 – Intermediate Physics Laboratory, Lecturer and Laboratory Instructor

7(c) . INDEPENDENT STUDY COURSES AT WPI

I have on a couple of occasions taught PH 3401 (Quantum Mechanics 1) as an Independent Study Course for students who could not take the course during B term because of an off-campus project; I also allowed two students to sign up for 1/6 of a unit (half a regular course) in recognition of a two week intensive nano-fabrication course that they took at MIT under my supervision. This past fall I taught a graduate version of PH 3401 for one graduate student who transferred to WPI Physics program from Mechanical Engineering.

7(d). COURSES TAUGHT AT PENN STATE

PH 213 – General Physics: Fluids & Thermal Physics, Lecturer
PH 214 – General Physics: Wave Motion & Quantum Physics, Lecturer
PHYS 420 – Thermal Physics, Graduate Student Assistant
PHYS 457W – Experimental Physics, Graduate Student Assistant
PHYS 211 – General Physics: Mechanics, Recitation Instructor

PHYS 212 – General Physics: Electricity & Magnetism, Recitation Instructor
PHYS 250 – Introductory Physics I, Recitation Instructor

7(e). TEACHING INNOVATIONS

I introduced a number of important improvements to PH3401 (Quantum Mechanics 1) and PH2651 (Intermediate Physics Laboratory), and PH1130 (Modern Physics):

PH 3401:

- Was reorganized in order to fit within WPI's 7 week format while simultaneously introducing Dirac Notation earlier in the course
- Introduced MATLAB exercises in order to better teach the idea of statevector and Hilbert spaces, see for example our paper: <http://arxiv.org/abs/0704.1622>

PH 1130:

- Created a wiki site for the course with copyright free content;/MQPs.html
- Introduced two new labs, wherein students used MATLAB to quantitatively analyze electron diffraction experiment results and two-slit light interference patterns.

PH 2651:

- Was modernized by introducing LaTeX type-setting of reports as a requirement (standard in physics and required by places like MIT as well);
- Was expanded by adding five new experiments;
- Was made significantly more student-friendly by tweaking the course format to allow students to resubmit reports for regrading and by introducing an intensive error analysis tutorial during week 1;
- Was improved by converting and reorganizing all the laboratory instructions and materials according to a uniform electronic format, to aid students in finding and using materials at the course website. (See for example: <http://www.wpi.edu/~garcia/2651>).

.8(a). STUDENT ADVISING: UNDERGRADUATE PROJECTS (Senior Theses):

The projects may also be found at my website:

<http://www.wpi.edu/~garcia/MQPs.html>

- “Observing a Wetting Transition for Water,” Shinya Segawa (2004)
- “Quartz Microbalance Apparatus for the Study of Wetting Phenomena,” Modercai Waegell (2005).
- “Wetting Behavior of Nitrous Oxide Near its Critical Point,” R. Weiler (2006).
- “Quartz Crystal Microbalance Measurement of Adsorption Potential Well-depths,” Ryan Foltz (2007).
- “Thickness Coexistence in thin films of 4-n-octyl-4'-cyanobipenyl (8CB) liquid crystalline systems,” Ergys Subashi (2008)
- “Determining the Contact Angle of a Droplet on a Substrate,” Kenneth Osborne III (2008)
- “DC Glow-discharge Plasma Gun,” Justin R. Carmichael (2008).
- “Quantum Conductance,” Christopher Bruner, co-advised with Prof. Nancy Burnham (2008)
- “Modeling RF Excitation of a CO₂ Laser,” Daniel LaTorella (2009)
- “Rutherford Scattering and GeLi Detection,” by Joseph Mullin, Dericc Orso, Mathew SilvaSa (2009) (co-advised with Germano Iannachione and Susan Weekes)

8(b). STUDENT ADVISING: HUMANITY CAPSTONE PROJECT (called IQP at WPI):

- “Contrasting Immanuel Kant and Ayn Rand,” Colin DeGraf, co-advised with Prof. Shikiar (2007).

8(c). STUDENT ADVISING: GRADUATE THESES at WPI

WPI's physics department is small and therefore subject to large fluctuations in students. Only recently have I had the opportunity to advise graduate students WPI.

- Kenneth Osborne III, formally an undergraduate, now an MS student, is making good progress to complete a Master's degree with me during the Spring semester of 2009
- Saonti Chakraborty, started working in my laboratory in January 2009.

I also served on the Ph.D. committees of the following two students:

- Dr. Aleksander Roshi, G. Iannachione, 2005
- Dr. Florentin Ion Cruceanu, Advisor: G. Iannachione, 2008

I also helped advise graduate students at Penn State when I was a Post Doc there.

8(d). STUDENT ADVISING: GENERAL ACADEMIC ADVISING AT WPI

Since 2006, I have served in the role of academic advisor to a group of about 10 physics majors per year.

SERVICE

9(a). SERVICE TO PROFESSION: EDITORIAL AND REFEREE ACTIVITIES

I have been asked to review articles for the American Chemical Society Journals, the Journal of Low Temperature Physics, and to referee grant proposals for the Petroleum Research Fund, and Netherlands Bureau of Space Research.

9(b). SERVICE TO DEPARTMENT AND UNIVERSITY

I have served on the following departmental Committees:

1. Colloquium Committee Chair: 2003-2006
2. Physics Department Undergraduate Curriculum Committee (PDUCC):
As regular member: 2004-2006,
As **Chair**: 2006-2008
3. Physics Department Graduate Committee (PDGC):
As regular member: 2006-2008,
As **Chair**: 2008-2010.
4. Physics Department Search Committee 2004-2005, 2006-2007, 2007-2008.
5. Physics Department Departmental Tech Support Committee 2005-2006.

I have also served as a judge in the GRAD 2008 and GRAD 2007 Graduate Poster Competitions at WPI.

9(c). SERVICE TO STUDENTS AT WPI

Faculty Advisor for WPI's chapter of the *Society of Physics Students* (SPS):2005-present
While the advisor we implemented the "Wonderful Speaker Program" which successfully married the department colloquium series with the participation of SPS club members.

I created the physics department's Wiki site: <http://physics.wpi.edu/wiki/>

9(d). SERVICE TO COMMUNITY-Civic, Cultural, Religious, etc.

As of 2008, I have been volunteering my services as an *administrator (also known as an admin or sysop)* for the Wikipedia project, with particular responsibility for protecting the Latin language edition at <http://la.wikipedia.org>

See also section 6(c).

9(e). PROFESSIONAL SOCIETY MEMBERSHIPS AND OFFICES

1. American Physical Society: 1993-present
2. American Association of Physics Teachers: 2003-present
3. American Chemical Society: 2003 -present

10. PROFESSIONAL REFERENCES

1. Germano Iannachione, Dept. Head, Physics Dept., 100 Institute Rd. Worcester, MA, 01609 508-831-5420
2. Milton Cole, Penn State Physics Dept., 104 Davey Lab, University Park, PA, 16802 miltoncole@aol.com, (814) 863-1065
3. Moses Chan, Penn State Physics Dept., 104 Davey Lab, University Park, PA, 16802 chan@phys.psu.edu, (814) 865-2622

(Additional Reference available on request.)