

Curriculum Vitae

Richard G. Sonnenfeld, Ph.D.

Professor of Physics & Research Scientist
Physics Department, New Mexico Tech
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EDUCATION

1987. *Ph.D., Experimental Physics, University of California, Santa Barbara*
Dissertation: "Tunneling microscopy of surfaces immersed in aqueous solutions,"
advisor: Paul K. Hansma (APS Fellow, Biophysics)

1981. *B.S.E., cum laude, Physics and Mechanical Engineering, Princeton University,*
Undergraduate theses:
"Photoacoustic spectroscopy study of rare-earth powders," advisor: B.S.H. Royce
"Improving linearity of a 3-axis ion-air-flow anemometer," advisor: E. Durbin.

POSITIONS HELD

5/2015-Present. *Professor and Research Scientist, Dept. of Physics, New Mexico Tech,*
Socorro, New Mexico

7/2002-5/2015. *Associate Professor and Research Scientist, Dept. of Physics, New Mexico Tech,*
Socorro, New Mexico

2008-Present. *Consultant, Sonnenfeld Technical Enterprises.*
Consulting on lightning effects and high-voltage testing.

1996-2002. *Senior Director for Drive Instrumentation, Operating Systems and Performance, Advanced*
Technology Department, Maxtor Corporation, 510 Cottonwood Drive, Milpitas, California

1995-1996. *Technologist and Director, Advanced Concepts Department, Seagate Technology,*
Scotts Valley, California

1987-1995. *Research Staff Member, IBM Corp., Research Division, Almaden Research Center,*
San Jose, California

1982-1987. *Research Asst. for Prof. Paul K. Hansma, Physics Dept., Univ. of California, Santa Barbara*

PATENTS AND DISCLOSURES

"High Resolution Atomic Force Microscope", P. Hansma and R. Sonnenfeld
Disclosure 9/8/86, U.S. Patent **#4,800,274** granted 1/24/89 [Owned by UC]

"RAID System and Method Compatible with Improved Drive Select", U.S. Patent **#8,065,481** B. Hiller,
R.Sonnenfeld and many co-inventors, granted 11/2011. Patent from project I started at Maxtor.

Ten patents obtained by IBM under the heading "Surface Inspection Tool" including **#6,704,435** and
#6,624,884 based on my work and the the work of my team on the Automated Visual Inspection Tool.

"Automated Destruction of Digital Data", R. Sonnenfeld, Disclosure 10/22/2004

“Schemes for Aware Containers”, R. Sonnenfeld, Disclosure 3/6/2006

HONORS

Distinguished Research Award, 2006
New Mexico Academy of Sciences.

IBM Research Division Award, 1994
Using optical surface analyzer to make time-lapse movies of disk evolution under a flying head

IBM Outstanding Technical Achievement Award, 1992
For developing and using capacitance microscopy to observe, in-situ, failure events in
IBM 3390 head-disk interface

Recipient of 1987 UCSB Graduate Fellowship recognizing outstanding dissertation at
the University of California, Santa Barbara.

39 REFEREED PUBLICATIONS and 15 INVITED TALKS

2002-2014, nine refereed publications, 40 contributed talks/posters, and several invited talks on
atmospheric electricity

1991-2001, 14 refereed publications on instrumentation for hard-disk drives

1984-1991, 15 refereed publications on scanning tunneling microscopy (plus a featured article in the
journal “Science”) and three citations by name in a Nobel Prize speech

(see http://www.nobelprize.org/nobel_prizes/physics/laureates/1986/binnig-lecture.pdf)

1982, One publication on instrumentation for high-energy physics

1992-1995 Three invited talks in disk-drive instrumentation

1986-1987 Six invited talks on Tunneling Microscopy

FUNDING HISTORY

(1) “An E-sonde for Tornadoic Lightning Studies” (Merage Foundation)

Award **08/01/2014** **\$82,000** *R. Sonnenfeld (PI)*

(2) **NSF subcontract from Geophysical Institute**, University of Alaska, Fairbanks

“High time-resolution imaging of sprites”

Award **07/15/2012** **\$9,000** *R. Sonnenfeld (PI)*

(3) **DMS-0724771** CMG COLLABORATIVE RESEARCH in Measurement and Analysis of
Thunderstorm Electrification and Lightning Award **08/24/2007** **\$726,249**

Junping Wang (program officer). *R. Sonnenfeld and W. Hager (Co-PIs)*

(4) **NASA-Space Grant** “Commandable cutdown and flight controller for lightning research in upper
troposphere and near-space environments.”

Award **02/2/2007** **\$15,000** *R. Sonnenfeld (PI)*

(5) **New Mexico Tech – LANL**, Collaborative Research Project “Relation between narrow bipolar
events and lightning charge transport.”

Award **02/2/2006** **\$10,000** *R. Sonnenfeld (PI)*

(continued)

(6) **AGS-0331164** Lightning Propagation Inside Thunderstorms
Award **10/27/2003** **\$1,366,682**
Bradley F. Smull (program officer) *W. Winn, K. Eack, R. Sonnenfeld (Co-Pis)*

FUNDING APPLIED FOR BUT DENIED

(0) **PHY-7511350** “Experimentally demonstrating the origin of astrophysical and geophysical magnetic fields” PROPOSAL SUBMITTED 10/3/2014.
DoE/NSF Partnership in Basic Plasma Science and Engineering Notice 13-596
R. Sonnenfeld and M. Nornberg [U. of Wisconsin, Madison] **\$748,000**

(1) **GEO/ATM – 1401750** CMG COLLABORATIVE RESEARCH Multi-sensor studies of in-cloud lightning processes. Physical and Dynamic Meteorology Call PD 98-1522
Applied October 2013: Requested **\$1,072,000**
R. Sonnenfeld and T. Marshall and M. Stolzenburg (Co-PIs)

(2) **DARPA-NIMBUS** “Triggering Lightning with a Jet of Water”
Applied February 2010: Requested **\$1,158,151**
R. Sonnenfeld, S. Bhakhtiyarov [NMT] and D. Kimball [UC San Diego]

(3) **New Mexico Tech – LANL**, Collaborative Research Project “*Relation between narrow bipolar events and lightning charge transport.*”
Applied April 2006: Requested **\$202,831** over two years
R. Sonnenfeld, PI, Los Alamos Co-Investigator, Ken Eack

(4) **PHY-317501** “Magneto-rotational instability measurements and a laboratory alpha-omega dynamo experiment”
Applied December 2002 Requested **\$447,807**
S. Colgate and R. Sonnenfeld

(5) **The Research Corporation** – Research Innovation Award “*Integrated methods for understanding charge transport and distribution inside active electrical storms*”
Applied 2003: Requested **\$25,000**

INVITED PRESENTATIONS

ATMOSPHERIC ELECTRICITY

(Recent) Invited Seminars

"Physics of Lightning", American Physical Society Meeting, [Plenary Talk], Tuscon, AZ, NM, October 2011. [Slides are posted here: <http://www.physics.arizona.edu/4cs2011/>]

"Understanding Charge Transport by Lightning",
New Mexico State University, Physics Colloquium Series, February 2009.

"Understanding Charge Transport by Lightning",
American Physical Society Meeting, El Paso, TX, October 2008.

"Current Status of Vector Field-Change Measurements", *EOS Trans. AGU 87(0), Fall Meeting Suppl.*,
Abstract AE06, (2006) at AGU2006 Fall Meeting, San Francisco.

"Franklin's contributions to the study of lightning and modern results", Benjamin Franklin
tricentennial symposium sponsored by the New Mexico Academy of Sciences, December, 2006,
Albuquerque, New Mexico.

"Opportunities for Atmospheric Electricity and Lightning studies at DUSEL", DUSEL Homestake Mine
LOI workshop, February 10, 2006, Lead, South Dakota.

PROFESSIONAL AND SERVICE ACTIVITIES

Professional and Service Activities – Regional/National

Proposal and paper review for NSF and other agencies.

Chair (2014) Vice-Chair (2013), Student paper competition chair (2013), Chair-Elect (2012)
American Physical Society Four-Corners Section

Program Committee Chair: American Physical Society Four-Corners Meeting
(held at UVU, October 2014).

External Reviewer: Served on review panel for Physics Dept. at Weber State University.
(March 2013).

Technical Appeal Organizer: “Technical Appeal of Draft Standard 988: Guide for Direct Lightning Stroke Shield of Substations” IEEE was going to (and did) pass a dangerous standard for lightning protection. Wrote a technical appeal to IEEE President and Subcommittee chair, coauthored with G. Aulich, W. Rison, P. Krehbiel. (Feb 2011)

Local Organizing Committee Chair: American Physical Society Four-Corners Meeting
(held at NM Tech, October 2012).

Student-paper Competition Chair: 2010 Fall Meeting, American Geophysical Union, San Francisco, California.

Session Chair: “Instrumentation for Tropospheric Atmospheric Electric Studies”, (AE-06) 2005 Fall Meeting, American Geophysical Union, San Francisco, California (with Prof. Andrew Detwiler, SDSMT Physics Dept.)

Session Chair: “Lightning: Detection, Meteorology and Climate”, (AE-42A) 2004 Fall Meeting, American Geophysical Union, San Francisco, California (with Dr. Don MacGorman, National Severe Storms Laboratory)

Professional and Service Activities – State

Member of MSAC (Math Science Advisory Council) – Since May of 2013

Nominated by Governor, Advise PED on strengthening Math/Science Education in New Mexico.

Geophysical Research Center Representative (2010-2013)

For three years, I coordinated/wrote all reports/budgets for NMT-GRC across Physics and EES to try to maintain (or increase) funding to GRC researchers. First person to prepare a coordinated report in decades.

Professional and Service Activities – Institute

Chair, New Mexico Tech Faculty Senate (2012-present).

Parliamentarian, New Mexico Tech Faculty Senate (2011-2012).

Budget Committee Chair, New Mexico Tech Faculty Senate (2010-2011)

Budget Committee member (2010-present)

Academic Freedom and Tenure Committee (2012-present)

Tenure Committee member – Anders Jorgenson

Ten years of service on the Oversight Committee for the Langmuir Charitable Trust

Professional and Service Activities – Department

Physics Department Library Representative (2007-present)
Physics Department Computing Committee Chair (2008-present)
Physics Department Recruitment Committee
Physics 121 Committee
Physics Department Demo Committee

Professional and Service Activities – Other

Governing Council President (2004-2006) -- Cottonwood Valley Charter School

Ran Physics Lab event for 9 years (with Dr. Lopez-Carillo) at State Science Olympiad. This event is a good recruiting tool for Tech. We developed custom labs that gave students an intense hands on experience in 45 minutes.

Professional Memberships:

Sigma Xi (Science Honor Society),
Sigma Pi Sigma (Physics Honor Society)
American Physical Society, *Group on Instrumentation and Measurement Systems*
American Geophysical Union, *Atmospheric and Space Electricity Focus Group*

GRADUATE STUDENTS

Jeff LaPierre – Ph.D. program, atmospheric physics [research and acad. advisor]
Ph.D., Atmospheric Physics, granted December 2015

Keith Morris – MS Instrumentation program, [research and acad. advisor]
MS, Instrumentation, granted May 2014

Jianhua Zhang – MS Electrical Engineering program, [research advisor]
MSEE, granted May 2010

Tao Wang – Ph.D. program, atmospheric physics [research and acad. advisor]
Advised for one year (till May 2008). Mr. Wang finished a Ph.D. degree under Andrew Dessler at Texas A&M and is another supportive Tech. Alum.

Will Walden-Newman – MS Physics, [research and academic advisor]
MS Physics, granted May 2008

Gaopeng Lu – Ph.D. Physics, [research co-advisor with W. Winn]
Ph.D. Physics, granted December 2008

John Battles – M.S. Physics, [research advisor]
MS Instrumentation, granted May 2005

Jeff Peischl – Ph.D. program, atmospheric physics, [research and academic advisor]
Mr. Peischl left our program after 18 months to take a job at the Aeronomy Lab at CU Boulder. He now runs the lab and remains a supportive Tech. Alum.

GRADUATE COMMITTEES

David Lee – Ph.D. program materials engineering [external committee member]
Advanced to candidacy, September 2014

Tyler McCracken – Ph.D. program, experimental astrophysics/instrumentation [committee member] – Ph.D., Physics granted January 2014

Alisa Schtromberg – MS, Instrumentation, [committee member]
MS, Instrumentation, granted April 2013

Sonja Behnke – Ph.D. program, atmospheric physics [committee member] – Ph.D., Physics granted 2012

Cathy Clewett – Ph.D. program, chemistry (NMR) [committee member] – Ph.D., Chemistry granted 2006

Rocky Ginani – MS Instrumentation, physics [committee member]

Howard Beckley – Ph.D. program, physics [committee member] – Ph.D., Physics granted December 2002

REFERENCES (SCIENCE)

Prof. Tom Marshall – University of Mississippi, Department of Physics

Dr. Maribeth Stolzenberg – University of Mississippi, Department of Physics

Prof. Steve Cummer – Duke University, Department of ECE

Prof. William Hager – University of Florida, Department of Mathematics

Prof. Andrew Detwiler – South Dakota School of Mines and Technology, Department of Atmospheric Science

REFERENCES (TEACHING)

Prof. Zeljka Fuchs

Dr. Carlos-Lopez Carillo

Dr. Will Walden-Newman

Mr. Keith Morris

Dr. Tao Wang

Mr. Jeff Peischl

REFERENCES (SERVICE)

Shane L. Larson, Research Associate Professor
Northwestern University, Department of Astronomy, Adler Planetarium

Dr. Mark Boslough, Distinguished Member of Technical Staff, Sandia National Labs

REFERENCES (EARLY CAREER)

Dr. Pantelis S. Alexopoulos -- Manager, IBM; CTO, Maxtor Corp; General Mgr, Hitachi Global Storage; Exec. Director, Data Storage Institute [Singapore] -- pantelisa@sbcglobal.net
Dr. Alexopoulos and worked closely throughout my industry career. He was my bosses boss at IBM Almaden Research and my immediate manager when I was Senior Engineering Director at Seagate/Maxtor/Quantum.

Dr. Bernhard Hiller -- Managing Technologist, Advanced Reliability Engineering at Western Digital Corp, San Jose, California
Dr. Hiller and I worked together at IBM and at Maxtor on hard-disk reliability, tribology and ramp-load.

Dr. Bruce Schardt – Principal Engineer, Western Digital Corp, Irvine, California
Dr. Schardt and I worked on tunneling microscopy together and THEN worked on hard drives together.

REFEREED PUBLICATIONS AND PROCEEDINGS

COMPUTATIONAL PHYSICS

"Computational Mechanics Featuring Matlab", by Richard Sonnenfeld, New Mexico Tech Press, (in preparation). See http://www.physics.nmt.edu/~rsonnenf/phys241/compmech_rev1.52.pdf for latest version.

ATMOSPHERIC ELECTRICITY

J. Lapierre, R. G. Sonnenfeld, H. E. Edens, and M. Stock (2014), "On the relationship between continuing current and positive leader growth", *J. Geophys. Res. Atmos.*, **119**, 1–10, doi:10.1002/2014JD022080.

R.G. Sonnenfeld and W.W. Hager, "Electric Field Reversal in Sprite Electric Field Signature," *Monthly Weather Review*, **141**, pp. 1731-1735, doi: 10.1175/MWR-D-12-00220.1 , (2013)

W.W. Hager, R.G. Sonnenfeld, et al., "Charge rearrangement by sprites over a north Texas Mesoscale Convective System," *Journal of Geophysical Research A*, **117** (Feb 12) doi: 10.1029/2012JD018309 , (2012)

R. Sonnenfeld, T. Kanmae, H.C. Stanbaek-Nielsen, M.G. McHarg, S.A. Cummer, G. Lu, and W.W. Hager., "Observations of E-field signature of sprites confirmed with high-speed video and B-field measurements," *Proceedings of International Conference on Atmospheric Electricity, 2011 Conference, Rio De Janeiro, Brazil.*

Winn W.P.; Aulich G.D., Hunyady S.J.; Eack K.B.; Edens H.E.; Krehbiel, P.R.; Rison, W.; and Sonnenfeld, R.G.; "Lightning leader stepping, K changes, and other observations near an intra-cloud flash," *Journal of Geophysical Research A*, **116** (Feb 12) doi: 10.1029/2011JD015998, (2011)

Lu, G.; Winn W.P.; and Sonnenfeld, R. "Charge transfer during intracloud lightning from a time-dependent multidipole model," *Journal of Geophysical Research A*, **116** (Feb 11) doi: 10.1029/2010JD014495 , (2011)

Hager, W.; Aslan B; Sonnenfeld, R.; Crum, T.; Battles, J.; and Ron, R. "Three Dimensional Charge Structure of a Mountain Thunderstorm," *Journal of Geophysical Research A* , **(115)** Jun 23, doi: 10.1029/2009JD013241 , (2010)

Hager, W.; Sonnenfeld, R.; Aslan, B.; Battles, J.; Lu, G.; and Winn, W. "Analysis of Charge Transport during Lightning Using Balloon Borne Electric Field Sensors and LMA," *Journal of Geophysical Research*, **112** (D18), Sep 25 , doi: 10.1029/2006JD008187 , (2007).

Sonnenfeld, R.; Battles, J.; Lu, G.; and Winn, W. "Comparing E-field changes aloft to lightning mapping data," *Journal of Geophysical Research*, **111** (D20) Oct 27, doi: 10.1029/2006JD007242 , (2006).

CONFERENCE CONTRIBUTIONS IN PLASMA PHYSICS

R. Sonnenfeld, J. Si, S. Colgate, A. Colgate, J. Martinic, and M. Nornberg , “A coherent liquid-sodium dynamo to understand the magnetohydrodynamic amplification of magnetic fields”

American Physical Society Conference, Orem UT, (October 2014)

<http://meetings.aps.org/link/BAPS.2014.4CF.D4.00005>

J. Si, S. Colgate, A. Colgate, R. Sonnenfeld, D. Westpfahl, J. Martinic, M. Nornberg, and H. Li , “The New Mexico dynamo, the past, the present, and the future”

American Physical Society DPP Conference, New Orleans, LA, (October 2014)

<http://meetings.aps.org/Meeting/DPP14/Session/CM10.6>

R. Sonnenfeld, S. Colgate, H. Beckley, R. Ginani and R. Koegler, “Instrumentation overview for NMT/LANL Liquid Sodium Experiment” Bull Am. Phys. Soc., Div. Plasma Physics, Abstract FO1.9, (October 2003) [<http://flux.aps.org/meetings/YR03/DPP03/baps/tocF.html>].

H. Beckley, S. Colgate, R. Sonnenfeld and R. Ginani, “Measurements of Annular Couette Flow Stability: The Fluid Dynamic Precursor to a Liquid Sodium alpha-omega Dynamo”, Bull Am. Phys. Soc., Div. Plasma Physics, Abstract FO1.8, (October 2003)

[<http://flux.aps.org/meetings/YR03/DPP03/baps/tocF.html>].

CONFERENCE CONTRIBUTIONS IN LIGHTNING PHYSICS

[To See All 29 AGU Abstracts in one place: <http://abstractsearch.agu.org/dbsearch.php?q%5B%5D=Sonnenfeld&field%5B%5D=all>]

J. Lapierre , R. Sonnenfeld, M. Stock, H. Edens, W. Hager, R. Thomas, “The Relationship Between Continuing Current and Positive Breakdown”, Fall Meeting Abstract AE12A-03 (December 2013).

<http://abstractsearch.agu.org/meetings/2013/FM/sections/AE/sessions/AE12A/abstracts/AE12A-03.html>

J. Trueblood, K. Eack, W. Winn, H. Edens, G. Aulich, E. Eastvedt, D. Petersen, M. Stock, J. Lapierre, R. Sonnenfeld, “Triggered Upward Negative Lightning Leaders”, Fall Meeting Abstract AE12A-07 (December 2013).

J. Lapierre , M. Stock, M. Akita, R. Sonnenfeld, P. Krehbiel, W. Rison, Z.Kawasaki, H. Edens, “K-changes and continuing current insights from LEFA and DITF” Special Conference on Lightning Research Technologies, Osaka, Japan (2013).

J. Lapierre , M. Stock, M. Akita, R. Sonnenfeld, P. Krehbiel, W. Rison, Z.Kawasaki, H. Edens, “Analysis of Electric Field Change, Interferometric, and Lightning Mapping Data to Study Intra-Cloud Lightning” EOS Trans. AGU **93**(55), Fall Meeting Abstract AE23A-0309 (2012).

J. Lapierre , M. Stock, M. Akita, R. Sonnenfeld, P. Krehbiel, W. Rison, Z.Kawasaki, H. Edens, “Analysis of Electric Field Change, Interferometric, and Lightning Mapping Data to Study Intra-Cloud Lightning” American Physical Society Conference, Socorro NM, (2012)

<http://meetings.aps.org/link/BAPS.2012.4CF.C5.7>

R. Sonnenfeld, W. Winn, G. Lu, H. Edens, S. Hunyady, J. Lapierre , “Intracloud Lightning Flashes Can Be Similar in Detail ” American Physical Society Conference, Socorro NM, (2012)

<http://meetings.aps.org/link/BAPS.2012.4CF.C5.5>

K. Morris , B. Butler , R. Sonnenfeld , “Turbulence Measurement at the Very Large Array”

American Physical Society Conference, Socorro NM, (2012)
<http://meetings.aps.org/link/BAPS.2012.4CF.C5.2>

J. Hartman, R. Sonnenfeld, W. Rison, "High-time-resolution Imaging of Lightning with the Long Wavelength Array" American Physical Society Conference, Socorro NM, (2012)
<http://meetings.aps.org/link/BAPS.2012.4CF.C5.1>

FOUR PAPERS (with many authors) From a Sprite Collaboration I was part of –
Characteristics of VLF and ELF sferics associated with TLEs observed in a combined aircraft and ground-based campaign in 2011 AE21A-0228
High-Speed Camera and High-Vision Camera Observations of TLEs from Jet Aircraft in Winter Japan and in Summer US AE21A-0241
Stereo observations of sprites in support of NHK project: The Cosmic Shore AE23A-01
Relationship between structures of sprite streamers and inhomogeneity of preceding halos captured by high-speed camera during a combined aircraft and ground-based campaign AE23A-04
EOS Trans. AGU **92** (54), Fall Meeting Abstracts (2011)

J. Lapierre , R. Sonnenfeld, W. Hager, K. Morris, "Characterizing Charge Centroids from Lightning Using a Slow-Antenna Network and the Levenberg-Marquardt Inverse Method" EOS Trans. AGU **92** (54), Fall Meeting Abstract AE31A-0268 (2011).

R. Sonnenfeld et al., "Correlated High Speed Video, Medium Range Electric-Field, and Magnetic-field observations of Sprites," EOS Trans. AGU **91**(53), Fall Meeting Abstract AE31B-04 (2010).

E. Eastvedt, K. Eack, G. Aulich, S. Hunyady, C. Murray, R. Sonnenfeld, J. Trueblood, and W. Winn, and C. Murray; "Observations of the Behavior of Multiple Channel Branches in Triggered Lightning," EOS Trans. AGU **91**(53), Fall Meeting Abstract AE33A-0273 (2010).

P. Krehbiel, W. Rison, S. Hunyady, H. Edens, R. Sonnenfeld, and G. Aulich; "Lightning Mapping and Electric Field Change Observations of a Stationary New Mexico Storm," EOS Trans. AGU **91**(53), Fall Meeting Abstract AE33A-0265 (2010).

R. Sonnenfeld et al., "Development of the Langmuir Electric Field Array," EOS Trans. AGU **90**(52), Fall Meeting Abstract AE43B-0265 (2009).

E. Eastvedt, K. Eack, H. Edens, G. Aulich, S. Hunyady, R. Sonnenfeld, W. Winn, and C. Murray; "Time Correlated High-Speed Video and Lightning mapping results for Triggered Lightning Flashes," EOS Trans. AGU **90**(54), Fall Meeting Abstract AE21A-0299 (2009).

W. Winn, G. Aulich, S. Hunyady, K. Eack, R. Sonnenfeld, H. Edens and G. Lu; "Vector Electric Field Measurements Near an Intra-Cloud Lightning Channel," EOS Trans. AGU **89**(53), Fall Meeting Abstract AE24A-03 (2008).

W. Hager, B. Aslan, R. Sonnenfeld, W. Winn, and J. Battles; "Three dimensional current generator structure of a mountain thunderstorm," EOS Trans. AGU **89**(53), Fall Meeting Abstract AE24A-04 (2008).

Aslan, B. C.; Hager, W. W.; Sonnenfeld, R.G.; Winn, W.P.; and Battles, J. , "Three Dimensional Current Generator Structure of a Mountain Thunderstorm: Analysis of some Interesting Flashes" *Eos Trans. AGU*, **89**(53), *Fall Meet. Suppl.*, Abstract AE31A-0266, (2008).

Walden-Newman, W.; Sonnenfeld, R.; Stock, M.; and Shao, X. "Correlation between Lightning Flash Count and Meteorological Parameters," *Eos Trans. AGU*, 88(52), Fall Meet. Suppl., Abstract AE31A-0027, (2007).

Sonnenfeld, R.; Battles, J.; Winn, W.; Mong, B.; Stock, M.; Peischl, J.; Hunyady, S.; Aulich, G.; and Eack, K. "Initial Data from Balloon Borne Slow Antenna," *Eos Trans. AGU*, **85**(47), *Fall Meet. Suppl.*, Abstract AE23A-0833, (2004).

Sonnenfeld, R.; Battles, J.; and Winn, W. "GPS Radiosonde with spread-spectrum transmitter for aerial dE/dt Studies," *Eos Trans. AGU*, **84**(46), *Fall Meet. Suppl.*, Abstract AE22A-1112 , (2003).

Sonnenfeld, R. . "Hail Strikes Socorro," *New Mexico Geology*, **26**, 4 (125).

OLDER REFEREED PUBLICATIONS

HARD-DISK DRIVE INSTRUMENTATION

Hiller, B.; Yaeger, J.R.D.; and Sonnenfeld, R.G. "Ramp load/unload friction dependence on temperature, velocity and ramp material," *IEEE Trans. Mag.* **37**, 1852-1854 (2001).

Schardt, B.; Schreck, E.; Sonnenfeld, R.; Haddock, Q.; and Haggis, J.H. "Flying height measurement while Seeking in Hard Disk Drives," *IEEE Trans. Mag.* **34**, 1765-1767 (1998).

Milby, R.; Schreck, E.; and Sonnenfeld, R. "Measurement of Head-to-Disk Stiction Force in an Unmodified Hard Drive Using External Hall-Effect Sensors," *IEEE Trans. Mag.* **34**, 1780-1782 (1998).

Schreck, E.; Kimball, R.; and Sonnenfeld, R. "Magnetic Readback Microscopy Applied to Laser-Texture Characterization in Standard Desktop Disk-drives," *IEEE Trans. Mag.* **34**, 1777-1779 (1998).

Meeks, S. and Sonnenfeld, R. "Disk handling damage detector," *IBM Tech. Disc. Bull.*, **37**, 577 (July 1994).

Horne, D.; Meeks, S.; and Sonnenfeld, R. "Method and apparatus for detecting defects and delaminations on a thin-film disk," *IBM Tech. Disc. Bull.*, **37**, 521 (March 1994).

Yee, S.; Kanazawa, K.; and Sonnenfeld, R. "Simultaneous distance and potential servo for the scanning Kelvin probe," *Proc. Electrochem. Soc.*, Honolulu HI (May 1993).

Sonnenfeld, R. and Gitis, N. "Experimental study of stationary head-disk contact in magnetic disk drives," *ACCESS*, **7**, 3-4 (May 1993).

Sonnenfeld, R. "Capacitance methods for head-disk interface studies," *IEEE Trans. Mag.*, **29**, 247-252 (1993).

Gitis, N. and Sonnenfeld, R. "Experimental study of stationary head-disk contact in magnetic disk drives," *Journal of Tribology*, **115**, no. **2**, 214-218 (1993).

Sonnenfeld, R.; and Singh, G.P. "Apparatus and technique for 3D microscopy and profilometry of magnetic recording hard disks using a flying slider," *IBM Tech. Disc. Bull.*, **35** (1992).

Sonnenfeld, R. "Fly-height, pitch and crown measurements of hard-disk sliders by capacitance stripe," *IEEE Trans. Mag.*, **28**, 2545-2547 (1992).

Gitis, N.; Volpe, L.; and Sonnenfeld, R. "Long-term stiction at the magnetic-thin-film-disk/slider interface," *Advances in Information Storage Systems*, **3**, pp. 91-105 (1991).

TUNNELING PHENOMENA AND SCANNED PROBE MICROSCOPY

[This set of articles has been cited about 1100 times in the scientific literature...]

Holland-Moritz, E.; Gordon II, J.; Kanazawa, K.; and Sonnenfeld, R. "Oxidative roughening of Au(111) films in aqueous environments," *Langmuir*, **7**, 1981 (1991).

Holland-Moritz, E.; Gordon II, J.; Borges, G.; and Sonnenfeld, R. "Motion of atomic steps of Au(111) films on mica," *Langmuir*, **7**, 301 (1991).

Sonnenfeld, R.; Schneir, J.; and Hansma, P. "Scanning Tunneling Microscopy: A Natural for Electrochemistry," in *Modern aspects of electrochemistry*, New York: Plenum Press, vol. 21, White, Bockris, and Conway, eds. (1990).

Schneir, J.; Harary, H.; Dagata, J.; Hansma, P.; and Sonnenfeld, R. "Scanning tunneling microscopy and fabrication of nanometer scale structures at the liquid-gold interface," *Scanning Microscopy*, **3**, 719 (1989).

Schneir, J.; Sonnenfeld, R.; Marti, O.; Hansma, P.; Demuth, J.; and Hamers, R. "Tunneling microscopy, lithography, and surface diffusion on an easily prepared, atomically flat gold surface," *J. Appl. Phys.*, **63**, 717 (1988).

Schneir, J.; Marti, O.; Remmers, G.; Glaser, D.; Sonnenfeld, R.; Drake, B.; Hansma, P.; and Elings, V. "Scanning tunneling microscopy and atomic force microscopy of the liquid-solid interface," *J. Vac. Sci. Technol. A*, **6**, 283 (1988).

Schneir, J.; Hansma, P.; Elings, V.; Gurley, G.; Wickramasinghe, H.; and Sonnenfeld, R. "Creating and observing surface features with a scanning tunneling microscope," *Proc. SPIE*, **16**, 897 (1988).

Sonnenfeld, R.; Schneir, J.; Drake, B.; Hansma, P.; and Aspnes, D. "Semiconductor topography in aqueous environments: Tunneling microscopy of chemomechanically polished (001) GaAs," *Appl. Phys. Lett.*, **50**, 1742 (1987).

Drake, B.; Sonnenfeld, R.; Schneir, J.; and Hansma, P. "Tunneling microscopy of processes at liquid-solid interfaces," *Surface Science*, **181**, 92 (1987).

Sonnenfeld, R. and Schardt, B. "Tunneling microscopy in an electrochemical cell: images of Ag plating," *Appl. Phys. Lett.*, **49**, 1172 (1986).

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HIGH-ENERGY PHYSICS

Cavalli-Sforza, M.; Coyne, D.; Cordes, S.; Hawley, J.; Newman-Holmes, C.; Sonnenfeld, R.; and Kirkbride, G. "Properties of bismuth germanate and its use for electromagnetic calorimetry," *Proc. Intl. Conf. on Instrum. for Colliding Beam Phys.*, Stanford Linear Accelerator Center (1982).

INNOVATIONS IN TEACHING

*Functioning web pages for all the courses I have taught may be found at
<http://www.physics.nmt.edu/~rsonnenf/classes/classes.html>*

Physics 121, 122. [Classical Mechanics and Electromagnetism] Have taught these at least a dozen times. Introduced Mastering Physics to the department and was an early Beta tester (and am still a “Faculty Expert” for Pearson). Despite its flaws, it has allowed us to cope with larger sections and reduced budgets for graders. Further, to deal with large class sizes, lead the departmental Workman 101 redesign committee, and then lead it again when smart classroom technology became available. Made the best of a difficult situation to keep Workman 101 effective as a classroom. Have introduced many faculty to pHeT, from CU Boulder. PheT brings simulations to large lecture hall that are complimentary to live demos and help drive home new concepts and calculations visually. I also was very vocal in initial clicker selection and pushed hard for the iClicker because it was the simplest and most portable clicker solution. I also encouraged the library to start stocking clickers so that students did not need to go buy them.

Physics 241. [Computational Mechanics]. Designed this course at the department's request and taught it five times. Have since successfully transferred it to Barry Sabol and Raul Juberias. Wrote a text for the course which was used by both faculty that took it over. It was difficult to fit programming and physics into the same course, but I think it has been effective. Some of the student projects have been quite brilliant. Students who took my course and THEN took ES 111 said that ES 111 was trivial after Physics 241.

Physics 321. [Intermediate Mechanics]. I selected the text by Taylor in 2002 and it was used continuously until Dr. Raymond switched to Sommerfeld. Because Lagrangian mechanics allows the ready creation of very complex differential equations that may not have analytical solutions, I taught students how to use numerical solvers so they could do independent projects on difficult systems like trebuchets, chaotic pendula or pendula whose support has a noticeable spring constant.

Physics 336L. [Electricity and Magnetism Lab]. EM Lab is really a “thinking person's lab”. Students who think reinforce all the physics they learned in Physics 333, but did not necessarily understand. I have reduced class sizes and upgraded equipment so every student has their own apparatus. This makes sure that everyone learns the material. I have upgraded the “optional labs” so that students can do things like learn how to decode a serial (RS-232) interface by looking at an oscilloscope as well as build an electric guitar pre-amp or working Geiger counter. In 2014 I organized a group to build an electromagnetic can-crusher. This was a potentially lethal lab, but I kept everyone safe while still giving them much freedom and allowing them to succeed.

In summer of 2014, I took the ALPha (Advance Laboratory Physics Association) course offered at Princeton Plasma Physics Lab which will allow me to add an introduction to plasma lab as part of Physics 336L.

Added Physics 536 to 336 so that graduate students could benefit. I have found that graduate students (particularly foreign graduate students) absolutely need the hand's on experience we are giving out undergrads, and many of them are not far ahead (or are behind) our undergrads.

Physics 535. [Physics of Lightning].

Designed this course, taking advantage of a seminar course in sparks offered by Dr. Winn in 2005. There are no really good texts for such a course, so I have had to do original development and help students access the research literature. Students model charge separation in a storm and crunch real LMA and Electric field data to learn about lightning directly.

Physics 589A/B [Electricity for Teachers / Electromagnetism for Teachers]

I have developed a pair of courses that fill a need for more physics in our MST program. I selected Hewitt's Conceptual Physics as a text so that teachers could get experience with a text they could use in their high-school classroom. However, my course goes far beyond the level of Hewitt. Each teacher receives a custom lab kit, so that they can try many labs for "homework" and then have materials to extend them to their students. Lack of good labs is endemic, particularly in New Mexico, and most teachers do not have the technical savvy (or time) to develop useful labs.