Appendix A – Statistical Data

FTES for entire year (sum of both semesters)
FTEF averaged for entire year
SFR = FTES/(2*FTEF)

	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15
Astronomy classes									
FTES	133.87	138.93	146.5	135.5	135.0	148.2	189.0	205.8	223.7
Physics classes									
FTES	132.4	138.07	160.5	162.1	163.9	167.8	185.2	183.7	180.9
Total of All Divisions									
FTES	266.27	277.00	307.1	297.7	298.9	316.0	374.2	389.5	404.6
FTEF	5.76	5.93	4.58	4.47	4.93	4.58	4.97	5.62	5.72
SFR	23.1	23.4	33.5	33.2	30.3	34.5	37.7	34.6	35.9
Majors	39.5	46	42	30	41	43	57	60	51
Degrees	5	12	11	6	8	11	6	10	4*

* does not include May 2015 graduates

Physics and Astronomy Enrollment by Semester 4/22/15

Course No.	Course Title	S15	F14	S14	F13	S13	F12	S12	F11	S11	F10	S10	F09	S09	F08
Phys 100-1	Descriptive Physics	37	27	40	40		50		52	47	40	49	47	43	49
Phys 102-1	Descriptive Phys Lab	22		22			22							17	
Phys 114	Intro.to Physics I	40	34	46	42	48	36	42	42	42	37	32	36	31	41
Phys 114W	Physics I Workshop		6	8	6										
Phys 116-1	Intro.to Lab Experience	19	22	22	24	24	24	23	24	24	21	22	21	19	20
Phys 116-2	Intro.to Lab Experience														
Phys 209A-1	General Physics Lab	20	24	22	23	25	24	24	24	24	24	24	24	25	24
Phys 209A-2	General Physics Lab	20	24	23	24	24	24	24	24	24	24	24	24	23	25
Phys 209A-3	General Physics Lab	23	23	24	22	24	23	24	24	22	24	25	24	21	25
Phys 209A-4	General Physics Lab	22	24												
Phys 209B-1	General Physics Lab	16	18	18	18	18	17	19	20	15	19	21	21	21	20
Phys 209B-2	General Physics Lab	20	18	16	18	19	18	19	19	13	18	21	20	21	16
Phys 210A-1	General Physics	104	97	100	113	111	115	118	99	94	90	113	125	107	125
Phys 210B-1	General Physics	59	59	77	55	75	58	74	72	52	59	73	77	66	52
Phys 214	Intro.to Physics II	12	25	20	24	17	26	17	27	27	30		14	18	12
Phys 216-1	Introductory Laboratory	5	11	11	5	12	12	19	22		12		11	16	9
Phys 300	Physics of Music	40	33		20	39				45					
Phys 313	Analog & Digital Electronics	13		13		19				15					
Phys 313L	A&DE Lab	13		12		19				15					
Phys 314	Intro.to Physics III	12		14		14				11		7		7	
Phys 320	Analytical Mechanics	8		12		11		6		8		3		9	
Phys 325	Intro to Mathematical Physics		12		15		15		13		8		14		10
Phys 340	Light and Optics	9		18		7		10		5		7		7	
Phys 342-1	Light and Color		40		40		34		40		38		37		18
Phys 366	Interm. Exp. Phys.		9	10		11		9				11			
Phys 381	CompApp'sforScientists		13		15		16		10		15				13
Phys 430	Electricity & Magnetism	7		14		6		10				5		14	
Phys 445	Photonics	13						7							
Phys 450	Statistical Physics		14		9		9		7		5		11		13
Phys 460	Quantum Physics		12		12		9		7				10		12
Phys 466	Advanced Experimental Phys	6													10
Phys 475	Physics of Semicond'r Devices					14						4			
Phys 492	Instr. Design Project	1			0		1		1	1		1		2	
Phys 493	Senior Design Project	6	1	3	1	2			3	1		1	1	1	3
Phys 494	WhatPhysDo Seminar	15	11	12	24	18	29	13	15	11	18	9	15	11	11
Phys 495-1	Special Studies in Phys		1	2	4		2		1	1	1	1	1	1	1
Phys 495-2	Special Studies in Phys	2	2	2			2		1	1	1		1	1	
Phys 495-3	Special Studies in Phys						3	2		1	1				
Phys 497	Undergrad Research	4	2	6	1	3		3	1	3	2	4	1	4	1
	PHYSICS FTES TOTAL	91.0	89.9	92.4	91.3	92.5	90.1	74.3	89.6	85.5	78.9	74.0	87.9	76.9	83.4
	Phys. Student Head Count	568	562	567	555	560	569	463	548	502	487	457	535	485	510
ASTRONOMY															
Astr 100-1	Descriptive Astronomy	237	125	125	117	190	125	207	125	72	75	128		124	76
Astr 100-2	Descriptive Astronomy	124	124	125	207	120	208	122	121	120	125	124	125	72	125
Astr 100-3	Descriptive Astronomy	125	125	100	121		124				123		125	54	124
Astr 100-4	Descriptive Astronomy		77		77										
Astr 231-1	Intro. Observ'l Astron.	24	23	24	18	24	24	24	25	21	24	23	20	22	17
Astr 231-2	Intro. Observ'l Astron.		23												
Astr 303	ExtraterrIntell/IntrstlrTravl		40		35		47		42		37		46		45
Astr 305	Frontiers in Astronomy		43		37		52		47		39		46		39
Astr 331	Astr Imaging			11											
Astr 350	Cosmology	41		40		42		39		46		53		45	
Astr 380	AstroPhysics: Stars			7											
Astr 482	Advanced Observ'l Astr	10													
Astr 492	Instr. Design Project			0	0	1		1		2					
Astr 495	Special Studies in Astr'y	5	1	1	2	1	1	2	1	1	1	1	1	2	1
Astr 495	Special Studies in Astr'y		3	1	0	1	1	1	1	1	1	1	1		1
Astr 495	Special Studies in Astr'y			1	0		1		1	1	1				1
Astr 495	Special Studies in Astr'y				0		1		1	1	1				
Asr 497	Undergrad Research	1		2	0	3		1							
	ASTRONOMY FTES TOTAL	110.5	113.3	84.5	121.3	74.3	114.8	77.3	70.6	57.1	83.3	64.3	70.8	62.3	84.4
	Astr Student Head Count	568	584	437	614	382	584	397	364	265	427	330	362	320	429
PHYSICS & ASTRONOMY TOTAL FTES		201.5	203.2	176.9	212.6	166.8	204.9	151.6	160.2	142.5	162.2	138.3	158.7	139.1	167.8
	P&A Student Head Count	1136	1146	1004	1169	942	1153	860	912	767	914	787	897	805	939
	PHYSICS L.D. FTES	65.0	63.7	72.1	68.5	64.3	72.1	64.3	73.5	65.1	65.1	64.7	72.8	67.1	68.6
	PHYSICS L.D. HEAD COUNT	419	412	449	414	397	449	403	449	384	398	404	444	428	418
	ASTRONOMY L.D. FTES	100.4	93.3	73.2	106.8	65.2	94.6	69.0	52.5	41.2	67.8	53.5	52.7	52.9	67.3
	ASTRONOMY L.D. HEAD COUNT	510	474	374	540	334	481	353	271	213	347	275	270	272	342
	P & A TOTAL L.D. FTES	165.4	156.9	145.3	175.3	129.5	166.7	133.3	126.0	106.3	132.9	118.1	125.5	120.1	135.9
	P & A TOTAL U.D. FTES	36.1	46.3	31.7	37.3	37.3	38.2	18.3	34.2	36.2	29.3	20.1	33.3	19.1	31.9
	P&A TOTAL FTES	201.5	203.2	176.9	212.6	166.8	204.9	151.6	160.2	142.5	162.2	138.3	158.7	139.1	167.8
	AY ASTR TOTAL FTES	223.8		205.9		189.1		147.9		140.4		135.1		146.7	
	AY PHYS TOTAL FTES	180.9		183.7		182.6		163.9		164.3		161.9		160.3	
	AY Phys & Astr TOTAL FTES	404.7		389.5		371.7		311.8		304.7		297.0		306.9	

Appendix B: Graduates and Their Career Pathways

INTRODUCTION: Each year we have asked all of our graduates to keep in touch with the Department and to report their contact information, achievements, and comments on their education at SSU. SSU has 457 physics graduates, of whom 350 (77%) are listed here. While not totally representative, this list does show what many physics graduates do.

Kevin Ablett ('83) is a software engineer for Bender RBT Inc.

Chris Addiego ('98) is an Optical Engineer at L-3 Communications, He formerly worked at JDSU in Santa Rosa.

Marc Afifi ('89) teaches physics and chemistry at Pacific Grove High School in Pacific Grove, CA. He earned an M.S. in science education at Montana State University in 2005.

Clifford Alapa ('00) is an engineer at JDSU in Santa Rosa.

Eileen Leidel Albertsen ('77) teaches ice skating at the Genoveva Chavez Community Center in Santa Fe, NM and runs a jewelry-making business.

Siana Hurwitt Alcorn ('97) was for many years a group manager, managing software to acess validate, analyze, visualize, and report aerometric data, at Sonoma Technology, Inc. in Petaluma.

Jason I. Alexander ('92) is the business development manager at IMRA America, Inc. He has worked at several companies in the laser field since earning an M.S. in physics in 1995 at Indiana University-Purdue University at Indianapolis.

Cristhyan Alfaro ('12) is a laboratory technician at Santa Rosa Junior College.

Kenneth Aline ('81) is a materials and process engineer with Lockheed Martin Advanced Technology Center in Palo Alto. He has worked on the Hubble Space Telescope, the Spitzer Space Telescope, and numerous other satellites.

George Amorino ('86) passed away 13 September 2008. He was an assistant professor in radiation oncology at the University of Virginia, where he did research in the radiosensitization of prostate cancer. He earned his Ph.D. in cellular and molecular radiobiology at Colorado State University in 1995 and his M.S. in biomedical engineering from California State University, Sacramento in 1988. (photo)

Scott Anderson ('78) is web designer and writer at Notch by Notch, a consultant at IBM and a programmer for Wild Duck, LLC. He is also the editor and primary author of Science for People. He is author or coauthor of several science-related books.

Philippe Argouarch ('88) is an internet consultant in France, where he runs a regional press agency. Formerly manager of the International Herald Tribune website in Paris, he has also been a senior software engineer with Wells Fargo Online Financial Services and a computer graphic specialist and accelerator system operator at the Stanford Linear Accelerator Center.

Frederick Arioli, Jr. ('75) retired in 2014 after many years as an engineer at Lockheed Martin Space Systems in Palo Alto. He worked on software for several space missions, including the Spitzer Space Telescope and the forthcoming James Webb Space Telescope.

James Aroyan ('87) is the principal of JRJ Simulation & Design, providing consulting services in physical, numerical, and biological modeling. He earned his Ph.D. in physics in 1996 at the University of California, Santa Cruz, where he developed 3-D bioacoustic simulations for modeling dolphin biosonar and hearing . He continues to do research in bioacoustic modeling, dolphin biosonar, and marine mammal hearing.

Marcus Asaro ('01) is a part-time mathematics instructor at Chaffey College in Rancho Cucamonga. He earned an M.S. in physics at San Francisco State University in 2004, and did further graduate work in physics at the University of California, Riverside.

Katie Badham ('13) is a graduate student at San Diego State University, where she is studying for an M.S. in physics with an electro-optics concentration. She was formerly an intern working on femtosecond laser ablation at Raydiance in Petaluma.

Brandon Baker ('13) is a distributed antenna system technician with Ridge Communications in San Ramon. He formerly worked for Yupana LLC in Walnut Creek.

Safura Baporia ('14) is an AutoCAD technician at Nana Wall Systems, Inc. in Mill Valley

Thomas Barbour ('78) is the senior manager of global clinical applications and IT liaison for the biostatistics and clinical data management groups of Allergan in Irvine, CA. He also writes a blog.

Norman Basham ('85) is writing apps for the iPhone and iPad.

Shawna Moyer Baskin ('02), is office manager at DeepNet Computer Consulting LLC. She was formerly Diagnostic Test Engineer with Alcatel-Lucent.

Steven Becerra ('98) was CEO of Mockworld, a developer of Real-Time 3D First-Person Shooter and Multiuser Games. He also operated the online games portal Shockwave3D.com.

Danielle Beddow ('07) is a process engineer at Alluxa in Santa Rosa. She recently returned from teaching English in Taipei, Taiwan, where she was also an engineering consultant to East-Tender Optoelectronics Corp.

Keith Benguiat ('75) is director of the engineering support division at the Department of Energy's Hanford Site in Richland, Washington.

Paula Bennett ('86) is a nurse in an intensive care unit at a hospital in the Sacramento area. She has taken classes in photography and took the photos of the Department's reunion in 2001.

J. Scott Berry ('00) is a software engineer. He has worked at Rentrak in Portland, OR. He earned a second bachelor's degree in mathematics in 2011 at Cameron University in Oklahoma, and he formerly developed software for Tridactyl, LLC, a start-up company specializing in I-Phone apps.

Russel Best ('86) is a physician assistant in the Emergency Department of the Camp Pendleton Naval Hospital. He earned a Master of Medical Science degree at Midwestern University in 1999. Formerly wastewater permits manager for the Arizona Department of Environmental Quality, he has also worked in the department of public works in Santa Paula and has been a lecturer in civil engineering at California Polytechnic State University, San Luis Obispo, where he received his M.S. in civil and environmental engineering in 1989.

Michael Brown Bick ('85) is a tutor in Hawaii. He earned an M.S. in physics at San José State University in 2000, and did further graduate study in physics at the University of California, Riverside.

Allyson Bishop ('86) is a self-employed property manager in San Francisco. She received her Ph.D. in biomedical physics at UCLA in 1994 after winning a fellowship upon graduation from SSU.

Tom Bittancourt ('03) is a test engineer at EchoStar Corporation in Colorado. He was formerly a metrology process engineer at GE/PrimeStar Solar in Arvada, CO.

Ron Bleau ('79) passed away 2 January 2013 in Florida, where he had written that he enjoyed spoiling grandkids, assisting his wife Dianne with her two APHA Paint horses, riding and working on motorcycles and working on his tan. He was busy teaching the basics of physics and astronomy to several of his grandchildren and was an active Cub Scout Den Leader. He had retired in 2008 as a Senior Staff Research Engineer from the Skunk Works in Lockheed Martin Aeronautics Company. (photo)

Anthony Blume ('92) is a research and development engineer doing microwave design for Tektronix in Beaverton OR. He formerly worked for many years for Hewlett-Packard and Agilent.

Earl Boysen ('75) retired to Port Townsend, WA after various engineering positions in the semiconductor industry. He is the author of a blog on nanotechnology and the websites BuildingGadgets.com and UnderstandingNano.com. He has coauthored several books on electronics and nanotechnology, of which the most recent is *Complete Electronics Self-Teaching Guide with Projects*.

Kevin Bransford ('09) is a coach and training specialist in Lake Oswego, OR.

Keith Brister ('82) is a research beamline scientist and a senior research associate at the Advanced Photon Source at Argonne National Laboratory. He is also an associate research professor in Northwestern University's Synchrotron Research Center. He earned his Ph.D. in applied physics at Cornell University in 1989. He was formerly a staff scientist at the Cornell High Energy Synchrotron Source.

Patrick Brown ('08) is a project engineer at Deposition Sciences, Inc. in Santa Rosa.

Charles Bullen ('75) is retired and living in Auburn, CA. He was formerly the owner of a computer networking/service/consulting firm, Olympic Computer Services, Inc., serving the marine industry in the Northwest. Before that he was a radio electronics officer in the merchant marine.

Ben Burress ('85) is at the Chabot Space and Science Center in Oakland, where he writes and produces live planetarium shows. He has written blogs for KQED Quest. Formerly head observer at the Naval Prototype Optical Interferometer Observatory, an editor and writer on NASA's Stratospheric Observatory for Infrared Astronomy, and a telescope operator on the Kuiper Airborne Observatory, he has also taught high school mathematics and physics as a Peace Corps Volunteer in Cameroon.

John Philip Cabaud ('80) is the principal of Serve Rite, an engineering services firm in Sonoma. He was formerly an engineer at Thermo Jarrel-Ash.

William F. Cabrall ('76) is a lead engineer with the Boeing Company in Colorado. He earned an M.B.A. in finance at the University of Denver in 1985.

Jesse A. Campagna ('04) is the epidemiologist in Texas. He earned a Masters in Public Health, specializing in both Epidemiology and International Health, at the University of Alabama at Birmingham in 2009.

Miriam Carolin ('82) passed away 12 August 2010. She was a volunteer at the SSU Observatory for many years after her graduation, and she earned an M.A. in history at SSU in 1990 with a thesis on astronomer Heber D. Curtis. She also earned a B.A. in history at the University of Cincinnati many years before coming to SSU.

Charles Carpenter ('84) is a programmer with Western Industrial X-ray, Inc. in Fairfield.

Antonio Cazarez ('14) is a dealer at Graton Resort & Casino in Rohnert Park.

Robert Chavez ('03) is teaching conceptual physics

at San Francisco State University. He has also taught at physics and astronomy at the College of Marin , SSU, and Santa Rosa Jr. College. He holds previous B.S. (UC Berkeley) and M.S. (Stanford) degrees in electrical engineering.

Kitty Chelton ('81) is a somatics trainer in Sebastopol. She earned an M.A. in biophysics at the University of California, Davis in 1984.

Lisa Christensen ('94) is a controlled document specialist at the Stanford Linear Accelerator Center, where she was formerly an accelerator operator. She earned a teaching credential and a master's degree at Stanford University in 1995.

Arnie Christiansen ('74) is the principal of Computerized Data Systems, Inc, a consultant firm in Houston.

Bruce Clark ('86) is a senior quality engineer with TheraSense, now part of Abbott Diabetes Care, in Alameda.

Andrew Clawson ('05) is the product line manager for optical products at OptoSigma in Santa Ana.

Patrick Colbus ('05) was a process engineer doing molecular beam epitaxy and ion implantation in the High Frequency Technology Center at Agilent Technologies in Santa Rosa until an industrial accident.

John Collins ('03) is an equipment technician for the School of Science and Technology and the Department of Chemistry at Sonoma State University. Formerly he was the principal of Gizmophile, an eBay store. He sold much of the surplus equipment from Darwin Hall when the building was emptied for remodelling.

Peter Conwell ('76) is an associate professor of physics at Westminster College in Utah. He earned his Ph.D. in computational physics at the University of Utah.

Christopher Cook ('88) is principal engineer at Edmund Optics in New Jersey. Formerly director of thin films development at Axsun Technologies, he previously built a thin film laboratory while simultaneously working at MIT's Lincoln Laboratory and earning an M.S. in electro-optics engineering at Tufts University. He worked at Optical Coating Laboratory, Inc. while a student at SSU.

Cherie Copeland ('95) is a manager at Winsoft in Santa Ana.

Stephan Crandall ('82) is now an artist and photographer. He formerly managed a team of engineers for Polaris Networks in San Jose.

Gregory M. Crawford ('88) works in biotechnology sales with Novo Nordisk, a manufacturer of rDNA origin medications for the treatment of diabetes. He lives in Tracy.

Christopher Crosher ('01) is a staff engineer with Schafer Corporation in Albuquerque. He was formerly a graduate student and research assistant in the department of chemical and nuclear engineering at the University of New Mexico.

Phil Cullen ('89) is a senior consultant with Manex, a non-profit NIST affiliate, helping small to mid-sized manufacturers to be more competitive. He earned an M.B.A. degree at Santa Clara University in 2008.

Michelle Renée Curtis ('04) is a reliability technician currently on assignment at Keysight Technologies in Santa Rosa.

Antoinette Matthies Davis ('84) is the executive director of the Activities & Attractions Association of Hawaii, where she directed the creation of a Central Reservation/Global Distribution system for Hawaii's activities & attractions: http://www.PonoRez.com. She earned an M.B.A. at the University of Hawaii in 2002.

Greg Davis ('90) is the lab technician in the Chemistry & Physics Department at Santa Rosa Jr. College.

Jon Davis ('89) is a services capture manager at Hewlett Packard, where he has worked for 35 years.

Matt Davis ('93) teaches physics at Santa Rosa High School.

Tiffany Davis [formerly Borders] ('04) is a student at Animation Mentor, now living in Emeryville. She worked as a research and instrument analyst at the Space Telescope Science Institute from 2008 to 2013 . She earned her M.S. in astronomy at San Diego State University in 2008. Formerly a telescope operator at the Very Large Array of the National Radio Astronomy Observatory in Socorro, NM, she worked at NRAO and also at the Hubble Space Telescope during summers while a student at SSU. She has been featured on the Hubble website.

Dakota Decker ('08) is CTO at GeoOrbital in the Boston area. He formerly worked in the propulsion department at SpaceX in Hawthorne, CA. He earned an M.S. in mechanical engineering at UCLA in 2009.

Susan Milligan DeFelice ('98) is an estate and trust manager with Lifetime Advocacy Plus in Seattle.

Richard K. DeFreez ('80) is a senior scientist for both Met One Instruments, Inc. in Grants Pass, OR and Photon Systems, Inc. in Covina, CA. He has held similar posts at MesoSystem Technology and Hach Homeland Security Technologies in Grants Pass, OR. He has also been on the faculty of Linfield Research Institute and the Oregon Graduate Institute of Science and Technology, where he earned his Ph.D. in applied physics in 1985. He was honored as one of Sonoma State University's Distinguished Alumni in 1995.

Joanne del Corral ('83) has been a lecturer in the SSU Department of Physics and Astronomy since graduation. She teaches several introductory laboratory courses.

Alan DeMars ('78) is a member of the DSP/BIOS Kernel development team at Texas Instruments in Santa Barbara, CA. He was formerly manager of DSP applications development with Ericsson IP Network Edge & Access in

Santa Barbara. He received an M.S. in scientific instrumentation at UC Santa Barbara in 1980.

Jeremy Dixon ('07) is a controls engineer with View Dynamic Glass (formerly Soladigm) in Olive Branch, MS.

J. Robert Dobbson [formerly Mark Robinson] ('93) is the physical sciences technician at College of Marin.

Bill Dover ('95) is director of business development for Edmund Industrial Optics.

Joel Drake ('82) is a program manager at General Atomics in the San Diego area.

Adolfo Duarte ('97) is a network engineer with Hewlett Packard in the Sacramento area.

Michael Duncan ('09) earned an M.S. in physics at California State University, Fresno in 2012. He did research in experimental particle physics at CERN.

Alan Duquette ('93) is a quality supervisor at Amy's Kitchen in Santa Rosa. He was formerly the quality manager at Dynatex International, a manufacturer of semiconductor equipment and materials in Santa Rosa.

Adam Dye ('09) is a full-time mathematician at International Game Technology in Reno and a part-time graduate student in mathematics at the University of Nevada, Reno

Tim Engel (’80) is an engineer at Keysight Technologies (formerly Agilent) in Santa Rosa. **Douglas Epperson** ('88) teaches physics, astronomy, and other science courses at West Valley College in Saratoga. He was formerly a lecturer in physics at California Polytechnic State University, San Luis Obispo. He earned his Ph.D. in physics at the University of California, Santa Cruz, in 2001 after doing research at the HERA accelerator in Hamburg, Germany. He earned his master's degree in physics at San Francisco State University.

Lance Erickson ('80) is a professor of applied aviation sciences at Embry-Riddle Aeronautical University. He earned his Ph.D. in astronomy at the University of Florida in 1987.

Christopher Espenlaub ('86) retired in 2009 after 33 years as a psychiatric technician at the Sonoma Developmental Center.

Crystal Ewen ('12) is an engineer at Raytheon in Arizona. She earned a master's degree in applied physics at Northern Arizona University in 2014.

Jim Eyer ('83) is a part time senior analyst with Distributed Utility Associates in Livermore. He is also a consulting analyst with the California Energy Storage Alliance (CESA) in Berkeley. Jim is also principal of his own consulting firm, E&I Consulting, in Oakland. He provides consulting services involving benefits, markets, applications and R&D related to 1) electrical generation fueled by renewable energy and 2) distributed energy resources (DERs) including distributed electrical generation and storage. A three-time candidate for Congress, he earned a B.A. with a double major in physics and management and he earned an M.A. in management at SSU.

Jarod Fahle ('12) is an acoustic test engineer at SGS in Lenexa, KS.

Keyvan Farahani ('85) is the Chief of the Imaging Guided Intervention Branch of the Cancer Imaging Program in the National Cancer Institute. He also teaches part-time in the Johns Hopkins University school of medicine. He was formerly an assistant professor of radiological sciences and biomedical physics at UCLA, where he received his Ph.D. in 1993.

Richard Ferguson ('87) is a pilot with United Airlines, flying to Latin America from Miami. He served as an officer in the U.S. Air Force after graduation from SSU.

Davy Figaro ('91) is a physicist at PNI Corporation developing new orientation algorithms and working with magnetic sensing technology. Previously he worked as an electrical engineering consultant developing a custom RF network analyzer, and before that for seven years as a microwave engineer at Agilent Technologies.

Michael Fink ('93) teaches mathematics and science at Cooley Middle School in Roseville. Formerly a teacher at Cross & Crown Middle School in Rohnert Park, he earned his teaching credential at SSU in 1994.

Timothy Finnegan ('84) is a self-employed tax consultant in Kansas. He earned an M.S. in nuclear engineering at the University of Wisconsin, Madison, in 1986.

Winston Fisher ('09) is an intern engineer at Zeiss XRM in Okaland. He was formerly an account executive at Ricoh Americas Corporation.

Elizabeth "Libby" Hays-LaPlace ('93) is an emergency room physician at Schnieder Regional Hospital in the Virgin Islands. She earned her M.D. at the University of California, San Francisco in 1997 and did her residency in Santa Rosa.

Justin Flory ('02) is an assistant research scientist in the Center for Applied Structural Discovery of the Bioldesign Institute at Arizona State University, where he completed his Ph.D. in 2014. After graduation from SSU he worked seven years as an engineer in the diabetes care division of Abbott in Alameda and at Symmetricom, Inc. in Santa Rosa. He also played in the American Philharmonic — Sonoma County.

Arthur B. Flynn II (’76) retired in 2004 as the director of the US Department of Energy National Training Center in Albuquerque. He is now a professional consultant for various companies including Sandia National Laboratory.

 REMOVED FROM WEBSITE AT HIS REQUEST **Matthew Fontana** ('12) is a graduate student and teaching assistant in chemistry at

UCLA. He received his M.S. in 2013.
Leon Fossett, Sr. ('00) is a profesional real estate investor in Albany, OR. He was formerly a research and development engineer with Hewlett-Packard in Corvallis, Oregon.
Lydia Fowler ('82) is a tax advisor at H&R Block. She was formerly a pilot with United and other airlines.
Scott Fraser ('95) is teaching physics at Cal Poly San Luis Obispo. He earned a Ph.D. in physics, with a dissertation on black holes and extra dimensions, at the University of California, Santa Barbara in 2010. Previously he earned a certificate of advanced study in theoretical physics at the University of Cambridge after spending a year at the University of Heidelberg on a Barry Goldwater Scholarship.
Sean Fraser ('95) is a graduate student and teaching assistant in physics at the University of California, Riverside. He has taught physics and astronomy at Moorpark College in Moorpark, CA. He was previously a lecturer in physics at the University of California, Santa Barbara, where he received his M.A. in 2002. He earned a certificate of advanced study in theoretical physics at the University of Cambridge in 1996 after spending a year at the University of Heidelberg on a Barry Goldwater Scholarship.
Marta Fuentes-Filp [aka Marta Fuentes] ('05) is teaching physical science at Westmoor High School in Daly City. She earned her teaching credential at San Francisco State University in 2012. She was formerly a graduate student and teaching assistant in physics at the University of Iowa and later worked in business.
Bill Garcia ('10) has returned to California and is a laboratory technician at Stonestreet Winery in Healdsburg. He was formerly a field service engineer at AlsoEnergy in Lafayette, CO.
Jim Garrett ('90) is teaching science at Summit High School in Bend, OR. He formerly taught at Petaluma High School.
Melissa Geissinger [formerly Crain] ('07) is the principal of New Skin Media, Santa Rosa, which specializes in website development, branding, and marketing for professional photographers. She is also a co-organizer and president of Web and Interactive Media Professionals, a community of designers, programmers, marketing specialists, search engine optimization experts, social media gurus and just about anyone having to do with the evolving technological world. She has just published a book on designing a website in one day. She also does photography.
Alan Gilbert ('77) retired in 2008 as a programmer analyst and software engineer. After graduation he taught math and science in Swaziland as a Peace Corps Volunteer.
Blaine Gilbreth ('10) is a graduate student in computer science at the University of Pennsylvania.
David Goldkind ('82) is a consultant on management and process engineering with Rebecca Robinson Associates, Inc. in Rough and Ready, CA. He also does consulting in optics.
Dennis Goodrow ('78) is a senior technical staff member at IBM Tivoli in Emeryville, developing products and services that enable enterprises to manage the security and compliance of desktops, servers, and mobile computing devices.
Paul Goodwin ('71) was chief scientist of Variance Dynamical Corp. in Kasilof, Alaska when he passed away on 21 October 2008. He earned a Ph.D. in geophysics at the University of Alaska, where he taught courses in philosophy and developed a physics program for the Alaska native community. He was at one time president of Earth Science Consulting and Technology Corp. and of the Fairbanks Native Association, Inc. He was also a consultant in mathematical neuropsychology in Anchorage.
Ross Goodwin ('78) is managing partner with the Bennett Valley Group, Inc., a marketing and consulting firm in Santa Rosa, and also teaches business courses at College of Marin and Dominican College. He currently serves on the Board of Directors of the SSU Alumni Association. He was formerly an account executive with Socratic Technologies, a market research firm in San Francisco and for many years a business customer research consultant for Hewlett-Packard. A former chair of the Bennett Valley School Board, he earned an M.B.A. at the University of California at Berkeley in 1980.
Daniel Gospe ('04) is chief operating officer at dmi Networking Solutions in Santa Rosa.
Charles Granger ('08) is a graduate student in optics at the University of Rochester. In 2013 he earned an M.S. in physics at San Diego State University, concentrating on electro-optics.
Tim Graves ('01) is manager of special projects at Telecare Corp. in Alameda. He was formerly a business analyst with Pacific Pulmonary Services in Novato. For ten years he was an educational developer and information technology consultant on the NASA Education and Public Outreach team at Sonoma State University.
David Gray ('05) is the Equipment Division Manager at Deposition Sciences Inc. in Santa Rosa.
Barbara Allen Greene ('75) passed away 23 March 2008. She studied in the Energy and Resources Group at the University of California, Berkeley and earned a master's degree in psychology at SSU. She worked in alternate energy and computer programming.
Sean Greenwalt ('05) is a security guard in Santa Rosa. He was formerly assistant project manager at Solaris Inc., an installer of solar photovoltaic systems in Sebastopol, CA.

Douglas Greenwood ('81) is an internet sofware consultant in Tahoe City.

Robert Greeson ('89) is a Fleet Implementation Officer in the U.S. Navy.Formerly a naval pilot, he now uses his physics background to conduct analysis on underwater acoustics.

Steve Grossberg ('92) teaches mathematics at Churchill High School in Eugene, OR. From 2004-06 he taught high school mathematics, including International Baccalaureate courses, at the European School in Heredia, Costa Rica. Previously he taught math and science at Geyserville Educational Park, along with numerous courses for Sonoma State University's PreCollege Programs.

Michael Grzesik ('00) was a graduate student in physics at the University of Massachusetts, Lowell when last heard from.

Brooke Haag ('01) is an assistant professor of physics at American River College. She formerly taught physics at Hartnell College. She earned her Ph.D. in nuclear physics at the University of California, Davis in 2009.

Milton Hagler ('85) is General Director at BriskHeat Vietnam, an information and technology firm. He has managed several companies in Vietnam, where he has lived for many years..

Zee Betty Hakimoglu ('75) is President and CEO of ClearOne Communications. In 2007 she won Frost & Sullivan's 2007 Audio Conferencing CEO of the Year award. Formerly vice president for product line management of Oplink Communications in San Jose, she earned an M.S. in physics at Drexel University in 1979. She was chosen as one of SSU's Distinguished Alumni in 2011.

Daniel R. Hale ('96) teaches physics and astronomy at Folsom Lake College. He earned an M.S. in physics at Michigan State University.

Luke Haley ('11) is a software developer at Keysight Technologies [formerly Agilent Technologies] in Santa Rosa.

John J. Hall ('80) is teaching middle and high school science and math in Sonoma County. He earned his teaching credential at SSU in 1998 after working as a thin film design and project engineer at Optical Coating Laboratory, Inc., Santa Rosa for 15 years.

Barnell Hampton ('98) is a program analyst with E&J Winery.

Brooks Hanley ('12) is a graduate student and graduate teaching associate at California Polytechnic State University, San Luis Obispo, where is he pursuing both an MS in electrical engineering and an MBA.

Elizabeth Harmony ('05) is a laboratory technician at ICon Professional Services.

Roy W. Harthorn ('78) is a building safety and code consultant in Santa Barbara. With grants from the state and federal governments he published a book on methods for the temporary shoring and stabilization of earthquake-damaged historic buildings. He is a former chief of building and safety for the city of Santa Barbara and is currently a member of the California State Historic Building Safety Board.

David K. Hawk ('77) is retired from his position as a software engineer at Lockheed Martin in Sunnyvale.

Douglas Hayes ('75) has been an architect, builder, and chef. He now works as a preservations consultant with the Preservation Sanctuary Learning Center in Calistoga.

John H. Hayes ('97) is the principal of Hayes Graphics in Camarillo. He was formerly a computer specialist with the high energy astrophysics division of the Smithsonian Astrophysical Observatory in Cambridge, MA, where he worked on the Chandra X-ray Observatory.

Harvey Hecht ('92) is the information technology manager for Service Employees International Union Local 1021 in northern California. He earned a master's degree in computer science at Regis University in 2006.

Michael W. Helm ('82) is now a self-employed property manager. For 31 years he was a network engineer at the Lawrence Berkeley National Lab, where he worked on the Energy Sciences Network and other projects.

Don Herriot ('72) is now the owner of ABV Anderson Bine and Vine in Anderson, SC. He was the director of Innovista Partnerships, the research district established by the University of South Carolina from 2010 to 2013. He retired in 2009 from his position as head of Global Chemical Operations for Swiss drug maker Roche Pharmaceuticals. He was responsible for the production of Roche's chemically produced pharmaceutical active ingredients at four factories in Europe and two in the US. He has also served as chairman of the South Carolina Governor's Task Force on Workforce Education, the South Carolina Chamber of Commerce, and the School Foundation. He serves on the board of the Palmetto Institute, and he was one of SSU's Distinguished Alumni in 2003. In 2005 he was further honored with the Ashpy P. Lowrimore award of the United Way of Florence County.

Richard Hertz ('78) is the principal of Hertz Research, a polling and software company in Bodega Bay. Currently he is also teaching a course in the SSU Department of Political Science, in which he earned his M.A. in 1989.

Roman Hewette ('05) is serving in the air force as a space event duty technician at Vandenberg Air Force Base responsible for orbital protection and overall space situational awareness. He earned an M.S. in aeronautical science at Embry-Riddle Aeronautical University in 2014.

Victoria Moore Hewitt ('87) and her husband own and operate a thoroughbred horse farm, Arundel Farm, in

Paris, Kentucky. They are also authors, whose first novel won the Pinnacle Book Achievement Award for fantasy and romance. She was formerly the principal of Lawrence Cook Middle School in Santa Rosa.

Jeremy Hieb ('03) is an electric powertrain engineer at Zero Motorcycles in Scotts Valley.

Laurel Allen Highland ('83) is a teaching assistant, teaching science at Forestville Elementary School. She was formerly an engineer at Optoelectronics.

Jim Hill ('71) retired in 1999 from teaching physics at Piner High School in Santa Rosa. He is a past president of the Northern California/Nevada section of the American Association of Physics Teachers.

Logan Z. Hill ('06) is a security operations technician with EdgeWave.

Bill Hinkle ('87) is an application developer at Discovia in San Francisco. at Zero Motorcycles in Scotts Valley.

Victor Hipkiss ('96) is an engineer at Agilent Technologies in Santa Rosa.

Daniel Hogan ('99) is an officer in the U.S. Navy, currently the communications officer aboard the USS Pennsylvania, a nuclear submarine based in Bangor, Washington.

Ian Holland ('95) is a a licensed Marriage and Family Therapist practicing in Santa Barbara. He intends to relocate to Marin County soon. He was formerly a counselor with the Academy of Healing Arts for Teens, running groups to raise social and emotional intelligence. He earned an M.A. in Clinical Psychology from Antioch University Los Angeles.

Ben Hood ('90) is principal of Designed Solutions, a worldwide software consulting firm based in Colorado.

Henry Hoppe ('74) passed away in 2014. He and his wife operated a tour business in Napa.

Jay Hubbard ('11) is a calibration technician at International Process Solutions in San Carlos, CA.

Lynn Marie Hubbard ('75) is the head of the Emergency Preparedness and Response section and radio-analytical laboratory at the Swedish Radiation Protection Authority. The recipient of a National Center for Atmospheric Research fellowship upon graduation from SSU, she earned her Ph.D. in physical chemistry at the University of California, Riverside.

Martha Hunt [formerly Schopp] ('88) is secretary-treasurer of Monsoon Construction, Inc. in Healdsburg.

Monika Ivancic ('93) is the manager of the NMR Facility of the University of Vermont. She was formerly associate director of the Magnetic Resonance Facility in the Chemistry Department of the University of Wisconsin-Madison. She did postdoctoral research in biochemistry at the University of Vermont after earning her Ph.D. in Biochemistry and Biophysics at Oregon State University in 2001.

Stephan R. Jackowski ('14) is a graduate student in materials engineering at San José State University and an intern engineer at BAE Systems in Santa Clara.

Ashley Janny [formerly Wiren] ('04) is an engineer at Boeing in Kent, WA. She is also an officer in the Washington National Guard in a chemical, biological, radiological and nuclear unit. She earned an M.S. in Aerospace Engineering Sciences at the University of Colorado at Boulder in 2005.

Holly Jessop ('93) is a research scientist (epidemiology/biostatistics) in the Worker Health & Safety Branch of the Department of Pesticide Regulation in the California Environmental Protection Agency. She is also a Ph.D. student in epidemiology at the University of Hawai'i at Manoa. She earned an M.S. in tropical conservation biology at the University of Hawai'i at Hilo in 2008 and a second M.S., in public health, at the University of Hawai'i at Manoa in 2011. She formerly worked in the Education and Public Outreach program of the Chandra X-ray Observatory at the Smithsonian Astrophysical Observatory.

Miriam Jewell [formerly Tobin] ('90) and her husband operate the Jewell Ranch in Sebastopol, where they have apple orchards, grape vineyards, and a trucking business.

Steve Jilka ('71) is a project manager with Teradata in San Diego.

Kevin John ('07) is an education resource developer in SSU's Education and Public Outreach Group.

Chris Johnson ('09) teaches physics at Elk Grove High School in Elk Grove, CA.

John R. Johnson ('80) is retired after working as an hardware or software engineer at Ford Aerospace, Rockwell Avionics, Lockheed Space Operations Company, Daden Engineering and KW Microwave in southern California. He designed hardware and software components and systems.

Jon M. Jurgovan ('85) is an Administrative Patent Judge in the Dallas area. He was formerly a senior patent attorney with BlackBerry in Texas and with Alston & Bird LLP in Atlanta. He earned an M.S. in electronic engineering at California State University, Fullerton and a J.D. at Washington & Lee University in Virginia.

Rick Kamen ('80) is running three on-line businesses: HeirloomStories.com and Elderhood.com, for the "third stage of life." He is also a docent at Torrey Pines State Reserve and the Museum of Man.

Alon Katz ('93) is a founder of the Boulder Developer Collaborative, LLC, and a web applications developer at Headsets.com

Jeff Kavanaugh ('94) is an associate professor of earth and atmospheric sciences at the University of Alberta and the director of the Juneau Icefield Research Program. Formerly a postdoctoral researcher in the department of geography at the University of California at Berkeley, he earned his Ph.D. in earth and ocean sciences at the

University of British Columbia in 2000. His research in glacier dynamics has taken him to the Yukon, Antarctica, and points in between.

Daniel Kelley ('11) teaches mathematics and computer science at Kehillah Jewish High School in Palo Alto.

David M. Kelson ('80) is the principal of David Kelson Sound, Inc., which provides full production sound and production video assist services for the motion picture and television industries.

Bruce Kemmell ('72) has taught physics and mathematics at several colleges in New Mexico. He earned his Ph.D. in theoretical physics at the University of New Mexico in 1992.

Greg Keys ('92) is a software engineer in the defense and space industry.

Tim Kimball ('92) is a data archive specialist at the Space Telescope Science Institute.

Kerry King ('87) passed away in November 2007 after tutoring mathematics, chemistry, and physics at Santa Rosa Jr. College for many years. She earned a degree in accounting and worked in that field before coming to SSU. She was proud to be an SSU physics graduate.

Bill Kobabe ('90) is teaching seventh grade at Woodland Star Charter School in Sonoma. He has been the principal of Bill Kobabe Woodworking in Petaluma and a teacher of woodworking and physics at several schools. He earned a teaching credential at CSU, Monterey Bay.

Paul Kohlmann ('92) is a senior engineer and manager of the science and technology labs for Flex Products, a division of JDSU in Santa Rosa. In 2009 he graduated from the Empire College School of Law and was admitted to the California Bar.

Bruce Kuhlman ('81, physics and biology) passed away 8 August 2010. He was an engineer who worked at Optical Coating Laboratory, Inc. and several other companies, the last being Cierra Photonics in Santa Rosa. He was also known as a tennis player.

John Lacombe ('83) is a self-employed IT consultant in the Bay Area. He was formerly the network administrator for Pacific Lists, Inc., a list brokerage and management company in Corte Madera.

Robert Lahaderne ('94) is a Senior Quality Manager at Endologix Inc. in southern California. He was formerly an engineering manager with the Design Assurance team at Medtronic Endovascular in Santa Rosa and a senior process engineer at SpectraSwitch, Inc., he earned an M.B.A. at the University of San Francisco in 2007.

David J. Lamb ('94) is an advanced physics research specialist in the Optical Systems Division of 3M in St. Paul, MN, where he is currently working on applications development for LCD TVs and desktop monitors and managing a group of application engineers who are dedicated to improving display energy efficiency while maintaining visual performance and quality. He received his Ph.D. in physics at the University of Alabama in Huntsville in 1999, where he worked on the use of Fresnel lenses in a proposed space-based extensive air shower observatory called the Orbiting Wide-angle Light-collector (OWL).

David Lapp ('84) teaches physics and calculus at Tamalpais High School in Mill Valley, CA, and has taught part-time at SSU. He spent 2002-03 at Tufts University where he wrote a book, *The Physics of Music and Musical Instruments*, while holding a prestigious Wright Fellowship. He earned his M.S. in physics in 1990 at DePaul University.

Kenneth Larson ('69) is a professor emeritus of computer science at Southern Oregon University, now living in Corvallis, OR. He earned an M.A. in mathematics at SSU in 1970 and a Ph.D. in information and computer science at the University of California, Irvine in 1977.

Michael Laufer ('03) is teaching mathematics at the Greene Correctional Facility in Coxsackie, NY. He earned a Ph.D. in mathematics at the City University of New York Graduate Center in 2011.

Rodney Lee ('97) teaches science courses at Portland Community College. He recently earned a second master's degree in chemical and life sciences at the University of Maryland. Formerly at Marin Catholic High School, he earned his teaching credential at SSU in 1999 and an M.S. in astronomy at Swinburne University of Technology in 2003.

Paul LeFebvre is a thin film engineering consultant in Oregon. He worked as an engineer at JDSU in Santa Rosa for more than thirty years and then as an engineering manager at Deposition Sciences, Inc. for two.

Orion Leland ('08) is an electrical engineer at RETECH Systems LLC in Ukiah. He formerly worked at Twin Creeks Technologies in San Jose. He earned a master's degree in electrical and electronic engineering at California State University, Sacramento in 2014.

Mark Lenhart ('94) was formerly a quality control technician with ARM Systems in Cotati.

Valerie J. Leppert ('87) is an associate professor in the School of Engineering of the University of California, Merced and a Visiting Associate Professor in the department of chemical engineering and materials science at the University of California, Davis. She earned her Ph.D. in materials science and engineering at Northwestern University in 1994.

Linda Lindsley ('02) was formerly a graduate student and research assistant in science and engineering of materials at Arizona State University.

Joseph Lingad ('02) is a videographer and producer for the Wall Street Journal and Barron's Penta in New York City. He received certification in film production from the

Center for Digital Imaging Arts at Boston University in 2008.

Robert Linstadt ('93) teaches mathematics and science at Foresthill High School/in Foresthill.

Mark Loguillo ('03) is an Instrument Systems Scientific Associate at the Spallation Neutron Source at Oak Ridge National Laboratories. He was formerly a systems engineer with United Space Alliance working with hazardous gas detection systems in and around the space shuttle at the Kennedy Space Center.

Eric Lundy ('09) is a manufacturing process engineer at Alluxa (formerly Sirrus Technology) in Santa Rosa. He earned an M.Sc. in mechanical engineering at Manchester Metropolitan University in 2012.

Amy Weber Madruga ('97) is a full-time mom in Monument, CO. Formerly an engineer at Cisco Systems, Inc. in Petaluma and Next Level Communications, Inc. in Rohnert Park, she has served as a member of the executive board of the SSU Alumni Association.

Gregory Madruga ('96) is a senior systems analyst with Science Applications International Corporation (SAIC) in Monument, CO. He was formerly an assistant vice president for network services at North American Mortgage Company, where he managed the voice and data networks for the company's 300 branch offices.

Julia Maisen ('03) is the online giving coordinator coordinator at Monterey Bay Aquarium in Monterey.

Jeanie Mar ('05) earned an M.S. in mechanical engineering at the University of Colorado, Boulder in 2007.

Mario Marckwordt ('95) is an aerospace engineer at the University of California at Berkeley Space Sciences Laboratory. He earned his M.S. in physics at San Francisco State University in 1997. (photo)

Patricia Marriott ('67) is retired. She worked for IBM, Hewlett-Packard, Apple, Electronic Arts, Adobe, and other companies in various software development, marketing, and excecutive positions. The Department's first graduate, she earned an M.S. in computer science at the University of California at Berkeley in 1976.

David E. Marshall ('88) is an information technology consultant, private pilot, and aircraft owner. He currently manages the IT support group in the College of Natural Resources and Sciences at Humboldt State University, where he earned an M.S. in mathematical modeling in 1998.

Donald W. Martin ('83) retired in 2013 after fourteen years as an instructional assistant in mathematics at Berkeley City College. He had previously taught in a prison and at Solano Community College and worked as a telescope operator at Kitt Peak National Observatory.

Kenneth Martinelli ('09) is a quality engineer with Sonoma Photonics, a subsidiary of Northrop Grumman Corp., in Santa Rosa.

Nancy Mason [formerly Kunnari] ('90) is a senior product engineer at NVIDIA in Santa Clara.

Michael May ('04) is a project design engineer for Alliant Techsystems in Maryland working on missile and launch vehicle programs.

James A. McBride ('75) is an independent wealth management advisor in Petaluma. He did similar work for 18 years with Merrill Lynch in Santa Rosa and has been the business editor of KFTY Channel 50. A past president of the SSU Alumni Association, he earned a second bachelor's degree in mathematics at SSU in 1976 and an MBA at Pepperdine University in 1983.

Michael McBride ('75) is retired. He was formerly a regional sales representative for Gallagher Fluid Seals and a sales manager with Research Electro-Optics, Inc. A past president of the SSU Alumni Association, he earned his M.A. at the American Graduate School of International Management in 1977.

Corey McCarthy ('04) when last heard from was a pilot with Atlantic Southeast Airlines. He graduated from the Commercial Airline Pilot Training program at Embry-Riddle Aeronautical University in Daytona Beach, Florida in 2005.

Ryan McDaniel ('07) is an engineer at Deposition Sciences, Inc.. a wholly owned subsidiary of Lockheed Martin Corporation in Santa Rosa.

Jennifer McIntosh [formerly Wright] ('83) is a quality engineer at JDSU, Santa Rosa.

Douglas McKenzie ('83) is an applications and sales engineer at Dillon/Quality Plus, Inc. He is also the guitarist for the Pulsators.

Timothy McKernan ('05) is a lifecycle support engineer working on solar electric inverters for Fronius International GmbH in Wels, Austria.

Andrew E. McLean ('75) is a Senior Account Executive for SPSS, Inc. selling data mining and analytical software to the financial industry.

Alexander McMahon ('07) is a senior SIEM (security information and event management) engineer at Leidos in Portland, OR. He is also working on a master's degree in system engineering at Johns Hopkins University.

Tom McMahon ('85) works at the University of Arizona, where he is now the program manager for the Center for Astronomical Adaptive Optics, project manager for the Large Binocular Telescope Interferometer, and deputy project manager for OCAMS suite of cameras for the OSIRIS-REx Asteroid Sample Return Mission. He was previously principal systems engineer of the Multiband Imager for the Spitzer space Telescope, and he has worked on several other major instruments.

Scott McWilliams ('91) is director of PVMC Technology Programs at SEMATECH in Albany, NY. He earned an M.S.E. in electronic materials and devices at San José State University in 1996.

Nickolas Melville ('93) is a a senior engineer building batteries for satellites with SSL in Palo Alto. He earned an M.S. in mechanical engineering at UC Davis in 1995.

David E. Miller ('96) earned a master's degree in experimental particle physics at Purdue University in 2000. He later worked at the Lawrence Livermore National Laboratory.

Kalie Miller ('12) is a structural analyst working on the KC-46 tanker program with the Boeing company in Everett, Washington.

Iad Mirshad ('89) is a senior applications engineer with Qcept Technologies, a developer of non-visual defects detector technology in Fremont. He earned a Ph.D. in experimental nuclear physics at the University of California, Davis in 1995.

Richard Montgomery ('81) is a professor and past chair of the Department of Mathematics at the University of California, Santa Cruz, where he works on the N-body problem of classical mechanics. He earned his Ph.D. in mathematics at the University of California at Berkeley. He has been a Sigma Xi Distinguished Lecturer.

Frank Moraes ('90) is an author. He earned a Ph.D. in atmospheric physics at the Oregon Graduate Institute of Science & Technology in 1995.

Fausto Morales ('90) is the Director of Organization at Neo Metrics, a Business Intelligence consultancy based in Madrid, Spain. He also invents and publishes logic puzzles, and was interviewed recently for the "Once a Physicist" column in the June 2010 issue of Physics World. He earned an M.S. in physics at the University of Michigan in 1991 and an M.S. in mathematics at Bowling Green State University in 1993.

Brett Morgan ('82) is the Chief Technology Officer at Global Payout, Inc. in San Diego.

Sharon Morganelli [formerly Gilkison] ('76) is a disclosure analyst with Jones Hall, a municipal bond law firm in San Francisco.

Douglas A. Morris ('78) is the president of Polaris Battery Laboratories, LLC, a lithium ion processing center, and also of EnerSol, Inc. a consulting business focused on batteries and energy systems, both in the Portland, OR area. He is also a board advisor or partner to several other companies in energy systems, and he is co-chairman of the Oregon Electric Vehicle Finance Steering Committee. He was formerly vice president of Motorola's Energy Systems Group in Lawrenceville, GA.

Kathleen Morrison ('11) is teaching physical science in San Rafael. She earned her teaching credential at SSU in 2012.

Stephen K. Mosier ('90) is an anesthesiologist associated with the Department of Anesthesia and Critical Care at the University of Pittsburgh. He earned his M.D. at the State University of New York at Brooklyn in 1998 and completed his residency in anesthesiology at the University of Pittsburgh in 2002.

Eric Mueller ('93) is the plant operations manager at DuPont Pioneer, a biotechnology firm in Hawaii. He earned a master's degree in engineering at North Carolina State University in 2001.

David Munton ('82) conducts research in the Space and Geophysics Laboratory of the Applied Research Laboratories of the University of Texas at Austin, where he earned his Ph.D. in theoretical physics in 1991.

James Musto ('88) is Information System Manager at the Pacific Coast Tariff Bureau in Alameda, CA.

Chuck Neely ('13) is an associate materials engineer at Deposition Sciences, Inc., a wholly owned subsidiary of Lockheed Martin Corporation in Santa Rosa.

Kent Nelsen ('74) is retired and living in Hawaii. He served as the Department's equipment technician until 1982.

John C. Nelson ('76) is director of research at 10x Technology in Libertyville, IL. He was formerly a senior research specialist with the 3M Display and Graphics Business Laboratory in Petaluma.

s **Leslie Nelson** [formerly Kormier] ('96) is an environmental consultant and jewelry designer in San Luis Obistp.

Donald Nemec ('75) is a retired laboratory technician in Kingman, AZ.

Daniel Nicholas ('06) is a technical support engineer at EandM in Healdsburg.

David Nielsen ('74) retired in 2005 from his position as a computer systems supervisor in the Division of Emergency Services and Homeland Security of the Utah Department of Public Safety.

Leif Noble ('01) is a sales and marketing analyst at HydroPoint Data Systems in Petaluma. He also consults on renewable energy, energy efficiency, and finance. He was a business banker for Wells Fargo in Santa Rosa.

John P. Norton ('74) was for many years a reporter, covering chemical demilitarization, technology and schools for the *Pueblo Chieftain* in Pueblo, Colorado.

Dan Nottingham ('89) is director of product management for ABILITY Network's Innovation Office in Boston. He has done similar work for several companies, most recently Imprivata, after participating in rocket-launching experiments for the Boston University Center for Space Physics.

Lauren J. Novatne ('89) is the physics instructor at Reedley College. She earned her M.S. in physics at California State University, Fresno in 1999.

Zachary Nuño ('07), when last heard from, was a graduate student and teaching assistant in physics at California State University, Long Beach. **Bill Oakes** ('96) is an engineering manager at

TriVascular Technologies, Inc. in Santa Rosa. He formerly worked at Medtronic and JDSU, both in Santa Rosa.

Laura Odeh ('00) earned an M.F.A. in the New York University Graduate Acting Program and appeared in several plays in New York City and elsewhere. Formerly a marketing engineer in the electronics and solutions group at Agilent Technologies in Santa Rosa, she was SSU's student commencement speaker in 2000.

Bruce Odekirk ('78) is Director of SiC Technology at Microsemi PPG in Oregon. Former positions include vice president of engineering of Zeus Semiconductor and vice president of technology for Sarif, both in Vancouver, Washington. He earned his Ph.D. in applied physics at the Oregon Graduate Institute of Science & Technology in 1982.

Dan O'Donnell ('83) works in information security at Boeing in El Segundo. He was formerly the Information Systems Security Officer for the RAND Corporation in Santa Monica. He heads the MacIT Advisory Board.

Ryan Olson ('07) is a student in the Naturopathic Doctor program at Bastyr University in San Diego. He has worked as a youth camp coordinator for Cal Adventures.

Art Onwan ('93) is teaching math and science at Bangkok Christian College in Thailand. Formerly a nuclear medical science officer in the health physics department at Walter Reed Army Medical Center in Washington, D.C., he earned an M.S. in physics at the University of North Dakota.

Chris Ott ('85) is the principal of Christopher's Designs, a residential design studio in Santa Rosa, and the director of marketing for the International Footbag Players' Association.

Ed Ott ('01) teaches science at Greenbrier Academy for Girls in West Virginia, He previously taught in the Philadelphia area. He earned his teaching credential in 2002 at SSU.

Benjamin J. Owen ('93) is a professor of physics at Texas Tech University. He retains an adjunct appointment at Pennsylvania State University, where he was a professor of physics and director of the Center for Gravitational Wave Physics until the end of 2014. He was elected a Fellow of the American Physical Society in 2013 "for leadership in understanding how neutron stars can produce gravitational waves, for creating better methods to search for these waves, and for demonstrating how gravitational wave observations can be used to probe the structure and dynamics of neutron stars." He received his Ph.D. in physics in 1998 at Caltech, where he was awarded the Milton and Francis Clauser Doctoral Prize "awarded annually to the Caltech PhD candidate whose research is judged to exhibit the greatest degree of originality as evidenced by its potential for opening up new avenues of human thought and endeavor as well as by the ingenuity with which it has been carried out." He was awarded a National Science Foundation Graduate Fellowship upon graduation from SSU.

John Palmerlee ('85) is a production engineer with The Switch Lab in Sebastopol. He has been a senior software engineer and web developer with several companies, and he is working on a novel. A pilot, he is on the board of the CAFE Foundation.

William R. Parr ('69) is retired. He worked for many years for the County of Sonoma, ultimately as information systems project manager.

James A. Patrick ('83) is an airway transportation systems specialist with DataPath in Hawaii. He was formerly a military pilot.

Danny Paulson ('02) is a Realtor in Sebastopol. Formerly a science teacher at Maria Carrillo High School in Santa Rosa, he earned his teaching credential at Sonoma State University in 2003.

Andrew Peri ('91) was until recently advocacy director for the Marin County Bicycle Coalition. He has taught part-time in the department of geography and human environmenthttp://geog.sfsu.edu/ at San Francisco State University, where he earned an M.A. in 2005.

Richard Peters ('06) is a patent attorney and head of intellectual property practice at Inventus Law in Palo Alto. He earned his law degree at the University of New Mexico before coming to SSU.

Darith Phat ('87) is a professor of corporate finance and portfolio mananagement at Pannasastra University of Cambodia .

Eileen Philips ('74) is a retired programmer living in Novato.

David Piazza ('91) is teaching science at Hokkaido International School in Sapporo, Japan. He has also taught physical sciences at the Branson School in Ross. and at El Molino High School in Forestville since earning his teaching credential at SSU. He earned a master's degree in science education at the University of Washington in 1999.

Chris Piazzo ('97) is a manufacturing engineer at JDSU in Santa Rosa.

Jim Pisano ('82) was for many years a software engineer at the National Radio Astronomy Observatory in Charlottesville, VA, where he developed software for the Atacama Large Millimeter Array.

Bert Plambeck ('78) is a supplier quality engineering manager at JDSU in San Jose. He has held similar positions with several other technical firms in the Bay Area. He has published papers on overlay metrology and the implementation of coherence probe microscopy.

Claude Plymate ('81) is Telescope Engineer/Chief Observer for the Big Bear Solar Observatory 1.6-meter New Solar Telescope. He was formerly site manager of the National Solar Observatory's McMath-Pierce Solar Telescope at Kitt Peak. He received the AURA

Technology and Innovation Award in 2001 and earned an M.S. in astronomy from the University of Western Sydney in 2003.

Teresa Plymate [or Bippert-Plymate] ('84) has launched LookingUP! Astronomy Services, LLC, a business that brings astronomy to the resorts and camps in the Big Bear Lake area of southern California. She formerly worked at Steward Observatory as Interferometry Technical Specialist for the Large Binocular Telescope Interferometer and was previously the technical writer for the SOLIS project at the National Solar Observatory.

Jorge Polanco ('95) is the manager for radio frequency optimization at Autoconsa, a Central American contractor for the cell phone industry. He earned an M.S. in reliability engineering at Galileo University after returning from SSU to his native Guatemala.

Jeff Porter ('83) is now working in the National Energy Research Scientific Computing Center at the Lawrence Berkeley National Laboratory. He formerly did high energy physics research in the Center for Experimental Nuclear Physics and Astrophysics at the University of Washington. Before that he was database leader for the Solenoidal Tracker At RHIC (STAR) experiment at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory. He earned his Ph.D. in physics in 1995 at the University of California, Davis while participating in the DiLepton Spectrometer experiment.

Robert Porter ('71) is a retired international business and product development consultant living in Sebastopol. He earned his Ph.D. in psychophysiology at World College and University, UNESCO, in 1982.

Austin Powell ('11) is an analyst intern with Kaiser Permanente in the Bay Area. He also completing a master's degree in statistics at San Jose State University.

Kim Powers ('84) is a senior software engineer with Rockwell Collins in the Bay Area. He earned an M.S. in physics at the University of Arizona.

John Proud ('73) taught physics and astronomy for many years at Punahou School in Honolulu, where he chaired the science department and was director of the school's challenge ropes course. He earned a masters degree in educational administration at the University of Hawai'i.

Peter Quinliven ('04) is working for PG&E in San Francisco. Formerly an energy analyst with the California Energy Commission, he earned an M.S. in physics at the University of California, Davis in 2005.

Ryan Quitzow-James ('05) is a graduate student in physics at the University of Oregon, where he earned his master's degree in 2008 and is now working in the LIGO group.

Johannes Raab ('79) works in information security with a large insurance company in Munich, Germany. He earned a Ph.D. in experimental particle physics at the University of California, Santa Barbara in 1987 and did postdoctoral research at CERN, the University of Mainz, and the Max Planck Institute.

Roberto Ramirez ('72) has retired after teaching mathematics and physics for many years at Windsor High School and bilingual mathematics and science in the Department of Chicano and Latino Studies at SSU. Honored with a $15,000 Outstanding High School Teachers of America award by the Carlston Family Foundation in 2001, he was one of SSU's Distinguished Alumni in 2002.

Linda Rarey ('88) is a nuclear medicine technologist at Santa Rosa Memorial Hospital. She also performs PET/CT scans for DMS, a mobile imaging company. For eighteen years she was a clinical coordinator and instructor in Radiologic Technology at Santa Rosa Junior College and a lecturer at SSU. She earned a master's degree in an interdisciplinary major, Aging and Medical Facilities, at SSU in 1997.

Farzaneh Rasti ('10) is an engineer with Illumina in the San Diego area.

Chris Ray ('87) is a professor of physics and astronomy at St. Mary's College of California. He earned his Ph.D. in physics in 1994 at the University of California, Davis.

Jim Rector ('76) has retired after 23 years as a network operations specialist with Sprint in Sacramento. He now works part-time for the California Department of Parks and Recreation at Lake Oroville State Recreation Area.

John G. Reinecke ('84) is an engineer/scientist buying and building state of the art spectral measurement equipment to accurately measure the thin film coatings at JDSU. He was awarded a patent for contributions to a hand held instrument for measuring the color shift by angle of ink on $20 bills.

Katherine Rhode ('89) is an associate professor of astronomy at Indiana University. In 2009 she was awarded a prestigious Faculty Early Career Development Program award by the National Science Foundation. She was formerly an NSF Astronomy & Astrophysics Postdoctoral Fellow, dividing her time between Yale University, where she earned her Ph.D. in astronomy in 2003, and Wesleyan University, where she earned an M.S. in astronomy in 1997.

Kenneth Ritley ('88) is Head of Global IT Transformation for Swissport, the world's largest ground handling company in the aviation industry. He is responsible for transforming their distributed IT departments and IT systems into a single department with standards and processes. Until recently he was the head of the global IT delivery center for Sulzer in Winterthur, Switzerland. He was formerly a manager with the Swiss national railway. He earned a Ph.D. in physics at the University of Illinois in 1998 and afterward was a

postdoctoral researcher at the Max Planck Institute for Metals Research in Stuttgart, Germany.

Mallory Roberts ('94) is a visiting professor at New York University Abu Dhabi and an astrophysicist with Eureka Scientific. He also makes science-themed documentary films with Les Films Kookaburra. He earned his Ph.D. in astrophysics at Stanford University in 2000.

Willie Rodriquez ('97) is District Manager of Burney Water District in Burney, CA. He was formerly a product safety engineer at Agilent Technologies in Santa Rosa.

Michael Rogen ('84) is now studying Chinese in Taiwan. He retired after many years with Maxon Precision Motors, Inc., Burlingame, where he was vice president of electronics sales and marketing.

Charles Rogers ('94) is a compliance advisor at CoreLogic Flood Services.

Peter Rooney ('86) is working with the Fratelli Group, a public affairs firm in Washington, D.C. He was formerly the deputy staff director of the House of Representatives Committee on Science. From 1999 -2002 he was the founding Executive Director of the Forum on Technology & Innovation. As the American Physical Society's Congressional Fellow for 1998 he worked in the office of Senator Joe Lieberman of Connecticut. He earned his Ph.D. in physics at the University of California, San Diego, where he was an IBM fellow.

Josh Rose ('07) is a test engineer at Microsemi Corporation in Santa Rosa.

Tina Rosenberg [formerly Dearmin] ('92) is a site supervisor at the Santa Rosa Junior College Children's Center.

W. Chris Rostel ('96) is program manager for the special products group at Deposition Sciences, Inc. in Santa Rosa.

Scott Rowlands (BS, 6/86) is a product manager for JDSU in Santa Rosa. He is also a realtor with Coldwell Banker Residential Brokerage.

Rebecca Salvemini ('12) is tutoring physics at SSU and working in a Santa Rosa restaurant.

Lou Sanchez-Chopitea ('88) is a senior quality analyst engineer at Riverbed Technology in Sunnyvale. He was formerly a software engineer at Xilinx in San Jose. and a control systems programmer at the Stanford Linear Accelerator Center.

Jeff Sandberg ('90) is Water Conservation Programs Coordinator for the City of Portland Bureau of Water Works. He works in the engineering department performing water efficiency surveys and providing technical assistance to the commercial sector.

Gabriela "Gabi" Sanz-Douglass ('08) is a graduate student and research asssistant in aerospace engineering at San Diego State University. In spring 2013 she worked at NASA Langley Research Center in Virginia.

Jerilynn Schisser ('03) is a laboratory technician for Veolia Water at the Richmond Wastewater Treatment Plant. She has been a chemist at Analytical Sciences in Petaluma and a quality engineer at Triformix. She has also taught physics and chemistry at Bethel High School in Vallejo and worked as an optical engineer developing three-dimensional graphics systems with Real D in Beverly Hills.

Jacques Schlumberger ('82) sold Michel-Schlumberger Benchland Wine Estate and retired in 2012. He and his wife Barbara were recognized by SSU with an Alumni Community Achievement Award in 2007.

Else-Marie Schmidt ('94) is a senior application engineer at Keysight Technologies in Santa Rosa.

Greg Seeger ('74) is the owner of Sport Select, providing software to ski areas and sporting goods stores.

Niles Severy ('71) is a professor emeritus at Napa Valley College, where he taught physics, engineering, and mathematics for many years. He earned an M.S. in geology at the University of Colorado.

Alexander Sevilla ('07) is a production supervisor at Deposition Sciences, Inc. in Santa Rosa. He formerly worked on the design and construction of electric vehicles for Thunderstruck Motors in Santa Rosa.

Hugh Shacklett ('92) retired from his position as program manager for environmental cleanup (PCBs) at Mare Island Naval Shipyard in 1996. He is now a teaching assistant in the Special Education program at Rancho Cotate High School, where he helps teach 9th grade physical science.

Lorie Siebler ('03) is the Assistant Department Director of the Resource and Referral Department for the Community Child Care Council of Sonoma County.

Peter Sieck ('82) is a consultant in thin film design and manufacture for R&D and production groups. He was for many years a senior scientist with AFG Development Corporation in Petaluma, where he developed new window coatings for buildings and cars.

Mary Silber ('81) is a professor in Northwestern University's Department of Engineering Sciences and Applied Mathematics. She earned her Ph.D. in physics at the University of California at Berkeley.

Sarah Silva ('02) operates Silva Star Farm in Sebastopol. She was formerly the program manager in the NASA Education and Public Outreach Team at Sonoma State University.

Tim Silver is an independent translator of Japanese working in Tokyo. He earned a master's degree in international relations at the University of California, San Diego.

Jon Simmonds ('74) is a pilot with Alaska Airlines, based in Seattle. He has flown for Alaska and Eastern

Airlines for a total of 34 years. Before that he flew in Antarctica in support of NSF polar research projects while a pilot in the U.S. Navy.

Gray Slater ('04) was until recently working with electron beam coating machines at Research Electro-Optics, Inc. in Boulder, CO.

Stephanie "Steph" Snedden ('83) is an astronomer at the Apache Point Observatory in New Mexico working on the Sloan Digital Sky Survey. An employee of New Mexico State University, she earned her Ph.D. in astronomy at the University of Nebraska, Lincoln.

James Snyder ('97) is a research engineer in the Applied Optics Laboratory at SRI International in Menlo Park. Formerly he was a program manager at Deposition Sciences Inc. in Santa Rosa.

Paul Somerville ('93) is a partner in MojoJava, a combination Cafe/Motorcycle shop in San Francisco. He has also been a project manager for Coherent, Inc. in Santa Clara and a motorcycle racer. (photo)

Keith Soreng ('81) is the principal of Golden Gates, a Petaluma-based company that specializes in custom automatic gates and entry systems.

Greg Sprehn ('93) and his wife provide technical and scientific consulting services to medical device startups as Rivendell Heights, Inc. He has been a physicist in remote sensing, chief scientist in radiological imaging, and vice president of engineering in ophthalmic imaging. He has been awarded several patents in image processing and fiber-optics.

Bob Steele ('71) founded Motion Engineering, Inc. [now part of Kollmorgen] in Santa Barbara in 1990 and served as its chief technical officer for many years. In that position he used skills that had their start with an NCR Century 200 computer at Sonoma State. He earned his Ph.D. in physics in 1977 at UC Santa Barbara.

Imme Staeffler ('71) is a psychologist in San Francisco. She earned a doctorate in clinical psychology at Meridian University.

Lee Steele ('85) is a technical writer currently working at the naval warfare center in Indiana. He is has worked for Northrop Grumman and on NASA"s Fermi Gamma-ray Space Telescope.

Robert E. Steele ('70) founded and for many years led Motion Engineering in Santa Barbara. He is now retired and the company is now a part of Kollmorgen.

Tyana Stiegler ('03) is a postdoctoral researcher on the NEXT project at Texas A&M University, where she earned a Ph.D. in experimental particle physics in 2013. She is also teaching physics at Blinn College in Houston. Her thesis research was done on the LUX (Large Underground Xenon Detector) Project, a dark matter direct detection experiment in South Dakota. She earned a master's degree in physics at the University of California, Davis.

Joshua Stortz ('12) is the co-owner executive producer of the Vesuvius Group, LLC, an international collaborative of creatives specializing in developing online environments for community-building.

Mary Stowell [formerly Howland] ('86) works in ophthalmic lens design and new product development in the San Diego area. She was for twenty years an optical engineering manager at Signet Armorlite, Inc., a manufacturer of ophthalmic lenses in San Marcos.

Daniel Swearingen ('91) is the Director of Studio Operations of Autistry Studios, a non-profit organization to help teens and young adults with social, communication, and learning differences become successful independent adults, in Marin County. A long-time programmer, webmaster, and businessman, he earned a master's degree in physics at California State University, Northridge in 1991, and a second master's in astronomy at Indiana University in 1997.

Geoffrey Syphers ('93) is the chief executive officer of Sonoma Clean Power, the new, locally controlled electricity provider in Sonoma County. He was formerly chief stainability officer of Codding Enterprises in Rohnert Park, managing the transition to sustainable development through awareness education, training, policies and certification of all construction at Sonoma Mountain Village. He earned his M.S. in Energy Engineering at the University of Massachusetts, Lowell in 1994.

Ryan Taylor ('07) is a process engineer at View Dynamic Glass in Milpitas.

Bryce Terrell ('12) works for Clear Capital in Truckee.

Kevin Thomas ('02) is a police officer working for the California State University system.

William C. Tomlinson ('83) is data warehouse architect for ITT BIW Connector Systems in Santa Rosa. He formerly worked for Royce Instruments, Inc., a producer of test instruments used in the research and development of new silicon chips. He earned a second B.A., in management, at SSU in 1992, and an MBA, with a specialization in MIS, at the University of Arizona in 1994.

Tedman Torres ('04) is a surface warfare officer in the U.S. Navy. He recently completed a tour as the electrical officer in the engineering department of the U.S.S. Preble and is now in the nuclear propulsion program. He was formerly a postdoctoral researcher at the H. Lee Moffitt Cancer Center & Research Institute in Tampa, FL. He earned his Ph.D. in biological physics at Arizona State University in 2009 with a dissertation on fluorescence correlation spectroscopy.

David Turkington ('85) is now sermi-retired. He was formerly the project coordinator for the National Center for Data Mining/Laboratory for Advanced Computing at the University of Illinois at Chicago, where he earned an MBA in 1996. He has taught English in Japan and high

school mathematics and physics as a Peace Corps Volunteer in Cameroon.

Trudy Tuttle Hart ('91) is an engineering project administrator at Sappi Fine Paper North America in Maine.

Kris Tyson ('05) is a product development supervisor in 3M's Optical Systems Division in St. Paul, MN, where he leads product development teams developing the next generation of LCD-based optical films for smartphones. He earned a master's degree in management of technology at the University of Minnesota in 2012.

Raymond Ubelhart ('91) is a software scientist for Harris Corporation in southern California. He earned an M.S. in computer and engineering science at SSU in 2004. He has also worked in the Communications Solutions Group at Agilent Technologies and at Sola Optical USA Inc., Petaluma.

Clyde Underwood ('74) is a quality assurance engineer with Keysight Technologies (formerly Agilent) in Santa Rosa.

Michelle Valencia [formerly Jones] ('03) educates the public about astronomy at the Ukiah Latitude Observatory. She also tutors mathematics at the Tutoring Center

Frank van Gieson ('79) is an integrated circuit engineer in Boise, ID. He earned an M.S. in materials science at the Massachusetts Institute of Technology.

Paul Vanderbilt ('76) is an integrated circuit designer of 40+ Gbps communications chips with Applied Micro Circuits Corporation (AMCC) in San Diego.

Tomas Vera ('84) is a software engineer working in the Sacramento area. He served as an officer in the U.S. Navy after graduation from SSU.

Holly Wallace ('86) is an application development and support manager at Berkshire Hathaway Homestate Companies in the Bay Area.

Keith Waxman ('90) is an instructor of astronomy and head of the astronomy program at Santa Rosa Jr. College. He was formerly a part-time lecturer there, at San Francisco State University, where he earned an M.S. in earth and space science in 1994, and at SSU.

Eric Weiss ('91) is vice president of customer success at Uplogix, a software company in Texas. He earned his Ph.D. in physics at the University of Washington in 1998 with research in experimental particle physics at the Stanford Linear Accelerator Center.

Brenton White ('84) is the principal of Brenton White Company in Loveland, CO. He was formerly a product manager in measurement and automation software technology for Agilent Technologies in Loveland.

Mark Wiedeman ('09) is a remote solar designer for Sungevity Solar Home Specialists in Oakland, CA. He uses satellite imagery to remotely determine the solar potential of rooftops and uses point recognition software to design and place digital solar arrays.

Suryadi Wijono ('94) is senior marketing manager for polyamides and foams at BASF in Jakarta, Indonesia.

Dan Wilcox ('89) is a research support specialist at Cornell University's Space Sciences Lab. He was for many years an electronics technician at the Canada-France-Hawaii Telescope in Hawaii.

Jamie Williams ('06) is a youth program coordinator for Women's Mountain Passages, a non-profit agency devoted to improving the lives of women and youth in Quincy, CA.

Steve Williamson ('73) is a principal of MCTS, a consultant for manufacturing companies implementing productivity improvement and employee involvement. He earned a Master of Arts in Teaching degree in physics at UCLA in 1975.

Geoffrey A. Wilson ('84) is a consultant specializing in signal processing algorithms and optics in Oregon. He has worked on bioparticle detection at Hach Homeland Security Technologies in Grants Pass, OR, coherent laser radar at Coherent Technologies in Boulder, CO, and experimental quantum optics at the University of Oregon since earning his Ph.D. in applied physics at the Oregon Graduate Institute of Science and Technology in 1992.

Zachary Wiren ('02) is working in health physics at the Puget Sound Naval Shipyard. He earned a Ph.D. in physics at Oregon State University in 2008.

Alan J. Witten ('99) retired from his position as manager of inside sales at DEY L.P., a pharmaceutical manufacturer in Napa, in 2003. He is now active in community and charitable organizations in Lincoln, CA.

Laura Withnell ('00) is an asphalt quality control technician in Battleground, WA.

Anna Wojtowicz ('13) is a research associate at Oak Ridge National Laboratory, where she is developing software for enhancing nuclear reactor simulation modeling and data analysis.

Justin Wolfe ('01) is an optical engineer for mirrors and polarizers at the National Ignition Facility at the Lawrence Livermore National Laboratory. Formerly an engineer at Optical Coating Laboratory, Inc., Santa Rosa, he earned an M.S. in optical sciences at the University of Arizona.

Mark Wollam ('06) is a senior systems analyst at PLC's PLUS in Bakersfield.

R. Gary Wong ('75) is a chiropractor in Santa Rosa. He is Board certified in Chiropractic Orthopedics, a Certified Chiropractic Sports Physician, and a California Qualified Medical Examiner.

Katherine "Katy" Wyman ('09) is a technical assistant in the Director's Office for the Chandra X-Ray Observatory at the Harvard-Smithsonian Center for Astrophysics in Cambridge, MA. She earned a master's

degree in astronomy at Wesleyan University in 2011. A poster based on her thesis research won a Chambliss Astronomy Achievement Student Award at the June 2012 meeting of the American Astronomical Society. She did research in radio astronomy at the National Radio Astronomy Observatory in summer 2009.
Bradley Yearwood ('09) is principal software engineer at Calix Networks, Petaluma.
Michael Youmans ('07) is a manufacturing engineer at Spectra-Physics in Sunnyvale.
Ryan Young ('10) is a sales engineer at AER Worldwide in Fremont.
Gary Zupan ('69) is an engineer working for the Food and Drug Administration on approval and regulation of medical devices with embedded software such as MRI, CAT-scan, ultrasound, pacemakers, infusion pumps and dialysis. He was formerly a consulting software engineer with Legendary Systems, Inc. and was a self-employed software engineer for many years. He earned an M.Ed. at Hyles-Anderson College in 1983.

Last updated 2015-04-13 by *JST*

Appendix C – Curriculum Vitae

C.1 Lynn Cominsky

C.2 Jeremy Qualls

C.3 Scott Severson

C.4 Hongtao Shi

C.4 Thomas Targett

Lynn Cominsky

Professor and Chair
Sonoma State University
PHONE: 707-664-2655
EMAIL: lynnc@universe.sonoma.edu

a. Professional Preparation

Brandeis University	Physics and Chemistry	B.A., 1975
Massachusetts Institute of Technology	Physics (Astrophysics)	Ph. D., 1981
UC Berkeley Space Sciences Lab	Postdoctoral Research	1981-1984

b. Professional Appointments

2004- present – Chair, Dept. of Physics & Astronomy, Sonoma State University
1991- present – Professor, Dept. of Physics & Astronomy, Sonoma State University
1986-1991 – Associate Professor, Dept. of Physics & Astronomy, Sonoma State University
1984-1986 – Management, Extreme Ultraviolet Explorer, UC Berkeley Space Sciences Lab

c. Awards and Honors (partial list)

- SSU President's Award for Excellence in Scholarship 2015
- Aerospace Awareness award from Women in Aerospace 2014
- Women Honoring Women award from the Sonoma County Commission on the Status of Women, 2013
- Fellow, AAAS Fellow (Astronomy), 2013
- APS/CSWP Woman Physicist of the Month September 2012
- HEAD/AAS Rossi Prize Bill Atwood, Peter Michelson, and the Fermi Gamma Ray Space Telescope LAT team 2011
- NASA Group Achievement Award for Fermi Science Team 2010
- Fellow, American Physical Society (Education) 2009
- NASA Goddard Space Flight Center Exceptional Achievement Award for Fermi Large Area Telescope Science Team 2008
- Fellow, California Council on Science and Technology, 2008
- HEAD/AAS Rossi Prize to Neil Gehrels and the Swift Team 2007
- NASA Goddard Exceptional Achievement Award for Swift Science Team 2005
- Council for Advancement and Support of Education California Professor of the Year Award 1993
- Sonoma State University Outstanding Professor Award 1992

d. Brief Biography

Prof. Cominsky founded SSU's Education and Public Outreach (E/PO) group in 1999 and is the Project Director, Principal Investigator on all grants and final technical reviewer for all products. The mission of the SSU E/PO group is to develop exciting formal and informal educational materials as a means to inspire students in grades 5-14 to pursue STEM careers, to train teachers nation-wide in the classroom use of these materials, and to enhance science

literacy for the general public. Since 1999, the group has received over $15 million in grants, primarily from NASA, to lead the E/PO programs for four different space science missions, including XMM-Newton (launched in 1999), Swift (launched in 2004) and the Fermi Gamma-ray Space Telescope (launched in 2008) and the Nuclear Spectroscopic Telescope Array (NuSTAR, launched in 2012). Through these mission-funded education programs, she has developed a cohort of master teachers (Astrophysics Educator Ambassadors) who have trained over 65,000 other teachers (nation-wide since 2001) to do classroom activities in aerospace and space science. Cominsky is also a scientific co-investigator on Fermi, Swift and NuSTAR and an author on 125 scientific research papers in peer-reviewed journals.

Cominsky has also received funding from NASA EPOESS for the development of an online course in Cosmology for general education college students, and the development of formal curriculum for secondary students to build small satellite payloads for launch on high-powered rockets or tethered weather balloons. In November, 2013, Cominsky's SSU students (in partnership with other undergraduates from Morehead State University), launched the PocketQube T-LogoQube into low Earth orbit. Most recently, Cominsky is the STEM Director for "Learning by Making: STEM Success for Mendocino County" funded by the US Department of Education's Investing in Innovation program. For further information, see **http://epo.sonoma.edu**

Prof. Cominsky has given 145 invited lectures to scientific and public audiences on topics in high-energy astrophysics, and is an author on over 120 contributed conference presentations. For more than a decade, she served as the Deputy Press Officer for the American Astronomical Society, and currently serves as the Press Officer for the Swift and Fermi missions, explaining scientific topics to the public.

e. Recent Short-author List Publications

Big Ideas in Cosmology, Kim Coble, Kevin McLin, Janelle M. Bailey, Anne J. Metevier, Carolyn C. Peruta & Lynn Cominsky, published by Great River Learning, ISBN: 9781615499793 for Module I, ISBN: 978-1-61549-798-0 for Module II, ISBN: 978-1-61549-809-3 for Module III. This is a two-semester, web-based college curriculum. See http://www.greatriverlearning.com/cosmology

"Investigating Student Ideas about Cosmology II: Composition of the Universe" Kim Coble, Melissa D. Nickerson, Carmen T. Camarillo, Janelle M. Bailey, Laura E. Trouille, Geraldine L. Cochran, & Lynn R. Cominsky, Astronomy Education Review 2013, AER, 12 (1), 010111, doi:http://dx.doi.org/10.3847/AER2012039

"Investigating Student Ideas about Cosmology III: Big Bang Theory, Expansion, Age and History of the Universe" Laura E. Trouille, Kim Coble, Carmen T. Camarillo, Melissa D. Nickerson, Geraldine L. Cochran, Janelle M. Bailey, & Lynn R. Cominsky, Astronomy Education Review 2013, AER, 12 (1), 010110, doi:http://dx.doi.org/10.3847/AER2013016

"Small Satellites for Secondary Students", Lynn Cominsky, Kevin John, Logan Hill and Kevin Zack, in the July/August 2013 issue of Sport Rocketry magazine.

"Investigating Student Ideas about Cosmology I: Distances, Structure, and Composition of the Universe" Kim Coble, Carmen T. Camarillo, Melissa D. Nickerson, Laura E. Trouille, Janelle M. Bailey, Geraldine L. Cochran, & Lynn R. Cominsky, Astronomy Education Review, 2013, AER, 12 (1), 010102, doi:http://dx.doi.org/10.3847/AER2012038

"A Multi-Institutional Investigation of Students' Preinstructional Ideas About Cosmology" Janelle M. Bailey, Roxanne Sanchez , Kim Coble, Donna Larrieu, Geraldine Cochran & Lynn R. Cominsky, Astronomy Education Review, 2012, AER, 11 (1), 010302, doi: http://dx.doi.org/10.3847/AER2012029

f. Recent Conference Presentations and Papers (partial list)

"Twelve Years of the Fermi Education and Public Outreach Program" Cominsky, Lynn, McLin, Kevin, Simonnet, Aurore and the Fermi E/PO team, American Astronomical Society, HEAD meeting #13, #123.04

"Fourteen Years of the Swift Education and Public Outreach Program" Cominsky, Lynn R., McLin, Kevin, Simonnet, Aurore and the Swift E/PO team, GRB 2013, Nashville, TN, April 2013.

"NASA Astrophysics Educator Ambassador Program" McLin, K. M. and Cominsky, L. R., in *Ensuring Stem Literacy: A National Conference on STEM Education and Public Outreach*. ASP Conference Series, Vol. 483, proceedings of a conference held 20-24 July 2013 at San Jose State University, San Jose, California, USA. Edited by James G. Manning, Mary Kay Hemenway, Joseph B. Jensen, and Michael G. Gibbs. San Francisco: Astronomical Society of the Pacific, 2014., p.401

"Fermi Communications and Public Outreach" Cominsky, L., Simonnet, A. and the Fermi E/PO team. Presented at the Fifth International Fermi Symposium, Nagoya Japan, Oct 20-22, 2014. http://arxiv.org/abs/1502.07284

"Swift Communications and Public Outreach" Cominsky, L., Simonnet, A. and the Swift E/PO team. Presented at Swift: 10 Years of Discovery, Rome Italy, Dec. 3-5, 2014.

NASA Astrophysics E/PO Impact: The Astrophysics Educator Ambassador Program" Cominsky, L., McLin, K. and the SSU E/PO team, American Astronomical Society, AAS Meeting #225, #410.07, 2015AAS...22541007C

g. Recent Invited Talks (partial list)

Washington, DC (2014) "Blazars and Gamma Rays" invited talk to Amateur astronomers at the Winter AAS meeting (Jan. 7, 2014)

Santa Rosa, CA (2014) "Blazing Galaxies, Exploding Stars and Monstrous Black Holes: High Energy Visions of the Universe" invited talk at the Oakmont Symposium (May 8, 2014) http://www.oaksunsym.org/2014/140508_cominsky/cominsky.html

Internet lecture "Learning by Making: Rockets, Satellites and More" invited talk at the AAPT-AOK meeting, Arkansas (September 26, 2014)

Mt. Tamalpais, CA (2014) "NuSTAR's Sharper View of the Universe" invited lecture in the Mt. Tamalpais Astronomy program series (September 27, 2014)

Rohnert Park, CA (2014) "Science of War (and Peace)" invited lecture in the War and Peace seminar series, Sonoma State University (September 30, 2014)

Jeremy S. Qualls
Associate Professor
Coordinator of Science Freshman Year Experience
Sonoma State University
Email: Quallsj@sonoma.edu

a. Professional Preparation:

East Tennessee State University	Physics	B.S. 1994
Florida State University	Physics	M.S. 1997
Florida State University	Physics	Ph.D. 1999

b. Professional Experience

2011-Present STEM Science 120 Program Coordinator at Sonoma State University
Establish and lead university wide initiatives towards SSU STEM education demonstrating practices that attract and retain majors. The work includes cross campus and cross disciplinary networking, integrating community partners, and developing new academic models for STEM success. The program has gained much recognition and is quickly becoming a pioneer program for other universities. This position is funded through the NSF STEP program and includes administration duties of budget, hiring, and direction.

2011- Present Associate Professor/Researcher at Sonoma State University
Developed new academic and research programs, maintain a high level of competency in technology and science, attract and maintain external funding, supervise researchers, collaborate with other researchers in academics and industry, do fundable research in material science, teaching range of physics courses, service to University, development of STEM majors.

2007 – 2010	Assistant Professor of Physics, Sonoma State University
2003 – 2007	Assistant Professor of Physics, University of Texas Pan American
2002 – 2003	Visiting Assistant Professor/Lecturer, University of Texas Pan American
2000 – 2002	Assistant Professor of Physics, Wake Forest University
1999 – 2000	Post Doctoral Research Assistant, NHMFL, Florida State University

c. Publications: (~80 peer reviewed publications)

(i) Five most recent publicatons

1. V. Kornilov, J. Yamada, J. S. Qualls, and V. M. Pudalov, "Coexistence of superconductivity and spin-density wave in (TMTSF)2ClO4: Spatial structure of the two-phase state" Ya. A. Gerasimenko, S. V. Sanduleanu, V. A. Prudkoglyad, , Phys. Rev. B 89, 054518 (2014).
2. Ya.A.Gerasimenko, V.A.Prudkoglyad, A.V.Kornilov, S.V. Sanduleanu, J. S.Qualls, V.M.Pudalov" Role of anion ordering in the coexistence of spin-density-wave and superconductivity in (TMTSF)2ClO4", Pis'ma v ZhETF, vol. 97, iss. 7, pp. 485 – 490 (2013)
3. K. Nishiyamaa, T. Mitoa, Y. Kujiraia, T. Koyamaa, K. Uedaa, T. Koharaa, K. Takeuchia, H. Akutsua, J. Yamadaa, A. Kornilovb,V. M. Pudalovb, and J. S. Qualls, "77Se-NMR study of quasi-one dimensional organic conductor (TMTSF)2*X*", (2012) J. Phys.: Conf. Ser. 344 012026
4. T Adhikari, A. R., Lozano, K., Chipara, M. and Qualls, J. (2011), The effect of carbon nanofiber on the thermo-physical behavior of polyethylene oxide. J. Appl. Polym. Sci., 120: 3574–3580. doi: 10.1002/app.33542 (2011).
5. T. Mitoa, K. Nishiyamaa, T. Koyamaa, K. Uedaa, T. Koharaa, K. Takeuchia, H. Akutsua, J. Yamadaa, A. Kornilovb, V.M. Pudalov and J.S. Qualls "77Se NMR study of nonmagnetic–magnetic transition in (TMTSF)2X", Physica C: Superconductivity, Volume 470, Supplement 1, (2010).

d. Synergistic Activities

1. Serves as director and lecturer for Science 120 for past three years. This role led to the development and creation of an NSF funded STEM- Freshman year experience which saw a rise in retention and attraction rates of STEM majors. This was a cross disciplinary effort across all STEM fields and required extensive management and pedagogy competency.
2. Served as content expert and representative for K-University "Vertical Alignment" (Texas), examining what constitutes the basic science concepts needed for modern scientists and college graduates. This prospective is vital in accessing the needs for future STEM majors and SSU students.
3. Serves as Chair of the University Program Review and oversees faculty review of all campus programs and assessment efforts towards meeting learning outcomes.
4. 14+ Years University Teaching Experience, including making significant changes by revising outreach, advising, and curriculum. This included developing new degree plans, teaching certificate plans, advising and orientation process, student assessment and program evaluation, integration of new laboratories into science courses, and creating new outreach methods. Advised 3 graduate students and over 60 undergraduate students in research projects.
5. Serves as an annual NSF and NHMFL expert in material science.
6. Extensive background in physical sciences and experimental design, construction, and application.
7. Serves as a STEM expert for CSU Chancellor's Office efforts to increase STEM retention.
8. Serves as a department advisor, orientation leader, SSU science symposium organizer, and editor of department newsletter.
9. Maintains active conference presence (AACU, APS, SENCER, STEP, STEM education, and local universities).

e. Teaching

15 Years University Teaching Experience. Comfortable teaching any graduate or undergraduate physics and most physical science courses. Expert in learning by inquiry methods, critical thinking workshops, peer instruction, software incorporation, and alternative learning methods.

Courses Taught: Physical Science I and II (including labs), Research Seminar "Research Methods in Organic Conductors", Classical Dynamics, Junior Research Lab, Calculus and Algebra Based University Physics I and II, Senior Research Lab, Topics in Modern Physics, Astronomy, Experimental Methods, Intro to Solid State Physics, Modern Physics, Quantum Physics, GRE physics prep course, PHYS 100:Physics of Superheroes and Physics for Future Presidents, Physics of Toys, Science 120 **Advised**: graduate and undergraduate research students.

I am a teacher and a torch bearer. I try to be a beacon to not only offer safe passage from pitfalls of indifference and misconception but also to offer support to those that seek more. My approach to teaching follows two fundamental goals. The first goal is to be an ally and never be a *filter*, i.e. sorting the more prepared and motivated students from those that are not. My second goal is to always listen. Teaching is a dynamic process in which case, what works with one student is not guaranteed to work with the next. I myself am a student, and must be open to learn.

Curriculum Vitae

Hongtao Shi

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Phone: (707) 664-2013
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Position Description:

I joined the faculty in the Physics and Astronomy Department at Sonoma State University in Fall 2004. I have been teaching a wide spectrum of undergraduate physics courses that the Department offers, such as Descriptive Physics, Introduction to Physics, Electronics, Modern Physics, Analytical Mechanics, Mathematical Physics, Intermediate Experimental Physics, Statistical Physics, Quantum Physics, Electricity and Magnetism, and Physics of Semiconductors. Since 2008, I have been the advisor of SSU SPS (Society of Physics Students) chapter, which has won several National SPS Awards in the last few years, such as Marsh White Award (three years in a row from 2011 – 2014), Future Faces of Physics, and Undergraduate Physics Research Award. As the director of the Keck Microanalysis Laboratory at SSU, I have been training students in the field of nanoscience and nanotechnology, overseeing experiments that are conducted in this lab since 2004. I have also been chairing the Department RTP (Retention, Tenure and Promotion) committee since 2009, working with members on the committee to evaluate probationary faculty and part time lecturers. In 2013 and 2014, I participated in an NSF supported WIDER program which is a project conducted by SSU and UC Berkeley, learning about and implementing "flipped" classroom science pedagogies.

Previous Positions:

- Associate Professor, Department of Physics and Astronomy, SSU 08/2009 – 07/2014
- Assistant Professor, Department of Physics and Astronomy, SSU 08/2004 – 07/2009
- Postdoctoral Associate, Department of Physics, West Virginia University 01/2003 – 07/2004
- Assistant Professor, Department of Physics, Nanjing University, China 08/1992 – 07/1996

Education:

- Doctor of Philosophy, Physics, West Virginia University 2002
- Master of Science, Physics, West Virginia University 1998
- Master of Science, Physics, Nanjing University, China 1992
- Bachelor of Science, Physics, Nanjing University, China 1989

Research Interests:

My research focuses on semiconducting and magnetic thin film fabrication and characterization. In the last few years, I have been studying how to use electrochemistry to prepare zinc oxide

(ZnO) thin films and probe the light emission from these samples since ZnO is a wide band gap semiconductor with great potential in solar applications. In November 2013, one of my students presented his research at the APS California-Nevada session meeting, and won second place for the Steven Chu Undergraduate Research Award. Over the years, I have also been working with physics majors to develop instrumentation for physics experiments.

Major Projects and Awards:

- 2004-05 Sonoma State University Research, Scholarship and Creative Activity Program (RSCAP) Award
- 2007-08 RSCAP, Sonoma State University
- 2011 RSCAP Summer Fellowship, Sonoma State University
- 2011- 2015 School of Science and Technology Faculty Development Funds
- I was also Co-I on a few federally sponsored research projects at WVU, related to magnetism

Professional Memberships:

- American Physical Society (APS)
- Materials Research Society (MRS)

Selected Publications:

1. Correlation between ferromagnetism and superconductivity at interfaces of $La_{2/3}Ca_{1/3}MnO_3/YBa_2Cu_3O_{7-\delta}/La_{2/3}Ca_{1/3}MnO_3$ trilayers grown by DC sputtering
   F. Perez, E. Baca, W. Saldarriaga, O. Morn, H. Shi, and D. Lederman
   J. Supercond. Nov. Magn., **26**, 2289 (2013)
2. Influence of Mg-doping on the optical properties of ZnO thin films prepared via electrochemical deposition
   Hongtao Shi, Cristhyan F. Alfaro, Kalie R. Barrera, Timothy L. Hessong, and Stephanie R. Halbert
   Phys. Status Solidi A, **210**, 1163 (2013) / DOI 10.1002/pssa.201228569
3. Interface biquadratic coupling and magnon scattering in exchange-biased ferromagnetic thin films grown on epitaxial FeF2
   David Lederman, Prasanta Dutta1, Mohindar S Seehra and Hongtao Shi
   J. Phys.: Condens. Matter, **24**, 186001 (2012)
4. Mg-induced enhancement of ZnO optical properties via electrochemical processing
   Hongtao Shi, Kalie R. Barrera, Timothy L. Hessong, and Cristhyan F. Alfaro
   Materials Research Society (MRS) Proceedings, **1449**, mrss 12-1449-bb03-07
   doi:10.1557/opl.2012.958 (2012)

Scott A. Severson

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Professional Preparation

University of Wisconsin-Madison	Astronomy	B.S. 1990
University of Chicago	Astronomy and Astrophysics	S.M. 1992
University of Chicago	Astronomy and Astrophysics	Ph.D. 2000
UCO/Lick Observatory	Postdoctoral Researcher	1998-2002

Appointments

Sonoma State University	Associate Professor	2011-Present
Sonoma State University	Assistant Professor	2007-2011
UCO/Lick Observatory	Associate Research Astronomer	2002-2007
UCO/Lick Observatory	Postdoctoral Researcher	1998-2002
University of Chicago	Graduate Student Researcher	1992-1998
University of Chicago	Teaching Assistant	1990-1992

Education and Outreach Interests:

- Enriching the academic lives of Sonoma State University students through courses and research
- Mentoring the next generation of scientists and engineers
- Recruiting, educating and retaining a diverse population of scientists
- Enhancing the scientific literacy of society
- Innovative teaching practices

Research Interests:

- Development of next-generation adaptive optics (AO) systems
- Development of Sonoma State University observational capabilities
- Astronomical instrumentation with emphasis on the near-infrared and high-speed photometry
- Time domain astronomy, measurements of transient phenomena in the universe
- High-resolution imaging including the central regions of galaxies and planetary science

Synergistic Activities

- PI Sonoma State University PhysTEC Teacher Recruitment grant (PhysTEC $29,889). Program to increase the number of High School Physics Teachers, focused on recruitment effort, current.
- Co-PI Sonoma State University Robert Noyce Scholarship Program (NSF $899,842). The program encourages talented Science, Technology, Engineering, and Mathematics (STEM) majors to become teachers through a program that supports students while they pursue their STEM degree and their teaching credential, 2010 – present.
- Director SSU Campus Observatory, including organizing Public Viewing Nights, 2008 – present.
- Organize public lecture series “What Physicists Do” (~11 talks/semester), Fall 2009 – present.
- Co-PI KAPAO Adaptive Optics System for Table Mountain Observatory (NSF MRI $637,138) includes research supervision of 11 undergraduates and co-authorship with six, 2010 – 2013.
- Faculty Research Associate of the U.S. Department of Education-supported EnACT~PTD faculty development program in support of students with disabilities, 2008 – 2011.

- Scholarship of teaching and learning specific to the physical sciences resulting in five papers appearing in the Astronomical Society of the Pacific Conference Series, Volume 436, Learning from Inquiry in Practice, 2010.
- Staff member of the NSF Center for Adaptive Optics Professional Development Program; development and implementation of workshops supporting inquiry-based science and engineering teaching in post-secondary venues, 2003-2007.

Selected Teaching Activities

- Designed and instructed courses within the physics major and for general education: Descriptive Astronomy, Introduction to Observational Astronom, Frontiers in Astronomy, Astronomical Imaging, Cosmology, Astrophysics:Stars, Advanced Observational Astronomy; Introductory Physics Laboratory, Light and Optics, Statistical Physics, Advanced Experimental Physics, Physics Seminar.
- Student research mentorship at SSU: mentored students a combined 67 student-semesters, including 20 senior capstones.
- Nominated for the Excellence in Teaching Award 2011, 2012 and 2013.
- Student Evaluation of Teaching Effectiveness (SETE) average of 4.72 on a five-point scale (through latest cumulative review in 2010)

Selected Publications

1. “KAPAO first light: the design, construction and operation of a low-cost natural guide star adaptive optics system”, Severson, S. A., Choi, P., Badham, K., Bolger, D., Contreras, D., Gilbreth, B., Guerrero, C., Littleton, E., Long, J., McGonigle, L., Morrison, W, Ortega, F., Rudy, A., Wong, J., Spjut, E., Baranec, C., and Riddle, R., Adaptive Optics Systems IV, Edited by Marchetti, E.; Close, L.; Véran, J-P., Proceedings of the SPIE, Volume 9148, 2014.
2. “KAPAO: a MEMS-based natural guide star adaptive optics system”, Severson, S. A., Choi, P., Contreras, D., Gilbreth, B., McGonigle, L., Morrison, W, Rudy, A., Xue, A., Spjut, E., Baranec, C., and Riddle, R., MEMS Adaptive Optics VII, Edited by Olivier, S.; Bifano, T.; Kubby, Proceedings of the SPIE, Volume 8617, 2013.
3. “MEMS practice: from the lab to the telescope”, Morzinski, K., Norton, A., Evans, J., Reza, L., Severson, S, Dillon, D., Reinig, M., Gavel, D., Cornelissen, S., Macintosh, B., Max, C., MEMS Adaptive Optics VI. Edited by Olivier, S.; Bifano, T.; Kubby, Proc. of the SPIE, Vol 8253, 2012.
4. “Designing Effective Undergraduate Research Experiences”, Severson, S., 2010, Astronomical Society of the Pacific Conf. Series, Learning from Inquiry in Practice, eds. L. Hunter & A. J. Metevier (San Francisco: ASP), 436, 449.
5. “Villages: an on-sky visible wavelength astronomy AO experiment using a MEMS deformable mirror”, Gavel, D., Severson, S., Bauman, B., Dillon, D., Reinig, M., Lockwood, C., Palmer, D., Morzinski, K., Ammons, M., Gates, E., and Grigsby, B., MEMS Adaptive Optics II. Edited by Olivier, Scot S.; Bifano, Thomas G.; Kubby, Joel A. Proceedings of the SPIE, Volume 6888, pp. 688804-688804-7 (2008).
6. “The extreme adaptive optics testbed at UCSC: current results and coronographic upgrade”, Severson, S. A. Bauman, B., Dillon, D., Evans, J., Gavel, D., Macintosh, B., Morzinski, K., Palmer, D., and Poyneer, L. 2006, proc. SPIE Vol. 6272 pp. 62722J, Advances in Adaptive Optics II. Edited by Ellerbroek, Brent L.; Bonaccini Calia, Domenico.
7. "Demonstrating sub-nm closed loop MEMS flattening", J. W. Evans, B. A. Macintosh, L. Poyneer, K. Morzinski, S. Severson, D. Dillon, D. Gavel, and L. Reza, Optics Express 14, 2006.

CURRICULUM VITAE

THOMAS ANDREW TARGETT

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Nationality: USA and UK (dual)

Address: Dr. Thomas Targett
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RESEARCH INTERESTS

Galaxy evolution: (sub)millimeter galaxies, AGN hosts, radio galaxies, ULIRGS

Coupled black-hole and spheroid growth

The first galaxies

TEACHING POSITIONS

Sonoma State University	*Visiting Assistant Professor*	*Aug* 2013 – *Present*

RESEARCH POSITIONS

University of Edinburgh	*Postdoctoral research fellow*	*Apr* 2010 – *Aug* 2013
University of British Columbia	*Postdoctoral fellow*	*Apr* 2008 – *Mar* 2010
University of Birmingham	*Postdoctoral research fellow*	*Sep* 2007 – *Mar* 2008
California Institute of Technology	*Postdoctoral scholar*	*Jan* 2007 – *Aug* 2007

EDUCATION

University of Edinburgh, UK *Oct* 2003 – *Dec* 2006
Ph.D., Astrophysics

Thesis project: "Coupled Black Hole and Spheroid Formation in the Early Universe"
Advisor: Prof. James Dunlop

Cardiff University, UK *Sep* 1999 – *Jun* 2003
MPhys., (Honors), Astrophysics

Master's dissertation: "Hidden Hydrogen Disks in the HIPASS 21-cm Survey"
Advisor: Prof. Michael Disney

PROFESSIONAL ACTIVITIES

Teaching

- Lecturer: Five sections A100, two section A231, two sections A350 & A305, SSU
- Lower/upper division (A100/A350) GE classes taught as both online and "flipped class"
- Joint lecturer: Astronomy 101 & 310, UBC
- Course organizer and lecturer, graduate-level "SUPA Galaxies" course, Edinburgh
- Wrote, set, and graded graduate and undergraduate-level examinations
- All categories from official student evaluation of instruction > 4/5

Referee

- Gemini telescope time-allocation committee
- Scientific referee, MNRAS and ApJ journals

Supervision

- Several publications with undergraduate co-authors
- Project supervisor for numerous master's and undergraduate-level students
- Project supervisor for Caltech SURF and summer research students
- Thesis committee for masters and PhD students, UBC & Edinburgh

International collaborations

- Member, international astronomy collaborations: CANDELS, HUGS, & UDF12

Observing

- United Kingdom Infrared Telescope, Hawaii [3.8-m] – 34 nights
- James Clark Maxwell Telescope, Hawaii [15-m] – 6 nights
- William Herschel Telescope, La Palma [4.2-m] – 5 nights
- W. M. Keck Observatory, Hawaii [10-m] – 4 nights
- Palomar Observatory, California [200-inch] – 3 nights

Presentations

- Speaker, presenter, and session chair at numerous international conferences

Organization

- Organizing committee – CANDELS team meeting, Edinburgh
- Organizing committee – PPARC summer school, Edinburgh
- Seminar and colloquium talk series organizer, Edinburgh

Outreach

- Public astronomy correspondent, University of Edinburgh
- Guest speaker, BBC Radio Scotland
- Appearances on astronomy outreach podcasts, University of Manchester
- Regular guest speaker at primary and secondary schools
- Strong media presence with recent public outreach project
    - Articles in national newspapers and mainstream internet pages
    - Significant public response via Facebook and Twitter

PUBLICATIONS AND CITATIONS

The following is based on data from NASA/ADS retrieved on 09/01/2014

- Refereed papers: 29; citation count: 1318
- H-index: 17
- Refereed papers with ≥ 80 citations: 6
- Refereed first-author papers: 3 (several more in prep. 2015)

Appendix D – Previous Assessment and Self-Study Report

D.1 Self Study Action Plan from 2008

D.2. Self Study External Reviewer Report from 2008

H. Action Plan

H.1 Action plan based on findings and recommendations

The main recommendations of the external reviewer (see Appendix L for the complete report) are:
1) Develop a curriculum strategy that engages students early on so that as they become trained they are also able to help beginning majors

We share the concern of the external reviewer about the loss of beginning majors from the pipeline – often this occurs before they have even taken one course in our department. As a result, we actively advise incoming majors to enroll in What Physicists Do as well as getting involved with our Society of Physics Student club. The SPS students are also offering free drop-in tutoring in an attempt to help the lower division students. We will look into adding additional opportunities for lower-division students to engage in research, perhaps by being mentored by upper-division students or through supplemental instruction. This is a good suggestion and one which we will continue to explore.

2) Department chair should engage junior faculty in the governance of the department to ensure continuity

The junior faculty are included in all department meetings, which is what constitutes our governance structure. They have contributed to defining GE learning outcomes, both at the department and School level, have participated in recruiting activities through summer orientation of new students, and Seawolf day, and actively engage in other departmental activities. When Dr. Tenn finishes his FERP there will be additional need for junior faculty to step forward in leading our What Physicists Do series, as well as maintaining our website. Junior faculty have already taken over the advisor's duties, as well as the Physics Major newsletter editing (both previously the efforts of Dr. Tenn for many years.) We will look for additional ways to get junior faculty involved in running the departmental functions.

3) The Department should add two tenure-track faculty members as the FERP faculty departs: one in astronomy and the other in physics to bring the total to five plus the chair

We would very much like a new search for an Astronomer during 2008/9, in order to replace Dr. Tenn when he finishes his FERP, followed by another search for a physicist as remaining FERP faculty complete their service. See Section H.2.g for more discussion.

4) The Department should take advantage of the natural attraction of the Sonoma region to advertise its program nationally to attract more students

Pending availability of funding, this is something that we would like to pursue. We will revise our departmental brochure, which is now three years old. We will upgrade our website, if we can find someone to do the redesign work. We will look into working with

admissions to provide them new promotional materials about our department, in the hope that these materials will attract new majors.

5) The Department should consider adding more laboratory experiences starting in the junior year.

The Department used to have more junior level laboratory experiences, but these were all combined into Physics 366 in order to get enough enrollment to regularly offer this course. See discussion below in Section H.2.b Upper Division Labs for more of our plans in this area.

6) The Department should address the advising situation openly in order to determine if there should be one advisor for all majors, or if the task should be shared.

We have discussed the advising situation, and our consensus to retain released time for a single advisor is discussed further in Section H.2.f. below.

7) It is important for the campus to have an indirect policy that returns a portion to the PI, the unit and the college to support external grants activity

This important issue is being discussed in ongoing meetings with Academic Affairs and Administration and Finance. The results are not known at the time of this report.

8) The University should invest in the tenure-track faculty by providing release time to conduct research and submit proposals during the probationary years.

Although such released time is often requested, only support for the Galbreath Wildlands Preserve Observatory to Dr. Severson is currently being funded. Other junior faculty have received a total of one course buyout during their first semester at SSU.

H.2 Description of Proposed Program revisions

H.2.a. Teaching-learning methods

We are striving to introduce more small-group and interactive demonstrations into our lecture courses. This is not easy to do in large lectures, such as Astronomy 100 or Physics 210A and B, however. We are interested in obtaining a “clicker” system (such as TurningPoint) that could be installed in Darwin 103 for better interaction in this large lecture hall. However we do not see how to fund this at the present time.

We have adopted on-line homework tutorials from textbook publishers to augment the standard first-year physics sequence courses (both algebra-trig and calculus-based.) We have added support from the Tutoring Center in the role of “supplemental instruction” to help support our very large Astronomy 100 classes.

We discussed the possibility of trying again to team teach Physics 366 and/or 466 (Intermediate and Advanced Laboratory courses) so that the students are exposed to all the instrumentation in all three labs being developed by our experimental faculty. We will need to discuss these lab classes further as we develop more specific learning objectives.

H.2.b. Course content

Lower division labs: We recognize that there are great deficiencies in (at least) the calculus-based labs that have become more apparent since we got all the new equipment from the Darwin remodel. We would like to move to something between inquiry based and cookbook labs, which would also include the process of doing science. Most of the revised labs would concentrate on recognizing and using basic concepts that are better aligned to the lecture syllabi in P114 and P214. We would like to design at least one lab that would extend over a few weeks at the end of the course in which the students will be asked to design their own experiment to solve an experimental problem. A committee of faculty has been formed who will begin work this summer (2008) to figure out how to redo these lab courses, beginning with P116/216. This committee will also review the existing labs for P209A/B to see if they also need realignment and modernization.

Lower division lecture classes: These are standard sequences, and we are using standard textbooks. We will continue to utilize the on-line homework and tutorials for these classes, if the individual instructors continue to be enthusiastic.

Upper division labs: This spring Hongtao Shi will be teaching P366 and will try to do an overview of all the different major pieces of equipment that we have in the Keck Lab and Darwin. He will also ensure that P366 includes scientific process skills.

The new laboratories showcasing high magnetic fields (Qualls) and adaptive optics (Severson should be functional by Fall 2008. We will try to offer P466 to be team taught by Qualls and Severson to do an overview of these laboratories at that time. The long-term prognosis for P466 is unclear, however. Since students are not required to take it, most are choosing P495 (Special Studies) instead, for their upper division elective units, and to better prepare for the capstone experience. We would like P366 (which is a required course) to cover equipment in all three research labs when it is next taught in Spring 2009. Subsequent work by individual students with the experimental faculty would then continue through preliminary semesters of P495 and P497, leading up to the required capstone projects.

Upper division lectures: After considerable discussion, we do not see any way to fit these classes into the four-unit pattern proposed by the Administration. We discussed the possibility of changing P475 Semiconductors and/or P340 Optics from 3 units of lecture to 2 units of lecture and 1 unit of lab, which would be 4 WTUs and 3 SCUs. This would increase the number of hours spent on these classes without affecting the overall number of units in the major. It might also increase the workload of the faculty (an extra 2 hours per week for one additional WTU) and might improve the overall pedagogical objectives. However at this time, we have decided not to try these changes, but to continue to

evaluate these extra laboratory possibilities within the context of the changes to P366 and the possible elimination of P466. We will revisit this again after 2-4 years, when the new faculty have had more opportunities to teach P475 and P340.

There was no overall strong feeling in favor of increasing P450 (Statistical Physics) back to 3 units (as it was several years ago). It seems to be working out fine as it is currently taught. We have so few elective units in the BS program, we would rather reserve them for research-oriented activities. If we were going to raise the units and increase the content in any of our upper division theory courses, our first choice would be to consider raising P430 to 4 units, as we never seem to get past magnetostatics in this class, and the students do not get any radiation theory. However an analysis of how our students did on the practice GREs showed that they were the worst in Modern Physics and Relativity, in particular. We are not sure if this is due to a specific P314 class or a general trend, and so we will have to monitor this for a while to try to decide where the deficiencies may originate.

Capstones: We have decided that all students who are enrolled in capstone projects, as well as those who are in P495 (Special Studies) will be required to meet, as a group, with a team of all the research supervisors at least once per month. We have started this for the first time in Spring 2008. Students will be required to present their topics, preliminary work, etc. as the semester evolves, so that the final presentations will not be such a shock. This will also ensure that the students make progress throughout the semester, and don't wait until the last minute. With the expansion of our experimental facilities, we expect that there will be plenty of interesting student projects in the future. We also want to get copies of any extant writeups that focus on presentation skills so that we can share these with the students in this new group format.

GE Courses: We are happy with our current mix of GE courses and feel that we do a very good job of meeting the GE learning objectives, with the possible exception of the overwhelmingly large Astronomy 100 classes. We discussed having an environmental or more real world emphasis for P100, and then changing its title to sound more inviting so that we can use it to attract more potential students to the major.

Astronomy courses: We would like to ensure that A231 (Introductory Observational Astronomy) includes actual observations at telescopes. This may be done remotely, if weather does not cooperate. Since this course is taught each semester, and is a potential source of new majors, we need to encourage participation in a hands-on fashion by the students. We do not want to standardize our two or three sections of Astronomy 100, but we do want to ensure that some writing is being done in each section, as required for GE courses.

We do not see much of a future for A331 (Astronomical Imaging), a course which allows enrollment by non-science majors and is not a GE course. Since it is not required for anything, it has not generated enough enrollment to be offered frequently. We would therefore prefer to concentrate on A482 (Advanced Observational Astronomy), so that it could become the equivalent of P366 for our newly anticipated BS Applied with

concentration in Astrophysics (see Section i below.) This course (A482) will use the GLAST Optical Robotic Telescope (GORT, built by NASA), the SSU Observatory, other remote telescopes to which we have access, and of course the Galbreath Wildlands Preserve Observatory once it becomes operational

Service Learning: We have decided to encourage enrollment in P395 (Community Involvement Practicum) by allowing this course to count as elective units for the major. Students would meet with their advisors, at least monthly, and as part of the ongoing "Special studies and capstone" meetings (starting in Spring 2008) which are providing a venue to teach communication skills and presentation skills. We would also like to connect a service learning component to GWPO. We will do the paperwork for the P395 change next year as it is too late to affect the 2008-2010 catalog.

H.2.c. Learning objectives

We will work on ensuring that all of our GE courses in Areas B1 and B3 have specific learning goals and objectives. Currently these are missing for A231, A303, A305 and A350. We will also work on learning goals and objectives, derived from our skills matrix (see Section B5) for our upper division major courses and capstones.

H.2.d. Recruitment and Mentoring

Recruitment of additional physics majors is very important to the Department, and we are addressing this on many fronts.

"What Physicists Do" our popular physics colloquium series was started in 1971 partly as a recruitment tool. Many of the talks through the years have provided partial answers to the question, "What Can You Do with a BS in Physics?" which is now also the title of a web page proclaiming the achievements of our graduates. Recently, we also added web pages that are geared for prospective students to our site.

Expanding Your Horizons is a long-running program within Sonoma county that targets 7th and 8th grade girls to encourage interest in STEM (Science, Technology, Engineering and Mathematics) careers. The NASA E/PO group has participated in and supported this event for the past ~6 years, and advertises the Department at these events. The NASA group also has participated for several years in the science fair sponsored by the Sonoma County Office of Education (SCOE), both as judges and in doing activities with the student entrants.

Faculty in the Department are participating in the new SCOE-initiated program to provide talented high school students as interns to help do research during the summer. All three junior faculty submitted descriptions of their research, as well as the NASA group, which may be able to fund a student in addition to those funded by SCOE.

The NASA group is helping to fund and setup a MESA (Math, Engineering Science Achievement) program at SSU. There are several MESA school chapters (K-12), as well as several MESA Community College programs locally (SRJC, Mendocino JC, Napa JC), but no four-year University MESA program (which are called MESA Engineering Programs or MEP) in the local area. Cominsky and other SSU faculty recently went to Windsor High School to their MESA meeting, and did a recruiting presentation. NASA is paying a lecturer from the School of Ed (Dr. Ellie Galvez-Hard) to take the lead in organizing MESA recruiting efforts through the local chapters at other schools and community colleges. We are now in the process of negotiating an MOU with state-wide MESA to get a program started at SSU. Reaching MESA students, who are self-selected for interest in science and engineering is probably more likely to produce new majors than just going to high schools and talking to the entire populations of students. It turns out that the highest number of students that came to SSU from a single high school last year is 17. Since less than 1% of all entering students are physics majors, going around to individual high schools does not seem to add up. So we will try to target students that are already interested in STEM fields as potential physics majors.

Another recruiting program that is ongoing by the NASA group is the weekly after-school science and technology club at Roseland University Prep, a charter public high school in (predominantly Hispanic) southwest Santa Rosa. NASA E/PO has been working with these students since the founding of the school in 2004, and this year the

first class will be graduating. President Arminaña has pledged that any CSU-eligible students will be admitted to SSU, and to date that includes 42 of the 65 seniors. Last summer NASA organized and sponsored a 3-day RUP "Summer Experience" which included mini-college courses, a night at the SSUO, and advising sessions on financial aid and college applications. It was a great success, so we are doing it again in June for the next class of rising seniors. We will be following the progress of these students as they enter college and hope that we can find some potential physics majors in this group.

The Department is also planning on reinvigorating the Physics 395 Community Involvement Practicum course so that we can send the enrollees out into the community to tutor and work with STEM pipeline students. We have had requests from Boys and Girls Clubs as well as MESA programs for these types of tutors. Our majors will be more effective at recruiting than we will, as they will connect better to the STEM pipeline students. Our Society of Physics students are actively tutoring other SSU students at the present time, and have expressed a willingness to extend these efforts to the larger community.
The proposed new BS in Applied Physics with concentration in Astrophysics and the GWPO project are also important to our recruiting efforts. Having a moderate-sized new telescope, and a new way to describe an existing degree program should provide additional marketing and public relations value that can aid our recruitment.

Mentoring: We are increasing the mentoring done through our capstone process as discussed above. Moving to a mentoring model involving 2-unit capstone projects from a course-based model for upper division students was already a significant change in our curriculum - one that reassigned 1/3 of the elective units from the BS degrees to mentoring experiences. In addition, the students take one or more semesters of Special Studies (P495) or Undergraduate Research (P497) leading up to the capstone, which provides for additional mentoring opportunities.

We also work closely with the Society of Physics Students (SPS) club to provide additional mentoring opportunities. For example, the SPS is providing volunteer tutoring for first-year physics students twice per week. Peer mentoring has been shown to be very effective, and we are seeing good results from this effort to date.

One area that we have identified as needing additional mentoring effort is the perceived disconnect between the first year physics sequence for majors and the upper division courses. We want to do more to encourage the majors to take What Physicists Do for credit, or at least to attend regularly, in order to better connect them into the Department and to increase their understanding of physics career paths. We get approximately half of our students into the major as transfers from the community college system, and having special department-wide social events would help ease this transition for these students.

H.2.e. Assessment

We are happy with using the capstone projects as our main summative assessment tool, focusing on presentation skills and offering our students a choice between instructional

design, research or engineering design. However we feel the need for more formalized feedback about their physics content knowledge. We have looked into the Force Concept Inventory, but this is traditionally given after the first year sequence, and many of our majors do not take this class with us, as they transfer into SSU as juniors from the Junior College System.

We therefore would like to investigate the possibility of having our majors take the Major Field Test, as offered by the Educational Testing Service, and would implement this as part of the capstone experience. It would not count as part of their grade, and we would have to find a way to pay for the tests, but we feel that we would learn important information about physics content knowledge from the theory classes. See http://www.ets.org/ for more information.

H.2.f. Advising and mentoring in the major

We will continue to request 2 advising units from the Dean to support uniform and mandatory advising for all of our majors. This has not been funded for the past two years, however, and may be difficult to achieve given the present budget situation. For Spring 2008, Scott Severson has taken over being advisor, receiving 2 units of released time from the pool allocated for the program review. It is a very high priority within the Department to maintain our long-standing tradition of a single advisor, who is not the Chair, and who is supported by released time.

H.2.g. Tenure track faculty hiring plans

We have an urgent need to search for another astronomer, during the upcoming academic year (2008/2009), during which time Joe Tenn will be finishing his FERP. Beginning in Fall 2009, we will have only 1.5 astronomers as permanent teaching faculty, one of whom (Severson) is likely to continue to receive released time to develop the Galbreath Wildlands Preserve Observatory (GWPO), further depleting the ranks of instructors who are qualified to teach both lower and upper division astronomy courses. We are particularly interested in getting an expert in galaxies and cosmology who uses remote facilities, on ground or in space. We would then like to search for a computational person during the last year of Gordon Spear's FERP (2010/2011). (This was the focus of our cancelled search in 2002.) The position that will be vacated when Bryant Hichwa finishes his 0.25 FTE FERP (nominally in 2011/2012) has already been filled by Jeremy Qualls. If the campus continues to grow, we will argue for another search at that time.

H.2.h. New and replacement equipment

The following is a list of high-priority major research instrumentation that we will work towards acquiring through grants (such as the NSF MRI program) and/or donations:

- Ultrahigh vacuum deposition system from Kurt J. Lesker, ~$350,000, plus in-situ technique Reflection High Energy Electron Diffraction (RHEED) from k-Space Associates, ~$55,000, and RHEED guns from Staib Instruments, ~$45,000. Total

cost ~$450,000. This is the subject of NSF MRI proposal that is being resubmitted by Hongtao Shi.

- X-ray diffractometer for thin film samples. Possible vendor and model: Rigaku SmartLab, 9 kW rotating anode, high resolution, ~ $290,000.
- E-beam lithography to be attached to scanning electron microscope for making nanometer scaled patterns on different substrates. Possible vendor and model: JCNabity, NPGS system, $45,000, plus e-beam blanker ~$4,000, spin processor ~$6,000. Total cost ~$55,000.
- Cryostat for low temperature experiments: Janis Model SVT-400, liquid helium or liquid nitrogen. Suitable for optical experiments (UV, visible, or IR) and other magneto-optical and electro-optical experiments. ~$20K
- Helium 3 exchange gas system: to expand temperature range of current low temperature cryostat to 0.4 Kelvin. Janis is a vendor. ~$15k.
- Liquid Nitrogen Plant. Generates liquid nitrogen Cryomech sells a number of models ~$40k.

We received about $225K for new equipment when we moved back into the newly remodeled Darwin Hall in the Fall of 2006. However, there has been no replacement equipment money for many years, and we need to plan for upgrades and maintenance to our new lower division labs:

- We have relatively new function generators, oscilloscopes, computers and PASCO interfaces. In the next 3-5 years, we may need to upgrade some of the function generators to higher frequency range so we can offer high frequency based labs.

- The lower division labs need to purchase more hardware if the lab procedures become inquiry-based so students can choose among these devices to design and implement their experiments after a few introductory sessions.

- Revising the lower division to better reflect the course lecture content will require some additional equipment to cover rotation (at least.)

H.2.i. Changes to degree programs

BA-T degree: The BA-T degree provides adequate preparation for the multiple subject credential for future middle school and elementary teachers. Students in this degree program develop critical thinking and problem solving skills which will serve them well. This is also a good plan as part of a double major. We had hoped a few years ago that the Business majors would be interested in pursuing this option. However, this does not seem to have happened, as the business degree now has so many units that they do not produce many double majors. We would like to explore the potential of partnering with the Department of Environmental Studies and Planning to encourage some of their students – perhaps those in the energy management track – to add a physics double major. These students would learn skills such as electronics and materials characterization that would be valuable for future jobs in the emerging alternative energy markets. This combined degree would be more *environmental science* than *environmental studies* and would give us a large pool from which to draw new students. We have noticed huge attendance at our

environmentally-oriented What Physicists Do talks, so there is clearly a need for more teaching and learning in these types of subjects. If this became a popular option, we could then modify courses such as Physics 342 Light and Color to be more environmentally oriented.

BS in Applied Physics with concentration in Astrophysics: This proposed new concentration will allow us to build up additional Astronomy courses and additional enrollment in our existing courses to support the use of GORT and GWPO. Adaptive Optics and other cross-disciplinary aspects of astronomy will be highlighted in this option. This new concentration will allow us to leverage our strong existing astronomy course offerings and new cutting-edge facilities to provide a degree that will both attract and properly train students drawn to the physical sciences through astronomy. We may be able to revive the Astronomy 200 course (Introductory Astronomy with algebra and trigonometry) and the Astrophysics: Galaxies and the Universe (A390) course. There is only one CSU with a Bachelor's degree in Astronomy (SDSU), and we do not intend to propose such a degree, as it would probably not be approved by the Chancellor's office. However, strengthening the astronomy content within an existing physics BS degree would allow us to achieve many of the same objectives. Our goal is to get this new degree option into the 2010-2012 catalog.

May 10, 2008

Elaine A. Sundberg
Associate Vice Provost
Academic Programs and Graduate Studies
Sonoma State University
1801 East Cotati Avenue
Rohnert Park, CA 94928-3609

RE: Physics and Astronomy Department External Reviewer Report

Details of the campus visit

The review visit was conducted Friday, April 18, 2008.
The visit started at 9:00 AM and concluded at 8:30 PM.
Met all the tenured and tenure-track department faculty members: Lynn Comminsky (Chair), Brijant Hichwa (FERP), Jeremy Qualls, Scott Severson, Hongtao Shi, Gordon Spear (FERP), and Joe Tenn (FERP).
Met Dean Saeid Rahimi.
Met Vice Provost Carol Blackshire-Belay.
Met Administrative Assistant: Cathi Cari-Shudde.
Met Technical Staff: Steve Anderson.
Met with four students during lunch.
Visited the teaching labs, the research facilities, and the auxiliary NASA supported educational center.

Introduction

The guidelines for external reviewers recommend that the following points be considered in the review. My comments in italics follow each of these points. I conclude my review with a summary statement.

1. The department's curricular mission. Is it philosophically coherent? Is it appropriate for a comprehensive undergraduate institution that aspires to provide a strong liberal arts education for all undergraduates and to provide selected graduate programs in response to the professional development needs of the region? Does it uphold the SSU Mission Statement and Diversity Vision Statement in its dedication to perspectives of diversity?

The discipline of physics is essential in a comprehensive undergraduate university. The discipline of astronomy is an excellent companion to support a strong liberal arts education. The department aspires to provide access to all students requiring these two disciplines. It accomplishes it by providing several degree options to accommodate student interest and/or preparation. The program review is comprehensive and well prepared. It clearly demonstrates an interest in servicing the students of Sonoma State with a quality program.

2. The curriculum itself. Is it current? Does it have clearly stated goals that are consistent with the department's mission? Is it well focused? Does it reflect an appreciation of the richness of differences among us? What are its greatest strengths? Its weaknesses? Is the faculty appropriately prepared to deliver it?

Three faculty members are in the FERP program. These faculty members provided leadership to the department for many years and continue to provide excellent service. In fact, the three most recent hires speak highly of their wisdom in preparing the department to transition to a new era. The three faculty members most recently hired have impressive backgrounds and together establish a strong foundation for success. The department chair has distinguished career accomplishments in astrophysics. The department is focusing in two areas of research: applied solid state and astronomy. Both of these disciplines are of current interest and opportunities for external support are good. The three faculty members in tenure-track are experimentalists and should provide ample opportunities to engage students in research. The facilities are appropriate for the work they anticipate carrying out but it is unclear if there are sufficient resources to maintain them without significant external funding. There is only one technical staff person whose primary responsibility is to the teaching labs. Though he is dedicated and interested in assisting the faculty in their research, there is not sufficient time to do so. Thus, it is important that the faculty develop a curriculum strategy that engages students early on so that as they become trained they are also able to help beginning majors. A department needs a minimum core of five tenure-track faculty members. The department chair has substantial external support that is expected to continue in future years and is able to be released from teaching. Dr. Comminsky's involvement with NASA educational programs is impressive and an asset to the university. She is a good role model for the tenure-track faculty demonstrating what excellence is possible to accomplish within the CSU environment. The NASA program provides some opportunities for involving students in research through the NASA-funded GLAST Optical Robotic Telescope (GORT). Students majoring in the program can partner with NASA researches in the satellite missions. She is also a capable and caring department chair and her service is essential to the unit. However, in a very short time, as the FERP faculty members end their appointments, she will be the only senior faculty member. Since she has extensive responsibilities in NASA-funded projects, I recommend that she engage the junior faculty members in the governance of the department for continuity. It is also my recommendation that the department add two tenure-track faculty members as the FERP faculty departs: one in astronomy and the other in physics to bring the total to five plus the chair.

3. Program effectiveness. How effective does the department seem to be in preparing its students (both majors and GE students) as it wishes? Does the department have an assessment strategy adequate to reveal what is working very well and what is not? Is there evidence that the department has used assessment findings to guide program change?

The department graduates about ten students per year and this is outstanding for a physics program. Most institutions across the nation graduate 2-3 students per year and

for comparison, the top R-1 universities in the nation graduate about 50 physics majors per year. The students that I met were very satisfied with the program and would recommend others to attend Sonoma State. However, they mentioned that more hands-on experiences would be beneficial and they would like it. The department, Joe Tenn in particular, has maintained very detailed records of the alumni and it appears that its graduates have been successful over the years. The need to seek additional majors always exists. About half of the students majoring in the department are from the region's high schools and transfers from local community colleges. The Sonoma region has a natural attraction and I recommend that the department take advantage of it and advertise its programs nationally to attract more students. The program review describes an assessment program and compares itself with comparable institutions. A change the department has incorporated is a capstone course since 2005. The majority of these are experimental in nature. I would recommend that the department consider adding more laboratory experiences starting in the junior year. Hands-on experience is one of the most requested attributes of college graduates that technology related employers request. The department had a faculty member that provided advisement for many years. As the department is in transition, it is unsure of what method to use in the future: a single faculty member provides advisement with some release time or everyone shares in this task. Both methods can be effective and I recommend the department address this important function openly. Whatever methodology is adapted, advisement should be thorough, accurate and consistent and the unit should recognize this contribution and allocate resources.

4. Resource use. Are existing program resources being used to the greatest effect?

The department offers astronomy, a popular course that generates significant FTES to the department. However, it is my understanding that budgets are not necessarily FTES based and that significant variations exist from year to year. It is difficult for a unit to plan for the future if there is no clear mechanism for funding. The CSU in general has not been able to provide sufficient O&E support in recent years and Sonoma State is no exception. Yet, somehow, the department has been able to add equipment and facilities though there is no understanding how the funds are allocated. As the faculty engage in seeking external support, it would be important for the campus to have an indirect policy that returns a portion to the PI, the unit and the college to support the activity. The success of the program depends partly on the ability of the faculty to succeed in securing external support. I recommend that the university invest in the tenure-track faculty by providing release time to conduct research and submit proposals during the probationary years.

Summary

The department faculty members are dedicated to the mission of the university and the CSU. They have an impressive combined experience that of itself is a tremendous asset for the unit and the university. They interact collegially and appear supporting of each other. The department has a vision that will help it maintain the good track record it has since inception. The staff is integrated to the unit and is satisfied with their role. The

allocated space is adequate though other resources are scarce. The Sonoma State campus offers a pleasant setting and the department is an integral part of the college where it resides. The administration respects the accomplishments of the unit and in general appears supportive. Sonoma State is fortunate to have such a stable physics program and congratulations are extended.

Respectfully submitted by

Julio R. Blanco
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Appendix E - What Physicists Do

A combination undergraduate colloquium and public lecture series called "What Physicists Do" has brought speakers to the campus each week since the spring of 1971. The more than 1000 speakers have included fourteen recipients of the Nobel Prize, two of the Crafoord Prize, ten recipients of the National Medal of Science, eight MacArthur Fellows, eight Bruce Medalists, and a great many other nationally and internationally renowned scientists and engineers. The audience is made up of many components: the department's students and faculty; visitors from the community: retirees, high school and community college teachers and students; undergraduates from our General Education courses and others. Talks on energy and environmental issues or astronomy attract local enthusiasts for these fields. Current students meet and talk with the speakers, and faculty are helped to keep current in their fields by conversations before the talks and over dinners. More information about the series, and a complete list of past speakers, may be found at http://phys-astro.sonoma.edu/wpd/.

ADVANCED LIGO AND THE SEARCH FOR GRAVITATIONAL WAVES
Dr. Norna Robertson (Caltech and the University of Glasgow) reviewed the search for gravitational waves, and in particular discussed the Advanced LIGO detectors which are expected to carry out their first observational run during 2015.

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WHAT PHYSICISTS DO

"Not only is the Universe stranger than we think, it is stranger than we can think." - Werner Heisenberg

EIGHTY-NINTH SERIES
Spring 2015

Current Series in PDF History of the Series

Mondays at 4:00 p.m. **Darwin 103** **Coffee at 3:30 p.m.**

Feb 2	THE MARTIAN New York Times Bestselling Author Andy Weir will be joining us via Skype to discuss his debut novel and soon to be major motion picture, "The Martian." The son of a particle physicist, Mr. Weir is a software engineer and a self-confessed "space nerd." Mr. Weir has combined science and a survival story into a compelling work of fiction.
Feb 9	COSMOS - "THE ELECTRIC BOY" A viewing of an episode of the documentary series Cosmos: A Spacetime Odyssey. Explores the connection between 19th century physicist Michael Faraday and our modern world of high technology and instantaneous electronic communication.
Feb 16	CUBESATS FOR EARTH IMAGING Planet Labs co-founder and CTO Chris Boshuizen will discuss their plans to deploy an Earth-imaging satellite network via CubeSats.
Feb 23	BRINGING STAR POWER TO EARTH Dr. Jim Gaffney of LLNL discusses the world's largest and most energetic laser system, the National Ignition Facility (NIF). NIFs goal of driving thermonuclear fusion between isotopes of hydrogen could pave the way for nearly limitless, clean nuclear energy
Mar 09	THE UC DAVIS D-LAB: INTERDISCIPLINARY PROJECT-BASED LEARNING Dr. Kurt Kornbluth discuss examples of critical thinking, design, and innovation from the UC Davis D-Lab. He will highlight projects in developed and developing countries focused on Sustainable Energy and Agriculture, promoting Human Animal, and Environmental Health.
Mar 23	STRANGENESS, CHARM AND BEAUTY IN PARTICLE PHYSICS Dr. Vera Lüth of Stanford University will reflect on her career in particle physics, discussing Charge-Parity Violation, detector innovations and B decays.
Mar 30	THE CHANGING ROLE OF BIOMEDICAL PHYSICS IN MEDICINE Dr. Amir Huda of CSU-Fresno will present an overview of how the concepts and methods of physics are used to diagnose, manage, and treat human diseases.
Apr 06	ADVANCED LIGO AND THE SEARCH FOR GRAVITATIONAL WAVES Dr. Norna Robertson (Caltech and the University of Glasgow) will review the search for gravitational waves, and in particular discuss the Advanced LIGO detectors which are expected to carry out their first observational run during 2015.
Apr 13	MAKING FUELS FROM SUNLIGHT, WATER AND AIR Dr. Frances A. Houle, from Lawrence Berkeley National Laboratory, will discuss her work on Artificial Photosynthesis.
Apr 20	THE FUTURE OF ENERGY Dr. Frank Shu of UC San Diego is a preeminent Astrophysicist who has turned his attention to alternative energies in an effort to make an impact on climate change.
Apr 27	LIGHT FROM DISTANT SUPERNOVAE Dr. Xiaosheng Huang of the University of San Francisco will talk about Type Ia supernovae, the most powerful of all astronomical standard candles used to measure distances of far away galaxies.

SONOMA STATE UNIVERSITY

This series is supported by private donations and Instructionally Related Activities funds.

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Appendix F – Education and Public Outreach Group Contributions to the Physics and Astronomy Department

Prof. Cominsky founded this group in 1999 and is the Project Director, Principal Investigator on all grants and final technical reviewer for all products. The mission of the SSU E/PO group is to develop exciting formal and informal educational materials that use high-energy space science as a means to inspire students in grades 5-14 to pursue STEM careers, to train teachers nationwide in the classroom use of these materials, and to enhance science literacy for the general public.

The SSU E/PO group currently consists of Dr. Kevin McLin (Global Telescope network Director), Dr. Carolyn Peruta (Education Support Scientist), Kevin John (SSU grad, Education Technology Specialist), Aurore Simonnet (Scientific Illustrator), David McCall (Systems Administrator), Laura Chase (Project Support Coordinator), Hunter Mills (Research Assistant), Ben Cunningham (Research Assistant), and several SSU undergraduate students and special consultants.

Since 1999, the group has received over $12 million in NASA grants to support several different space science missions, including XMM-Newton (launched in 1999), Swift (launched in 2004), the Fermi Gamma-ray Space Telescope (formerly known as GLAST and launched in 2008) and the Nuclear Spectroscopic Telescope Array (NuSTAR, launched in 2012). We have also received funding from NASA EPOESS for the development of an online course in Cosmology for general education college students, and the development of formal curriculum for secondary students to build small satellite payloads for launch on high-powered rockets or tethered weather balloons. Cominsky is a scientific co-investigator on Swift, Fermi, and NuSTAR. She also acts as press officer for both Swift and Fermi. Most recently, Cominsky is the STEM Director for "Learning by Making: STEM Success for Mendocino County" funded by the US Department of Education's Investing in Innovation program (for $3 million for 5 years).

The SSU E/PO group is located on the third floor of the Schulz library in rooms 3048-3059. We have also built and operate a robotic telescope facility at the Pepperwood Preserve, about 30 minutes north of campus at a higher, darker site. A number of SSU students and high school summer interns have done research using the GLAST Optical Robotic Telescope (GORT) since it saw first light in 2004.

The following table lists the SSU students, staff, and faculty who have been employed by the SSU E/PO group since the last departmental Program Review in 2008. Unless otherwise noted, the SSU students graduated with degrees in Physics.

Name	Years Employed	Final Position at SSU E/PO	Year Graduated from SSU
Lynn Cominsky	7/00 - present	Program Director, Professor	NA
Aurore Simonnet	7/02 - present	Scientific Illustrator	NA
Logan Hill	8/02 - 9/13	Education Specialist	2006
Kamal Prasad	12/03 -9/12	Education Specialist	NA

Kevin McLin	5/04 - present	GTN Director	NA
Laura Chase	2/05 - present	Project Support Coordinator	NA
Kevin John	3/06 - present	Education Tech Specialist	2007
Carolyn Peruta	5/13 - present	Education Support Scientist	NA
Hunter Mills	2/12 - present	Research Assistant	2014
Benjamin Cunningham	8/13 - present	Research Assistant	2014
David McCall	?	Systems Administrator	NA
Patrick Brown	11/05 - 12/08	Student Assistant	2008
Eric Lundy	9/08 - 5/09	Student Assistant	2009
Katherine Wyman	9/08 - 5/10	Student Assistant	2009
Blaine Gilbreth	9/09 - 8/11	Student Assistant	2010
Timothy Hessong	9/09 - 5/10	Student Assistant	2009
Kathleen Morrison	5/10 - 7/11	Student Assistant	2011
Bryce Terrell	9/10 - 5/11	Student Assistant	2012
Gloria Ramirez Ceniceros	6/11 - 8/11	Student Assistant	2014 (Biology)
Jarod Fahle	9/11 - 5/12	Student Assistant	2012
Diamante Rueda Ortiz	9/11 - 5/12	Student Office Assistant	2012 (Business)
Anna Maria Wojtowicz	5/12 - 5/13	Student Assistant	2013
Brandon Baker	8/12 - 5/13	Student Assistant	2013
Maxwell Maurer	8/12 - 5/13	Student Assistant	current
Katherine Badham	9/12 - 8/13	Student Assistant	2013
Mallory Rice	5/13 - 8/13	Student Assistant	2014 (Biology)
Eric Waugh	5/13 - 8/13	Student Assistant	2014 (EE)
Lauryn Loudermilk	8/13 - 5/14	Student Assistant	2014 (CS)
Kevin Zack	8/19 - 8/17	Student Assistant	2014
Alyssa Afa'ese	5/14 - present	Student Assistant	Exp. 5/2015 (EE)
Anna McCowan	5/14 - 8/14	Student Assistant	current
Max Torke	5/14 - present	Student Assistant	Exp. 5/2015
Wesley Watson	5/14 - 8/14	Student Assistant	current
Amandeep Gill	8/14 - present	Student Assistant	Exp. 5/2015
Aaron Owen	8/14 - present	Student Assistant	current
Juanita Tenorio Ruiz	8/14 - present	Student Office Assistant	2014 (Women & Gender Studies/ Sociology)
Demitri Call	12/14 - present	Student Assistant	current

The following is a bibliography of citable presentations with contributions from SSU students or physics graduates through their work in the SSU E/PO group since 2008:

"A Multi-Institutional Investigation of Students' Preinstructional Ideas About Cosmology" Janelle M. Bailey, Roxanne Sanchez , Kim Coble, Donna Larrieu, Geraldine

Cochran & Lynn R. Cominsky, Astronomy Education Review, 2012, AER, 11 (1), 010302, doi: http://dx.doi.org/10.3847/AER2012029

"Investigating Student Ideas about Cosmology I: Distances, Structure, and Composition of the Universe" Kim Coble, Carmen T. Camarillo, Melissa D. Nickerson, Laura E. Trouille, Janelle M. Bailey, Geraldine L. Cochran, & Lynn R. Cominsky, Astronomy Education Review, 2013, AER, 12 (1), 010102, doi:http://dx.doi.org/10.3847/AER2012038

"Investigating Student Ideas about Cosmology II: Composition of the Universe" Kim Coble, Melissa D. Nickerson, Carmen T. Camarillo, Janelle M. Bailey, Laura E. Trouille, Geraldine L. Cochran, & Lynn R. Cominsky, Astronomy Education Review 2013, AER, 12 (1), 010111, doi:http://dx.doi.org/10.3847/AER2012039

"Investigating Student Ideas about Cosmology III: Big Bang Theory, Expansion, Age and History of the Universe" Laura E. Trouille, Kim Coble, Carmen T. Camarillo, Melissa D. Nickerson, Geraldine L. Cochran, Janelle M. Bailey, & Lynn R. Cominsky, Astronomy Education Review 2013, AER, 12 (1), 010110, doi:http://dx.doi.org/10.3847/AER2013016

"High School Observations of AGN Using the GTN," Kevin M. McLin, R. Jordon, A. Perkins, J. Adkins & L. Cominsky, *Bulletin of the American Astronomical Society,* 2008HEAD...10.2631M

"The Global Telescope Network," K. McLin, G. Spear & L. Cominsky, in *EPO and a Changing World: Creating Linkages and Expanding Partnerships ASP Conference Series, Vol. 389,* proceedings of the conference held 5-7 September 2007, in Chicago, Illinois, USA. Edited by Catharine Garmany, Michael G. Gibbs, and J. Ward Moody. San Francisco: Astronomical Society of the Pacific, 2080., p.89, 2008ASPC..389...89M

"A Proposed Student Built and Operated Satellite: The Gamma Ray Burst Polarization Observer (PolOSat)," B. Malphrus et al. including L. Cominsky and 12 other co-authors, *Bulletin of the American Astronomical Society,* 2009AAS...21347603M

"Epo's Chronicles: A Weekly Webcomic That Teaches Space Science," L. Cominsky, K. Prasad, A. Simonnet, K. John, K. McLin & L. Hill, *Bulletin of the American Astronomical Society,* 2009AAS...21346407C

"Transforming Introductory Astronomy in the Urban University," Kimberly A. Coble, M. Sabella, D. Larrieu, J. McDowell, R. Orlanzino, L. Cominsky & K. McLin, *Bulletin of the American Astronomical Society,* 2009AAS...21346206C

"Undergraduate Research Experiences with the Global Telescope Network," K. McLin, K. Wyman, N. Broughton, K. Coble, & L.R. Cominsky, *Bulletin of the American Astronomical Society,* 2009AAS...21346102M

"Photometry Of The Semi-regular Variable Tx Tau" Katherine Wyman, G. Spear, K. McLin, L. Cominsky, L. Mankiewicz, D. Reichart & K. Ivarsen, *Bulletin of the American Astronomical Society,* 2009AAS...21360205W

"Probing Student Understanding of Cosmology," Kimberly A. Coble, G. Cochran, D. Larrieu, J. Bailey, R. Sanchez, L. Cominsky, & K. McLin, *Bulletin of the American Astronomical Society,* 2010AAS...21546614C

"The NuSTAR Education and Public Outreach Program" L. Cominsky, K. McLin and the NuSTAR team, *Bulletin of the American Astronomical Society,* 2010AAS...21546506C

"The NuSTAR Education and Public Outreach Program" L. Cominsky, K. McLin and the NuSTAR team, *Bulletin of the American Astronomical Society,* 2010AAS...HEAD

"Using the Big Ideas in Cosmology to Teach College Students" K. Coble, J. Bailey, G. Cochran, V. Hayes, D. Larrieu, R. Sanchez, K. McLin and L. Cominsky, *Bulletin of the American Astronomical Society,* 2010AAS...21641605C.

"Using Telescopic Observations to Explore the Science of AGN with High School Students" K. M. McLin & L.R. Cominsky, American Geophysical Union Fall Meeting, 2010AGUFMED53A0528M.

"Investigating Student Understanding of the Universe: Perceptions of Astronomical Sizes and Distances" C. Camarillo, K. Coble, V. Hayes, M. Nickerson, G.L. Cochran, J. M. Bailey, K. M. McLin & L. R. Cominsky, *Bulletin of the American Astronomical Society,* 2011AAS...21833305C.

"Investigating Student Understanding of the Universe: Structure" V. Hayes, K. Coble, M. Nickerson, G. Cochran, C.T. Camarillo, J. M. Bailey, K. M. McLin, & L. R. Cominsky, *Bulletin of the American Astronomical Society,* 2011AAS...21833304H.

"Investigating Student Understanding of the Universe: Age and Expansion" K. Coble, G. Cochran, V. Hayes, M. Nickerson, C. Camarillo, J. M. Bailey, K. M. McLin & L. R. Cominsky, *Bulletin of the American Astronomical Society,* 2011AAS...21833303C.

"Investigating Student Understanding of the Universe: Dark Matter" M. Nickerson, K. Coble, G. Cochran, V. Hayes, C. Camarillo, J. M. Bailey, K. M. McLin, & L. R. Cominsky, *Bulletin of the American Astronomical Society,* 2011AAS...21833302N.

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"Investigating student understanding of the universe: Age and expansion" Cochran, G. L., Coble, K., Hayes, V. L., Nickerson, M., Bailey, J. M., McLin, K. M., & Cominsky, L. R. Poster at the 2011 Winter Meeting of the American Association of Physics Teachers, Jacksonville, FL, 10 January 2011.

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Appendix G – S3: STEPping Up STEM / Science 120

http://www.sonoma.edu/s3/
http://www.sonoma.edu/s3/curriculum.html
http://www.sonoma.edu/aa/flc/nonresidential/science.html

S3: **S**TEPping up **S**TEM at **S**SU is a NSF funded (Grant #:1068445) proposal from Sonoma State University (SSU) with a four year budget of $994,826. SSU has effectively combined many high impact strategies to demonstrate gains in both attracting and retaining undergraduate STEM majors. S3 was designed and implemented at SSU by faculty across the School of Science and Technology as well as cross discipline pedagogy experts. It is a robust program with many facets and safe guards including both internal and external review boards and external evaluator WestEd. The S3 program has a three prong approach.

The first element, and consequently bulk of the effort is a STEM First Year Experience investigating the regional watershed. This interdisciplinary class, called *SCI 120: A Watershed Year*, combines biology, math modeling, and critical thinking to address issues surrounding the Russian River watershed while facilitating strong personal connections with SSU. Innovative pedagogies and high-impact practices have allowed the program to show measurable success in only three years' time. Most notably, based on a matched cohort model with propensity score analysis and tracking the first year's cohort shows that students are roughly three times as likely to have a declared STEM major as are students in a comparable control group. The program targets prospective and entry STEM majors to enhance their engagement into scientific inquiry. The course consists of 12-units that meet general education requirements in critical thinking, life science, mathematics, and science laboratory. Class sizes is smaller than existing courses and courses are developed and taught by experienced tenure-track faculty members who have worked extensively on course development for first-year students in STEM fields. The program incorporates peer mentors to create supportive learning communities, smoothing the students' transition into the academic environment. Laboratory and field exercises introduce students to current advances in science and technology in STEM fields.

Table 1. Matched Cohort comparison done by WestEd.

	Treatment students	Matched comparison	All non-treatment first-time freshmen
Total N	48	96	1697
% Female	31% (n = 15)	34% (n = 33)	63%* (n = 1075)
% Underrepresented ethnicity	13% (n = 6)	16% (n = 15)	27%* (n = 461)
Mean SAT composite score	1088 (SD = 74)	1094 (SD = 139)	1009 (SD = 139)˜
Mean ACT/SAT math percentile score	64 (SD = 14)	64 (SD = 20)	50 (SD = 21)˜
Mean ACT/SAT reading percentile score	63 (SD = 15)	64 (SD = 21)	52 (SD = 22)˜
Mean high school GPA	3.2 (SD = 0.4)	3.2 (SD = 0.4)	3.2 (SD = 0.4)
% Declared STEM majors in Fall 2012	48% (n = 23)	41% (n = 39)	21%* (n = 354)
% Declared Non-STEM majors in Fall 2012	4% (n = 2)	1% (n = 1)	48%* (n = 815)

* indicates significant difference from treatment group as measured by a chi-square test
˜ indicates significant difference from treatment group as measured by an independent-samples t-test

The second element of S3 is to offer supplemental instruction to enhance the success of existing STEM majors in introductory STEM courses. Academic workshops and supplemental support was established for challenging gateway courses in Chemistry, Engineering Science, and Physics (PHYS 144). The grant also provided additional research opportunities for female and under-represented minority (URM) students in the physical science and technical fields in the form of summer and yearlong support. So far physics majors Justin Hoijer and James Garner have been supported by this program.

The third element expands the MESA (Mathematics, Engineering, Science Achievement) model by providing additional academic and career advising, tutoring, and undergraduate research opportunities for students, in order to help retain them in STEM. These practices can be readily incorporated into campuses especially in cohort building and STEM freshman courses. Funds from the grant supports Physicist Carolyn Peruta in the role of Science Advisor.

This synergistic three-pronged approach builds on best practices in science pedagogy and student support and is aligned with initiatives at the California State University (CSU) system level and at SSU to increase graduation rates across all disciplines. WestEd results have shown

For our project, STEM is defined as majors in biochemistry, biology, chemistry, computer science, earth science, electrical engineering, environmental studies, geology, mathematics, physics, and statistics.

All S^3: STEPping Up STEM participants (*as of January 31, 2014):

	STEM-FYE	Supplemental Instruction	Expanded Support	Total Unique	%Male	%Female
Yr1:2011-12	0	0	27	27	-	-
Yr2:2012-13	48	46	62	105	55	45
Yr3:2013-14*	51	55	92	193	51	49
Total	99	101	181	325	52	48

Declared majors of all project participants in Years 2 and 3:

	Biology	Biochem Chem	CS	Eng	EarthSc Geol	Env Stds	Math Stats	Physics	Other	Undcld	Total
Yr2:2012-13	14	11	8	6	6	5	8	5	13	29	105
Yr3:2013-14*	24	6	23	27	4	5	20	10	37	37	193

At the end of Year 3, the project is on track to meet objectives outlined in the original proposal.

Development of an Interdisciplinary STEM First Year Experience Program (FYE)
The STEM-FYE was successfully developed in Year 1, piloted in Year 2, in Year 3 and Year 4 the course continues to be offered as regular course. An interdisciplinary team along with on-campus and off-campus partners continues to fine-tune the program. The 12-unit course satisfies general education requirements in critical thinking, life science, mathematics, and the science lab requirement. The instructional team has included faculty from biology, mathematics, physics, computer science, and philosophy, with additional lab content experts in chemistry, geology, and engineering and is led by Dr. Qualls from the physics department.

Effective pedagogies and high-impact practices throughout the STEM-FYE distinguish this course. STEM-FYE students were enrolled in linked courses with environmental sustainability themes. Field experiences included a day-long field trip showcasing the Sonoma County watershed and introducing student to the community partners with whom they will later collaborate.

The fall semester is taught with a 1-hour plenary lecture, two 2-hour small group discussion and skill building sessions, and a 3 hour laboratory. The spring semester consisting of a 2-hour plenary lecture and four hours of guided as well as independent investigation focuses on questions about the watershed, research plans, transitioning into STEM disciplines, and developing skills to work effectively with community partners.

The STEM-FYE course utilizes a diverse instructional team that draws on the strengths of SSU and regional experts. STEM faculty and off-campus professionals serve as guest presenters introducing students to their fields. Peer mentors (PMs) support freshman transition to college. PMs facilitate presentations on topics such as note-taking, drug and alcohol awareness, and campus resources. Graduate students provide expertise in discussion sections that engage students in scientific inquiry including the collection and critical analysis of their data. We are successfully retaining STEM majors with 86.9% enrolled in the pilot STEM-FYE continuing as STEM majors in their sophomore year. This compares to the overall SSU STEM freshman continuation rate of only 70%[1]. Preliminary data for our 2013-14 STEM-FYE cohort indicates undeclared students are changing to STEM majors.

	STEM-FYE 2012-13			STEM-FYE 2013-14		
	2012-13	Continuing Sp 2014	Retention In STEM	2013-14	Continuing Sp 2014	Retention In STEM
All majors	48	38	79.2%	51	46	90.20%
Freshman STEM*	23	20	86.9%	17	13	76.40%
STEM**	23	23	100.0%	17	19	111.76%
*Incoming freshmen declared as STEM majors **incoming freshman STEM majors + any new STEM majors						

The results from these STEM-FYE surveys and other anecdotal evidence reveal several positive impacts:

- STEM-FYE students build a strong community with each other, faculty, and peer mentors. They call upon this community for support not only in their freshman year, but also later on in their studies.
- Close interactions with faculty, working with community partners and other research-related activities most influenced students' interest in pursuing a STEM major.
- Students reported big improvements in their ability to execute a wide variety of important, research-related tasks over the semester. For all areas queried, there was a marked shift in students' self-assessment as a result of having completed the course.
- Most students had no prior field experiences collecting data. STEM-FYE's emphasis on field work in the local watershed builds student abilities and confidence in STEM-related competencies and helps to strengthen their connection to STEM, SSU, and the region. Further, many students are initially unaware of the problems facing our local watershed and sustainable environments. They end the semester much more informed and empowered by the possibilities of their involvement.
- Group work provided opportunities to try on a variety of roles.
- Students are comfortable with TAs and find their assistance helpful. Most students met with TAs more than once during the semester and many met with them several times. Reaching out for support is an important strategy for success in STEM.
- Advising was helpful understanding the four year progression through STEM majors and deciding what major to pursue. Students are more engaged in their academic planning and take greater responsibility for their education and success.
- Undeclared students work closely with peer mentors, faculty, and advisors (including SSU's Advising Center) to build connections between their interests, studies and possible careers. Many of these students transition from being at risk of dropping out to connecting (perhaps tentatively for some) to a major by the end of their first year.
- Many students reported that learning presentation skills and learning about the environment were among the most valuable aspects of the projects with community partners. They also reported the experiences helped them gain knowledge about the work of STEM professionals and an idea of possible careers. Many of them gained knowledge about the environment in Sonoma County and also reported having enjoyed working with the community partners.

Appendix H – *Physics Major* Newsletter

The Department's newsletter, *The Physics Major*, has been published approximately annually since 1974. Sent to all current students, graduates, and prospective students as well as to educators, industrial scientists, and others who have requested it, it helps to keep alumni in contact with the Department, to show prospective students what is happening in the Department, and to disseminate news of alumni to current and prospective students. The largest "article" in each issue is a list of alumnotes, information about graduates obtained through the annual questionnaire. Included in this appendix is the 2014 edition of the newsletter. All past issues may be found at http://www.phys-astro.sonoma.edu/newsletter/.

THE PHYSICS MAJOR

Department of Physics and Astronomy

SSU Satellite Built and *in* Orbit

By Kevin Zack

Sonoma State's first satellite, T-LogoQube, is a first generation 3P (5 cm x 5 cm x 15 cm) PocketQube with on-board instrumentation. Designed and built by undergrads in a collaborative effort between Sonoma State University (SSU) and Morehead State University (MSU), the purpose of the T-LogoQube project is to develop a platform for future space-based scientific experimentation.

Satellite team at the Little h Ranch (left) Hunter M., Ben C., Kevin Z., Steve A., Aaron Pacheco (SRJC), Garrett J., Lynn C.

Launched on November 21, 2013, into a sun-synchronous polar low-earth orbit at an altitude of 700 km, T-LogoQube is one of the smallest, stand-alone satellites to send both a radio beacon and instrumentation telemetry. With the flight software written in the programming language MicroLogo, commands can be created, up-linked, and executed in real time, making this satellite the ideal platform for experimental space science.

T-LogoQube satellite.

T-LogoQube was in operation for eight weeks, during which the primary objectives of the flight were achieved. First packets were received on November 23; a command was sent the following day, with a prompt response from the satellite orbiting 700km above the ground station. Using a 100mW radio, which is approximately 4 times less powerful than a typical cell phone, packets from the satellite were received and decoded at distances ranging up to 2700 km .

Research and development of the T-LogoQube provided the foundation for a next generation PocketQube. Development and construction of this next satellite is currently under way, with the flat-sat (engineering boards in a test array, not in flight configuration) built, and undergoing design reviews and testing. Still in its design phase, the hardware sub-systems are currently being improved with the information gained from extensive testing. Slated for a Spring 2015 launch from the International Space Station, the satellite will fly a Cadmium-Zinc-Telluride (CZT) array and magnetometer to detect hard cosmic X-rays and particles while measuring properties of the Earth's magnetosphere.

Steve Anderson Receives Excellence Award

By Prof. Jeremy Qualls

The SSU Staff Excellence Award was established to recognize outstanding service and significant contributions to the University. We congratulate Steve for receiving this prestigious honor. It is well deserved. We are thankful for his accomplishments and his dedication. Over his many years of service, Steve has been a vital part of the Department, giving selflessly to everyone and being a keystone resource. On a personal note, I met Steve in 2007 and was surprised by both his passion for education and his ability to jerry-rig equipment into a functional state. During the last seven years, he has continued to surprise me with his knowledge of all things mechanical and craft oriented. Just this semester, I heard him sing and play drums in his band then dismantle and repair a high end laser system the next day. I really believe Steve has tried every hobby and craft on the planet. This rich and diverse background comes out when he is developing demos and operating on last minute notices. His demos are very impressive and are inviting to audiences. The recent total internal reflection exhibit for the SST Science Night and campus event laser shows are perfect examples of this. In addition to his daily duties of setting up labs, creating classroom demos, and maintaining instrumentation, Steve remains one of the best resources for new projects and bouncing ideas. For more information see:

Steve being Steve!

www.sonoma.edu/workplace/2013/05/anderson.html

SONOMA STATE UNIVERSITY

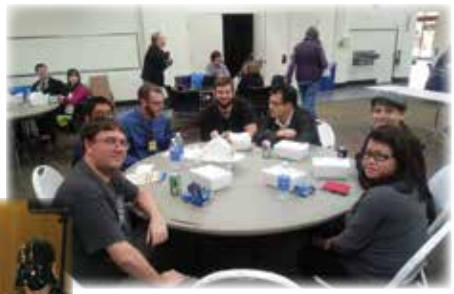
American Physical Society California-Nevada Section Meets at SSU - *By Prof. Lynn Cominsky*

Beginning with a spooky and laser-lit Halloween Welcome Party sponsored by SSU's SPS chapter, over 175 paid attendees of the California-Nevada section of the APS met at SSU for the first time. It was also the last meeting of the California-Nevada section, as during the business meeting, members voted to change the name of the section to "Far West." SSU E/PO Scientific Illustrator Aurore Simonnet designed the logo to go with the new section name as well as the "Lobo on Halloween" conference poster.

Focusing on undergraduate and graduate student research, the meeting featured 95 contributed talks filling 11 parallel sessions. SSU students Kevin Zack and Stephan Jackowski won first and second place Steve Chu awards, respectively for their presentations. Invited speakers included SSU Professor Emeritus Bryant Hichwa, who reprised his popular lecture on the Physics of Baroque Bassoons, as well as UC Davis Prof. Daniel Cox, who described his research on using Proteins as Nanolegos, UC Berkeley researcher Marjorie Shapiro, who filled us in on what we know about the Higgs Boson and Stanford Prof. Kam Moler discussing her work characterizing Emergent Phenomena in Quantum Materials.

On Friday night 11/1, attendees were treated to a wonderful banquet in the Commons followed by an outstanding presentation about the hazards of near Earth objects by former SSU E/PO employee and "Bad Astronomer" Phil Plait. Events on Saturday 11/2 included a free lunch and networking session with more senior members of the section, and a panel discussion on careers in Education and Public Outreach that included the SSU E/PO group's Kevin John ('07), APS Public Outreach head Rebecca Thompson, SSU Physics Alumna Prof. Brooke Haag ('01) and SLAC National Accelerator Laboratory Scientific Editor Kelen Tuttle. Thanks to everyone in SPS, the SSU E/PO group and the P&A department for helping with all the organizational tasks and for making the meeting such a great success! As Chair of the Local Organizing Committee, and Past Chair of the section, I was very proud to show off our lovely campus and our excellent students. To see the meeting details:

http://epo.sonoma.edu/aps/



Dr. Targett with some attendees at the free student lunch on Saturday.

(L to R) Anna McCowan, Aman Gill and Stephanie Church.

(L to R) Stephanie Church, Kevin Zack, Lynn Cominsky, Danny Ryan, Aman Gill, Stephan Jackowski, Anna McCowan and Jordan Sperry.

New Club on Campus

By Cody Johnson

The Material Science Club (MSC) is the newest science club on campus. It was started just a few months ago by President Cody Johnson, Treasurer Stephan Jackowski and Vice President Daniel Ryan, in an attempt to provide a more specialized science club on campus for those interested. Material science has become one of the most important scientific fields of the past few decades, combining the best parts of physics, chemistry, and engineering. Although SSU lacks a degree program in material science, there are plenty of students and faculty conducting research on materials and their properties. Dr. Hongtao Shi, for example, is working on creating and characterizing Co-doped ZnO samples, a material which has possible applications as a dilute magnetic semiconductor. This is amazing research with far-reaching implications and it's being conducted right here at SSU!

MSC is currently being held in conjunction with the Society of Physics Students' meetings but, once the club becomes more self-supporting, we will branch off and hopefully obtain a university charter from the Material Research Society (MRS). An MRS-chartered club would be a great resource for STEM majors on campus and would also provide more opportunities for students to attend conferences, network, and learn more about material science.

We aim to provide a fun social setting for students to discuss and learn more about material science. If you would like to be part of the club or would like to become a club officer please contact the club president, Cody Johnson, through email at ***johnscod@seawolf.sonoma.edu.***

Newkirk Award 2013:
Developing Next Generation Torque Coils

By Maxfield Torke

In 2013, the T-LogoQube satellite was launched into orbit. The satellite contained a torque coil to allow the satellite to re-orient itself by spinning. A torque coil is a coil of wire (solenoid) that generates a magnetic field when a current is passed through it. This magnetic field interacts with the Earth's magnetic field to apply a torque on the satellite. Through support available through the Newkirk Research Award, I have been working with Dr. Garrett Jernigan to recreate and investigate the torque coil that was implemented on the satellite. My goal is to understand the dynamics of the torque coil and modify design as needed to allow for precise control of the satellite's orientation while it is in orbit. Currently I am measuring the torque produced by an external magnetic field and programming a simulator to model satellite orientation. Preliminary measurements of the applied torque are being made using a torsional pendulum and an electromagnet (as well as utilizing the Earth's field) to measure the angular displacement with respect to time. Several other methods for experimental measurements are being considered. I have started to do basic programming in jLogo and will continue the project over the summer with hopes to build the next generation of coils for the next satellite to be launched in January 2015. I am very grateful to Nadenia Newkirk for the award and support during the past semester.

Torque coil in test station

What Physicists Do

by Wes Watson

What Physicists Do has been an SSU tradition for over 40 years, and this year we were fortunate as always to host brilliant men and women doing their part to advance the physical sciences.

We started the 86th/87th seasons off with Dr. Brian Welsch's presentation on the far-reaching influence of the sun's magnetic field. Our newest professor, Dr. Tom Targett, proved his science communication skills during a heavily attended lecture on applying the scientific method to the virtual world of Starcraft 2. A few speakers bridged the gap between physics and the rest of the world, with Wayne Sobon discussing the need for physicists in the field of patent law and Dr. Leslie Atkins highlighting the exclusionary effect of over-formalized scientific writing. Dr. Deborah Bard sent us off for winter break mulling over her explanation of gravitational lensing and its applications in observing the strange and distant bodies of the cosmos.

Spring semester kicked off with an exciting talk by graduating physics major Kevin Zack on SSU's own T-LogoQube satellite, which he helped to design. In February, Dr. Warren Wiscombe gave us a look at climate science in its formative years and Dr. Charles Lawrence presented the Planck mission's "map of the universe" - the most accurate measurement to date of anisotropy in the cosmic microwave background. In March the department celebrated women's history month with a group of all-female speakers including Dr. Jocelyn Read, who discussed the emerging field of gravitational wave astronomy and the neutron stars it will help us observe. We closed for the year with Dr. Beate Heinemann's explanation of the Higgs boson detection at CERN.

We would also like to express our gratitude to all the other speakers who've made the 2013-2014 series of What Physicists Do another enthralling venture into the frontiers of modern physics. What Physicists Do will resume in the fall with another round of talks about the captivating mysteries of the universe and the folks who try to sort them all out.

AlumNotes

Jon Simmonds ('74) *is a pilot with Alaska Airlines, based in Seattle. He has flown for Alaska and Eastern Airlines for a total of 34 years. Before that he flew in Antarctica in support of NSF polar research projects while a pilot in the U.S. Navy.*

Bert Plambeck ('78) *is a supplier quality engineering manager at JDSU in San Jose. He has held similar positions with several other technical firms in the Bay Area. He has published papers on overlay metrology and the implementation of coherence probe microscopy.*

Jacques Schlumberger ('82) *sold Michel-Schlumberger Benchland Wine Estate and retired in 2012. He and his wife Barbara were recognized by SSU with an Alumni Community Achievement Award in 2007.*

Peter Sieck ('82) *is a consultant in thin film design and manufacture for R&D and production groups. He was for many years a senior scientist with AFG Development Corporation in Petaluma, where he developed new window coatings for buildings and cars.*

Teresa Bippert-Plymate ('84) *has launched LookingUP! Astronomy Services, LLC, a business that brings astronomy to the resorts and camps in the Big Bear Lake area of southern California. She formerly worked at Steward Observatory as Interferometry Technical Specialist for the Large Binocular Telescope Interferometer and as the technical writer for the SOLIS project at the National Solar Observatory.*

Geoffrey A. Wilson ('84) *is a consultant specializing in signal processing algorithms and optics in Oregon. He has worked on bioparticle detection at Hach Homeland Security Technologies in Grants Pass, OR, coherent laser radar at Coherent Technologies in Boulder, CO, and experimental quantum optics at the University of Oregon in Eugene, OR, since earning his Ph.D. in applied physics at the Oregon Graduate Institute of Science and Technology in 1992.*

Keyvan Farahani ('85) *is the chief of the Imaging Guided Intervention Branch of the Cancer Imaging Program in the National Cancer Institute. He also teaches part-time in the Johns Hopkins University school of medicine. He was formerly an assistant professor of radiological sciences and biomedical physics at UCLA, where he received his Ph.D. in 1993.*

Tom McMahon ('85) *works at the University of Arizona, where he is now the program manager for the Center for Astronomical Adaptive Optics, project manager for the Large Binocular Telescope Interferometer, and deputy project manager for OCAMS suite of cameras for the OSIRIS-REx Asteroid Sample Return Mission. He was previously principal systems engineer of the Multiband Imager for the Spitzer Space Telescope, and he has worked on several other major instruments.*

McQuillen Scholar 2013:
Observed Effects of Mg-doped Zinc Oxide (ZnO) Thin Films via Electrochemical Deposition

By Jordan Sperry

Jordan with the McQuillens

SEM image of synthesized ZnO layer

The concepts and ideas I have been exposed to thus far as a Physics major at SSU, along with my own independent study, have led me to an interest into the realm of materials science. The research that I performed this summer for the 2013 McQuillen Summer Research Award with Dr. Hongtao Shi involved the development of Zinc Oxide thin films ideal for optoelectronic use. This is a fascinating field in physics and engineering that is continuing to grow due to the number of devices that can be developed with optoelectronics, such as solar panel components.

In order to develop these thin films, we decided to use a method that isn't typically used in industry, but is useful due to its low cost and low requirement of sophisticated tools or machinery. This method is called electrochemical deposition, and essentially works by applying a current to a chemical solution, which causes the charged ions in the solution to bond to a substrate in contact with a metal plate, due to a potential difference.

Dr. Shi had previously grown ZnO samples on Indium Tin Oxide (ITO) substrates with this method, and for my research, I wanted to dope the Zinc Nitrate $Zn(NO_3)_2$ solution with Magnesium Nitrate $Mg(NO_3)_2$ in order to create Mg-doped ZnO in the deposition process. In theory, the incorporation of Mg into the sample should widen the energy band gap of the grown ZnO sample. Based on previous research, Mg-doped ZnO has a highly tunable band gap, which only furthers the number of applications that this material can be used for.

I was able to successfully dope a number of ZnO samples with Mg using this process, however the ratio of Mg to Zn was far too large. I was not creating Mg-doped ZnO, but was instead creating Zn-doped MgO! This was a problem because MgO is an insulator and is not useful for semiconductor purposes. Adjusting the concentration of $Mg(NO_3)_2$ either gave me far too much Mg in the sample, or none at all. Near the end of the summer, I switched to a very common Sol Gel method in order to successfully incorporate the right amount of Mg and successfully shift the band gap of the ZnO.

The research I performed this summer provided me with an invaluable amount of experience with a number of microscopy methods, such as SEM, EDX, XRD, PL and UV-Vis Spectroscopy, all of which were required in order to obtain both the quantitative and qualitative results I needed in order to determine the validity of the samples I made. I would like to thank Mike and Sheila McQuillen for providing the means for this research to happen, the Physics & Astronomy Department for selecting me for this award, and Dr. Shi for his very valuable guidance and advice throughout the entire process. This was my first stab at research in the field of materials science, and it excited me to continue to do other research projects in this field in the future. I plan on continuing research on this project for my capstone research project in Fall 2014, in order to successfully create Mg-doped ZnO using this electrochemical deposition method.

AlumNotes

Allyson Bishop ('86) *has returned to California after more than twenty years in Europe and is now a self-employed property manager in San Francisco. She received her Ph.D. in biomedical physics at UCLA in 1994 after winning a fellowship upon graduation from SSU.*

Dan Nottingham ('89) *is director of product management at Imprivata in the Boston area. He has done similar work for several companies after participating in rocket-launching experiments for the Boston University Center for Space Physics.*

Jason I. Alexander ('92) *is director of business development at Metrue in Fremont. Formerly a marketing manager of organic light emitting diode (OLED) displays for OSRAM in San Jose, he earned an M.S. in physics in 1995 at Indiana University-Purdue University at Indianapolis.*

Benjamin J. Owen ('93) *was elected a Fellow of the American Physical Society in 2013 "for leadership in understanding how neutron stars can produce gravitational waves, for creating better methods to search for these waves, and for demonstrating how gravitational wave observations can be used to probe the structure and dynamics of neutron stars." A professor of physics and director of the Center for Gravitational Wave Physics at Pennsylvania State University, he received his Ph.D. in physics in 1998 at Caltech, where he was awarded the Milton and Francis Clauser Doctoral Prize for the most original and ingenius dissertation research that year. He received a National Science Foundation Graduate Fellowship upon graduation from SSU.*

Geoffrey Syphers ('93) *was recently appointed chief executive officer of Sonoma Clean Power, the new, locally controlled electricity provider in Sonoma County. He earned his M.S. in Energy Engineering at the University of Massachusetts, Lowell in 1994.*

Mallory Roberts ('94) *is a visiting professor at New York University Abu Dhabi and an astrophysicist with Eureka Scientific. He earned his Ph.D. in astrophysics at Stanford University in 2000.*

John H. Hayes ('97) *is the principal of Hayes Graphics in Camarillo. He was formerly a computer specialist with the high energy astrophysics division of the Smithsonian Astrophysical Observatory in Cambridge, MA, where he worked on the Chandra X-ray Observatory.*

Never a Dull Moment

By Prof. Jeremy Qualls

Prof. Qualls with the Freshman SCI 120 Cohort

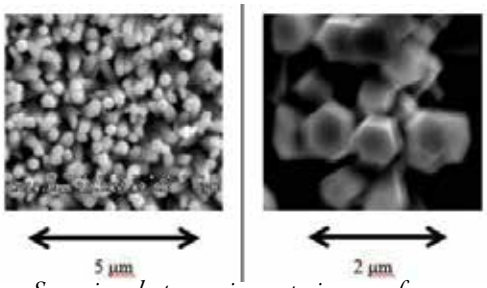
It is safe to say I have not had a dull year since being at SSU. This last year has been no exception. My work on organic charge transfer salts continues to elucidate the weak electron-electron and electron-phonon interactions that arise in the low dimensional regime and create environments susceptible to complex density wave ordering. I have continued publishing in this area in a number of journals and have been happy to serve as a material science expert for the National Science Foundation and the National High Magnetic Field Laboratory. In addition to this work, I branched into two new areas of research; water harvesting and shear thickening composites. In collaboration with physics major Danny Ryan, our first successful prototype design harvested ~100 ml of water from the air with no electrical power draw. I am very excited about this work and its potential to transform water impoverished areas of the world. The other research area, driven and initiated with physics major Cody Johnson, investigates composite systems and the feasibility of impregnating Kevlar and Dyneema to create stronger materials. We are collaborating with the Franklin County, Tennessee Police Department to develop these materials.

Of great importance this year were my efforts to coordinate the Science 120 program. Our STEP NSF-funded work on enhancing STEM education and developing a freshman entry program has been very successful and continues to evolve into a paragon transformative experience. I am still learning so much about our local ecosystem and watershed sustainability as well as teaching general education courses.

Nanowires for Optoelectronics

By Prof. Hongtao Shi

At the nanometer level (1 nm = 10^{-9} meters), some material properties are affected by the laws of atomic physics, rather than behaving as traditional bulk materials do. These man-made nanomaterials have the potential for wide-ranging industrial, biomedical, and optoelectronic applications and are the focus of my work. The electrochemical solution approach I have been using is appealing for the growth of Al-doped ZnO (AZO) because of its low growth temperature, low cost, ease of operation, and good potential for scale-up. Using the facilities in the Keck Microanalysis laboratory, we have demonstrated that the AZO films can be successfully grown on silicon wafers. The morphology of the samples can change from one dimensional nanowires to two dimensional flaky films. Ultraviolet light emission from these samples can be significantly enhanced after certain annealing processes. While as-prepared ZnO is often an insulator, AZO films could have tunable conductivity for different optoelectronic applications. Last November, Stephan Jackowski presented this work at the American Physical Society Far West Section, which won him the second place Steven Chu Undergraduate Research Award.



Scanning electron microscope images of Al-doped ZnO Hexagonal nanowires.

Bryant & Diane Hichwa Research 2013 Award:
Investigating Plasma Properties

By Amandeep Gill

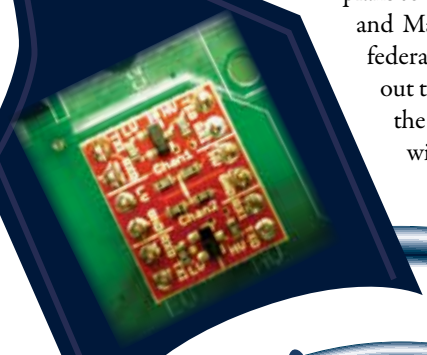
Last summer I had the delight of conducting research through the department's Hichwa Research Award. I worked with Dr. McLin at SSU E/PO, formerly NASA E/PO, using the robotic telescope, GORT at the Hume Observatory on the Pepperwood Preserve. GORT stands for GLAST Optical Robotic Telescope, and its primary mission is to track gamma-ray bursts and their afterglows. My goal was to study known quasi-stellar objects (QSOs), which are a type of radio-quiet AGN, to search for variability. The study of active galactic nuclei (AGN) is important to the understanding of the evolution of the universe. Taking QSO observations over many nights enabled me to establish a baseline luminosity and to search for variability.

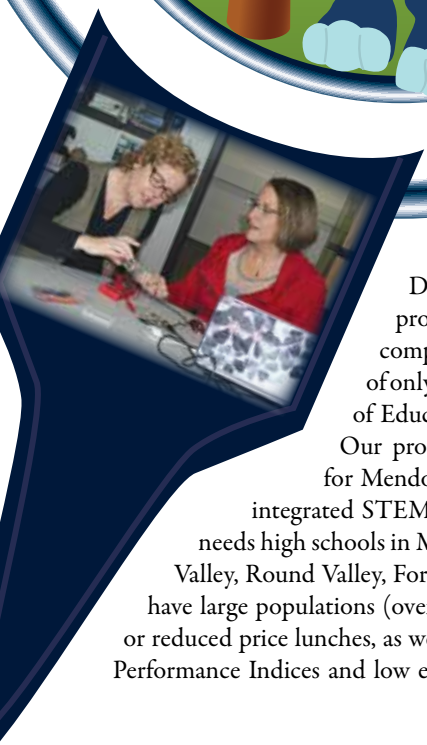
GORT is a 14" aperture telescope that was recently fully automated, with a CCD and filter wheel. When I began at E/PO, GORT was only partially automated, so many late nights and early mornings were spent powering up or down the telescope. After a night of collecting data on the target objects, I would use AstroImageJ to combine stacks of images and reduce for bias, dark, and flat fields. Image analysis was done using APT, Aperture Photometry Tool. I quickly learned that data collection is quick compared to the photometric analysis; however, the analysis is very important to reporting your data. An exciting outcome of my project was that I got a chance to present at the APS Far West meeting we hosted on campus last fall. It was a great chance to practice giving a professional talk. I would like to thank Bryant and Diane Hichwa for their support for this project.

Education and Public Outreach group gets new name and new focus

By Prof. Lynn Cominsky

This past year has been filled with dramatic changes for SSU's Education and Public Outreach (E/PO) group (formerly known as the NASA E/PO group). In April 2013, President Obama announced plans to consolidate Science, Technology, Engineering, and Mathematics (STEM) funding throughout the federal government. Part of this plan aimed to zero out the E/PO efforts at NASA that have supported the SSU group for the past fifteen years. Faced with the loss of nearly $1 million in funding, I began looking at other programs and federal agencies and writing many proposals to try to keep our efforts alive.

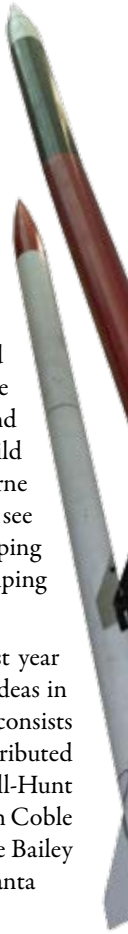




Teaming with Susan Wandling, Director of SSU's Early Academic Outreach program, I wrote a proposal that successfully competed against over 600 other groups to win one of only 18 Development grants from the Department of Education's Investing in Innovation (i3) program. Our program "Learning by Making: STEM Success for Mendocino County" will be designing two years of integrated STEM curricula that will be piloted with six high-needs high schools in Mendocino County: Ukiah, Willits, Anderson Valley, Round Valley, Fort Bragg and Point Arena. All of these schools have large populations (over ~60%) of students who are eligible for free or reduced price lunches, as well as poor scores on the California Academic Performance Indices and low eligibility rates (less than 30%) for admission to the UC or CSU systems. Our new curricula will focus on developing computational thinking by having students build experiments, use the Logo language to program computers to acquire data from sensors in the experiments, and analyze the data from sensors.

However, unlike the NASA programs that have supported the group in the past, the i3 program requires that 15% of the $3 million in funds that we receive from the government must be matched by private in-kind or financial contributions. To date we have secured most of the required match as in-kind services from Logo programming language expert Brian Silverman (President, Playful Invention Company), Dr. Garrett Jernigan (retired from UC Berkeley, expert in both Logo and experiment design) and Barry Silverman (Disus Inc., expert in web programming). We have also been offered discounts on parts from Adafruit Industries and Sparkfun Electronics. However, we still need to raise the rest of the required match by July 1, 2014. If you are interested in contributing to support this program, please let me know. Contributions can be accepted at any time during the next five years, but we need letters of commitment right away in order to keep our funding.

The SSU E/PO group will be doing all the STEM curriculum development for the Learning by Making program, building on the experience that we have gained during the past with programs such as our "Small Satellites for Secondary Students" (S4) program. The S4 program designed Arduino-based payloads to be built by middle and high school students and flown on high-powered rockets and tethered weather balloons. Last summer we all went down to Palmdale, CA to train 14 middle and high-school teachers and 4 Girl Scout leaders to build the S4 payloads, then launched them all at the Lucerne dry lake bed. To see photos and video from this event, see ***http://s4.sonoma.edu***. This year, the educators are helping the students to build their own payloads and we are helping them launch this spring and summer.



Another major accomplishment for the group this past year was the pilot in two different SSU classes of our "Big Ideas in Cosmology" web-based curriculum. The curriculum consists of three modules with 5 chapters each, and is being distributed by Great River Technologies, a subsidiary of Kendall-Hunt publishing. "Big Ideas in Cosmology" is authored by Kim Coble (Chicago State University), Kevin McLin (SSU), Janelle Bailey (Temple University), Anne Metevier (SSU and UC Santa Cruz), Carolyn Peruta (SSU), and me. Illustrations

West Coast Conference for Undergraduate Women in Physics

By Anna McCowan

The Annual West Coast Conference for Undergraduate Women in Physics (CUWiP) was held in Berkeley, CA in January of this year. Aman Gill, Nicola Peyko, Stephanie Church, and I (Anna McCowan) were able to attend, along with nearly 200 other women from all different institutions who were equally passionate about Physics.

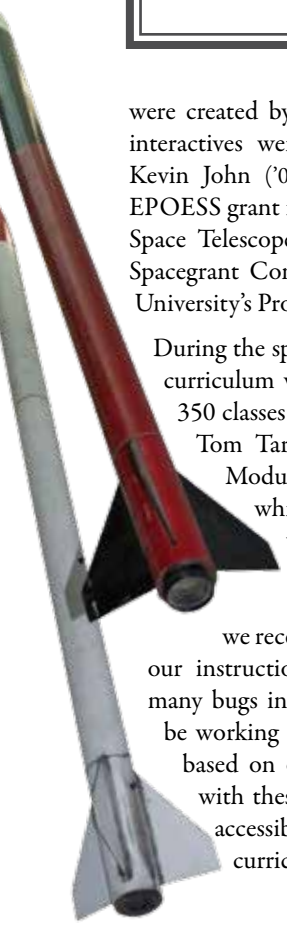
Because of its great location, the hosts were able to offer to those who were interested a tour of Lawrence Livermore National Laboratory. The opportunity to tour a renowned research and development institution for science and technology was a privilege in itself. We were able to peek into the windows of laboratories that have contributed so much to our current advancement in physics, engineering, and technology of our nation's security. The experience was truly remarkable.

The Conference itself opened our eyes to all of the great opportunities for women in the field of Physics. One highlight of the weekend was meeting with graduate students who are currently working towards their Ph.D.s. We were able to address any questions we had about research, careers, and life after graduation. It was refreshing meeting so many intelligent women who we could really relate to and open up about undergraduate life as a female in the science field. Another great aspect of CUWiP was the panels. They focused on getting involved at your institution, undergraduate and graduate research, balancing work and personal lives, and careers in all sorts of different fields. The speakers ranged from those who studied astrophysics to those who found a career in

Aman Gill, Stephanie Church, Anna McCowan, and Nicola Peyko at CUWiP

Pixar animation. There were scientists who found a passion in nuclear engineering and physics graduates who took the path to scientific journalism. I was in awe of all the different directions these women took from the same starting point, and they all seemed very proud of their accomplishments. I can say the same for all of the remarkable undergraduate students who presented their research and displayed their posters on the last day. I enjoyed seeing the different projects that students from a variety of schools had been working on.

CUWiP was a great experience because we were able to make connections and find allies in a field where historically women have been underrepresented. Being able to walk into a room full of young women who share my nerdy, yet awesome, interests was a fantastic and life-changing opportunity.



were created by Aurore Simonnet, and computer interactives were designed and programmed by Kevin John ('07). The work was funded by an EPOESS grant from NASA, the Fermi Gamma-ray Space Telescope E/PO program, NASA's Illinois Spacegrant Consortium, and the California State University's Promising Course Redesign project.

During the spring 2014 semester, the "Big Ideas" curriculum was tested in Astro 100 and Astro 350 classes taught by Visiting Faculty member Tom Targett. The intro class started with Module 1 and made it into Module 2, while the upper division class started with Module 2 and ended up somewhere in the middle of Module 3. Through all this testing, we received valuable feedback on how well our instructional strategies worked and found many bugs in the web implementation. We will be working all summer to incorporate changes based on our experiences using the material with these real students, as well as ensuring accessibility. The plan is to market the curriculum nationally starting in the fall.

2014 SSU Science Symposium

By Prof. Jeremy Qualls

The School of Science and Technology (SST) in partnership with the WATERS collaborative hosted the 2nd annual SSU Science Symposium. Held in the new Student Center, this event highlighted the research of over 120 students and included both open poster session and talks by Science 120 freshman students. There were 56 research posters from all of the SST departments with physics & astronomy tied with chemistry for most posters at 12 each. Awards were given out for Best Poster, Best Poster Runner Up, Best Water Related, and Most Innovative. Physics major Hunter Mills took Best Poster for "An Optical System for Application in Medical Physics and Astronomy" and Kevin Zack took Best Poster Runner Up for "Putting Sonoma State University into Space". Judges were very impressed by our majors and their ability to communicate their research to a general audience.

Physics majors Hunter Mills and Kevin Zack winning Best Posters!

Acoustic Measurements of Weill Hall and other venues of Green Music Center

By Dr. Mike Jones

It is quite possible that Weill Hall, the feature venue of the Green Music Center, is the finest concert hall located on a university campus. The presence of the Hall presents Sonoma State with unique educational and research opportunities. The Department of Physics & Astronomy is now proceeding to take advantage of both opportunities.

In the Spring of 2011, in anticipation of the completion of the Green Music Center, the Physics and Astronomy Department reestablished the Physics of Music (Phys 300) course. The new version of the course will be taught for the fifth time next Fall.

It has been the ongoing intent of the Physics of Music course to feature the various venues of GMC and the particular acoustics of each. The GMC is ideal for this purpose because of the extraordinary level and variety of acoustic control present in the different venues. Students are given a one or two class period tour featuring the solo and group practice rooms, the smaller concert rooms and finally Weill Hall. The students are fascinated by the elements of acoustic design on display and the distinct acoustic environments created. The tour is always the highlight of the class for the students.

Unfortunately, the interaction of the students with the GMC was limited to a walk-through tour. The Physics Department lacked the equipment necessary to actually measure and/or demonstrate the unique acoustics of the rooms. In the Fall of 2013, the department proposed the purchase and utilization of a room acoustics measurement system. The funding was granted as a Green Music Center Academic Integration proposal, and the equipment was purchased in early 2014. The system utilizes the Dirac measurement and analysis software and includes both omnidirectional and vocal-simulation sources along with omnidirectional and bidirectional microphones.

The system will be used to make detailed measurements for use in the Physics of Music class. The acoustic parameters of music and speech reproduction will be measured for rooms in the GMC as well as classrooms and other larger venues such as Person Theatre. We will use the equipment to demonstrate the effectiveness of acoustical elements during tours of the GMC facility.

Weill Hall is not just invaluable for demonstrating the principles of musical acoustics, it also offers a unique facility for research into concert Hall acoustics. Senior Jacob Lewis has selected as his Capstone Project the first measurements of Weill Hall. Jacob assembled and calibrated the complete system described above. Several classrooms in Darwin Hall were measured to establish a baseline and to confirm the correct operation of the measurement system. Measurements at 12 locations within Weill Hall were completed in April and the results were presented in early May.

Because of the deliberate physical and acoustic similarity of Weill Hall to the world's two highest ranked concert venues, Vienna's Musikverein and Symphony Hall in Boston, it is expected that these measurements of Weill Hall will show that it closely matches these Halls in the five ISO concert Hall parameters.

It is hoped that future research will result in extensive measurements of the acoustic parameters of the Hall as a function of listener location, under different arrangements of the acoustic curtains, and with and without the rear wall open.

In summary, we feel strongly that the Green Music Center is not just an artistic asset but a valuable scientific and educational asset for the Sonoma State University community.

AlumNotes

Brooke Haag ('01) *is now an assistant professor of physics at American River College. She formerly taught physics at Hartnell College. She earned her Ph.D. in nuclear physics at the University of California, Davis in 2009.*

Justin Flory ('02) *completed his Ph.D. in biological design at Arizona State University in 2014. He researched how to build an artificial device to convert water and sunlight into fuel, based on the natural process of photosynthesis. He plans to apply his research experience in artificial photosynthesis to improve solar energy technologies.*

Tyana Stiegler ('03) *earned a Ph.D. in experimental particle physics at Texas A&M University in 2013. She is continuing research there and also teaching physics at Blinn College in Houston. Her thesis research was done on the LUX (Large Underground Xenon Detector) Project, a dark matter direct detection experiment in South Dakota. She earned a master's degree in physics at the University of California, Davis.*

Michelle Valencia [formerly Jones] ('03) *educates the public about astronomy at the Ukiah Latitude Observatory. She also tutors mathematics at the Tutoring Center.*

Tiffany Davis [formerly Borders] ('04) *is now living in Emeryville and studying at Animation Mentor. She worked as a research and instrument analyst at the Space Telescope Science Institute from 2008 to 2013 . She earned her M.S. in astronomy at San Diego State University in 2008.*

Daniel Gospe ('04) *is chief operating officer at dmi Networking Solutions in Santa Rosa.*

Tedman Torres ('04) *is an officer in the U.S. Navy and is now in the nuclear propulsion program. He was formerly a postdoctoral researcher at the H. Lee Moffitt Cancer Center & Research Institute in Tampa, FL. He earned his Ph.D. in biological physics at Arizona State University in 2009 with a dissertation on fluorescence correlation spectroscopy.*

Roman Hewette ('05) *is serving in the air force as a space event duty technician at Vandenberg Air Force Base responsible for orbital protection and overall space situational awareness. He is also working on an M.S. in aeronautical science.*

Danielle Beddow ('07) *is teaching English in Taipei, Taiwan, where she is also an engineering consultant to East Tender Optoelectronics Corp. She was formerly a senior engineering technician at View, Inc. (formerly Soladigm, Inc.) in Santa Rosa.*

Melissa Geissinger [formerly Crain*] ('07)* *is the principal of New Skin Media, Santa Rosa, which specializes in website development, branding, and marketing for professional photographers. She is also the president and COO of Web and Interactive Media Professionals, a community of designers, programmers, marketing specialists, search engine optimization experts, social media gurus and just about anyone having to do with the evolving technological world. She has just published a book on designing a website in one day.*

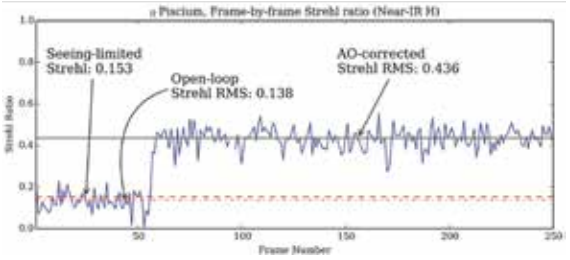
Alexander Sevilla ('07) *was recently promoted to production supervisor at Deposition Sciences, Inc. in Santa Rosa. He formerly worked on the design and construction of electric vehicles for Thunderstruck Motors in Santa Rosa.*

Progress in Adaptive Optics: KAPAO

By Prof. Scott Severson

KAPAO is an astronomical instrument that we have built in partnership with Pomona College and collaborators from Harvey Mudd College and Caltech. Behind a 1-meter telescope located at Table Mountain Observatory, a Jet Propulsion Laboratory site, the system brings high-resolution astronomy to Sonoma State University students. We completed "first light" with a prototype system in 2012 and "first light" with the much more capable final system in 2013. In Fall of 2013, I was honored to have a sabbatical semester to work with the system at Pomona College and at the observatory.

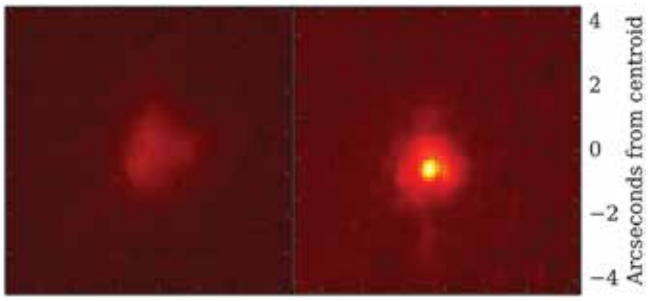
As seen in the image and plot of the star Eta Piscium, taken during this sabbatical, we are able to sharpen images of distant astronomical objects that are otherwise blurred by the Earth's atmosphere. The Hubble Space Telescope is able to take high-resolution images by going above the atmosphere, but Adaptive Optics allows us to measure and correct for the atmosphere and make superb images from the ground. Our KAPAO instrument, built with the explicit inclusion of undergraduates in every step of the process, measures the atmospheric distortion with a Wavefront Sensor, and corrects the distortion with a Deformable Mirror. These exciting technologies have students designing and building optical and mechanical components and developing control and analysis software. The KAPAO system is unique in the way it splits the light from a distant star to be captured by separate visible and near-infrared cameras simultaneously.



This figure shows the improvement of near-infrared image of the star Eta Piscium, as measured by a metric called "strehl", during an on-sky run in December 2013.

We have set the KAPAO system up to be used remotely. Living on the back of the telescope, it can send the light to the older non-adaptive optics camera, or can capture and correct the light. With a fast network connection, and enough monitor space for the myriad of control windows, a remote computer can control the telescope, the adaptive optics system, and the science cameras. In these early days with the system, we are certainly more comfortable up on the mountain top, so we can fix any stray technical challenge, but the system is designed to be used remotely to give SSU students the chance to work with the system from campus. This is quite an achievement for such a sophisticated system, and it is a testament to the hard work of the many students who have worked on the project over the years. (For a sample of the student perspective, please see Katherine Badham's article below.)

The KAPAO project is just getting started. In June, I will be presenting the final design and early results of the system at the SPIE Astronomical Instrumentation conference in Montreal, Canada, and serving as lead author on the companion paper. With the grant funding we are seeking, we expect to support several ongoing observing campaigns. These include monitoring volcanism on Jupiter's moon Io, follow-up on Kepler's extrasolar planet host stars, population studies in crowded stellar regions, to name a few. Stay tuned for the latest news!

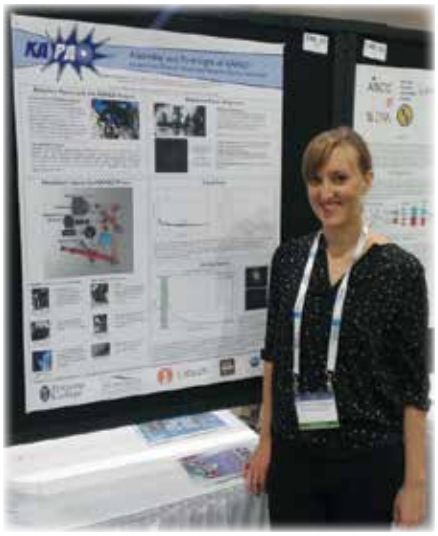


An uncorrected (left) and AO corrected (right) image of the star Eta Piscium from the near infrared camera during an on-sky run in December 2013.

Closing the Loop

By Katie Badham ('13)

During the summer of 2013 I had the honor of working with my advisor, Dr. Severson, and fellow undergraduate students at Pomona College on the most exciting venture of my life - the KAPAO project. I worked on KAPAO Prime, which is an Adaptive Optics instrument built in partnership by Sonoma State and Pomona, for the 1-meter Table Mountain Telescope. My role in this project involved characterization of camera performance, alignment of the deformable mirror and wavefront sensor, and data analysis for the assembled system. Christian Guerrero and I created code, in a language called IDL, that calculated several parameters for the system's near-infrared camera to determine its sensitivity to light, as well as the performance of KAPAO's optical camera. I also performed data analysis on telemetry produced during open and closed loops for the fully aligned system. During the last week of my work, after our tests ensured the system would perform well on-sky, we attached it onto a telescope at Table Mountain Observatory. On August 1st at 4:00 A.M., the KAPAO Prime system showed us that our hard work had paid off. We "closed-loop" on the star Beta Pegasi. This means we witnessed the blurry twinkling star close into a defined point of light. At that moment I had the pleasure of witnessing the beauty of Adaptive Optics.



I presented KAPAO Prime's in-lab tests and on-sky results at the American Physical Society meeting at SSU in November 2013 and later made a poster discussing the hardware, system alignment and on-sky results which I presented at the American Astronomical Society meeting in Washington D.C. Over the course of my time working on KAPAO, I learned an extensive amount about adaptive optics, instrumentation and a plethora of data analysis techniques as well as the focus and patience required to produce a successful system. I hope to work with adaptive optics systems like KAPAO in the future and build my knowledge in the world of astrophysics.

An OUT OF THIS WORLD Year

By SPS President Amandeep Gill

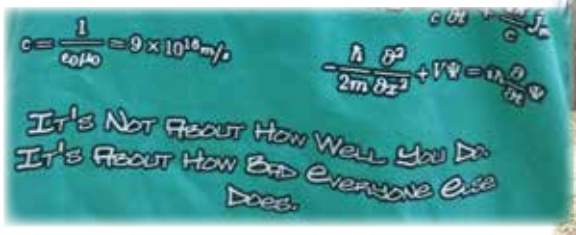
Conferences and grants and skills labs, oh my! The past year for Society of Physics Students has been one of firsts. We started off in Fall 2013 implementing a new peer-teaching program, Skills Lab, in which SPS members teach their fellow students skills such as soldering, photometry, or Arduino microcontrollers. The goal is to teach the research techniques necessary for a successful capstone project, as well as provide the peer-instructors a friendly setting to strengthen their understanding of the topic by presenting it to peers. In addition to starting up Skills Lab, SPS also began School of Science and Tech's Movie Nights, where all science majors come together and watch a nerdy movie. We continued to provide free tutoring to the lower division physics and astronomy students.

SPS BBQ

SPS competes during Geek Week

Perhaps most importantly, November 1-2, 2013 the Physics and Astronomy department hosted the American Physical Society's Far West Regional Meeting, with SPS members not only volunteering in large numbers to help run the event smoothly but also represented by seven (!) of us giving talks on the various research projects in the department. Additional, SPS hosted a Halloween reception the night before the conference to welcome visiting SPS members from around California, complete with mummy bowling and a laser light show courtesy of Steve Anderson! It was so great to see everyone come together to put on a great event and showcase our wonderful department.

It was only natural to keep the ball rolling, so the club applied for three different grants through National SPS. It made for a busy busy Spring 2014 when we won all three! SPS, in partnership with MESA, was awarded the SPS Future Faces of Physics Award to present a two-day long skills lab on microcontrollers after which attendees were loaned starter kits for the semester to further explore microcontrollers on their own. For a second year running, our chapter received the Marsh W. White Outreach award to promote physics and science in the community. The outreach event was held during the last Public Viewing Night of the semester and SPS put on a physics fair with demos explaining concepts like sizes and distances of the Solar System. In addition to the physics fair, SPS used the funds to digitize a collection of marvelous astronomical slides to present at the physics fair and to generally make them more accessible. Last but by far not least, we received the Sigma Pi Sigma Undergraduate Research Award to build a CubeSat ground station to complement the recently launched T-LogoQube satellite, built by SPS members Kevin Zack, Hunter Mills, and Ben Cunningham. Currently, there is a second satellite in development for a Spring 2015 launch off of the International Space Station; our goal is to have the ground station done in time to communicate with the next satellite.



It has been a demonstration of this SPS chapter's commitment to each other and physics that we have not only received every grant we applied to but also completed each to such a high level of success. More information for all the grants awarded to SPS this year can be found at the SSU School of Science and Tech's Spring 2014 newsletter: *http://www.sonoma.edu/scitech/newsletter/spring_2014.pdf.* While spring was a busy time for SPS, we still found time for fun activities, such as participating in the annual Geek Week on campus and tabling at various events to promote membership and interest in physics. We would like to thank the department, particularly our advisor Dr. Shi and Steve, for supporting us through all the various endeavors! It has truly been an out of this world year.

Behind every SPS accomplishment there is a member or a group of members who put in an extraordinary amount of time and effort through many sleepless nights and coffee cups to honestly make this year the club's best ever! I am so happy to have been a part of it all, it has been a wonderful experience being club president and I look forward to what SPS will achieve in the coming year.

Students interested in joining SPS should go to : ***http://www.students.sonoma.edu/clubs/sps***

Prospective and current physics majors are encouraged to view our Facebook page or the web site for any news and upcoming events.

Showing off the SPS 2014 T-shirt!

Thank You for Your Support!

We are truly grateful to those who continue to support the Department as we try to maintain our traditions and offer our students new opportunities for research and personal growth. Private donations have been crucial in the growth and continuation of excellence in the Department of Physics and Astronomy, especially important as state contributions continue to decline. Our academic programs rely heavily on the generous support of donors and your contributions help advance science and learning, making the world and our Department a better place for our students.

The "What Physicists Do" lecture series is supported through donations and grants from SSU's Instructional Related Activities Fund. Prof. Lynn Cominsky (lynnc@universe.sonoma.edu) ran the series this past year - we have just completed our 87th semester! This year we received a generous donation from alumnus James (' 75) and Patricia McBride to support the series, which was most welcome and is greatly appreciated.

We now have three ongoing student research assistantships: The Horace L. Newkirk Endowed Assistantship (spring semester) and the Mike & Sheila McQuillen and Bryant & Diane Hichwa Summer Research Awards. Research is thriving within the Department, and funded research experiences have provided our students with a great boost, helping them get into selective graduate programs and to begin successful careers in science. Other scholarship funds, such as the Duncan E. Poland Physics and Astronomy Scholarship, the Sol and Edith Tenn Scholarship, and the Joseph S. Tenn Scholarship, also support and provide students with opportunities they would not have if not for the generosity of donors.

If you would like to support our program and students please see *http://www.phys-astro.sonoma.edu/publicSupport.shtml*, contact the SSU Development Office at (707) 664-2712 or contact the Department.

AlumNotes

Charles Granger ('08) *is a graduate student in optics at the University of Rochester. He earned an M.S. in physics at San Diego State University, concentrating on electro-optics, in 2013.*

Bill Garcia ('10) *has returned to California and is now a winery equipment technician with the Criveller Group in Healdsburg. He was formerly a field service engineer at AlsoEnergy in Lafayette, CO.*

Matthew Fontana ('12) *is a graduate student and teaching assistant in chemistry at UCLA. He received his M.S. in 2013.*

Joshua Stortz ('12) *is an assistant A/V technical manager at AvaCon, Inc. and the principal and executive producer of the Vesuvius Group, LLC, an international collaborative of creatives specializing in developing online environments for community-building.*

Current Funds:

#C0141 Public Programs
Richard M. Bell, Robert Fisher, James A. ('75) and Patricia McBride (McBride Group), Joe and Eileen Tenn

#C0142 Physics & Astronomy Equipment and Supplies
Lauren Novatne ('89), Rivendell Heights, Inc. (Greg Sprehn '93), Deposition Sciences Inc.

#C0143 SSU Observatory
No donations this past year.

#C0144 Student Development Program
Bryant P. and Diane Hichwa, Michael T. and Sheila McQuillen

#S0265 Duncan E. Poland Physics and Astronomy Scholarship
Lynn Cominsky and Garrett Jernigan

Endowment Funds:

#E0185 Charles and Norma McKinney Fund
The Charles and Norma McKinney fund supports public programs.

#E0208 Horace L. Newkirk Memorial Student Assistanship
Established by Nadenia Newkirk in memory of her father to support student research.

#E0231 Duncan E. Poland Physics & Astronomy Scholarship
Lynn Cominsky and Garrett Jernigan

#E0269 Science at Work Fund
Established by John Max to support What Physicists Do.

#E0304 Sol and Edith Tenn Scholarship
Joe Tenn

#E0305 Joseph S. Tenn Scholarship
Established by relatives of Joe Tenn to honor his service to the Department.

Gifts In Kind:

Dean Wilson at JDS Uniphase: New BNC cables, HP 8921A Cell Site Test Set

New to the New World

By Visiting Assistant Professor Thomas Targett

Aman G., Anna McC & Dr. Targett.

One year ago, I was in a New York hotel room waiting to begin a phone interview with the Physics and Astronomy department at Sonoma State University. I had "Google-stalked" the staff, reviewed their academic courses, and located Rohnert Park on a map.

Today, I am in my office at the SSU Physics and Astronomy department, having completed my first year of full time teaching, learned so much about education, and am looking forward to Fall 2014 when I will resume my duties.

It's always a little scary moving to a new place, but the faculty and university have been most welcoming, and as my colleague Wes Ferris puts it "This is one of the best little departments in the world". The quality of teaching and research is truly excellent, and I'm very happy to be a part of it.

It has also been a pleasure to involve SSU students in my academic research. At present I am measuring the size-mass relation of galaxies at very great distances, and creating telescope-like images from numerical simulations of the early universe. I have been amazed by how well my project students have engaged with their projects, and am glad to provide them their first (hopefully of many) experiences with professional astronomy.

All-in-all, I find myself very happy here at SSU.

AlumNotes

Katie Badham ('13) *is an intern working on femtosecond laser ablation at Raydiance in Petaluma.*

Chuck Neely ('13) *is an associate engineer at Deposition Sciences, Inc. in Santa Rosa.*

Anna Wojtowicz ('13) *is a research associate at Oak Ridge National Laboratory, where she is developing software for enhancing nuclear reactor simulation modeling and data analysis.*

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Appendix I: Sonoma State University Observatory (SSUO), KAPAO and Galbreath Wildlands Preserve

1. Overview of the SSU Observatory

The observatory is a 12 by 24 foot sliding roof structure that was established in 1976. At the time of its establishment the observatory was dedicated to the students, faculty, and staff of Sonoma State University. The observatory was established at the darkest location on campus, on the southeast corner of campus just outside of what was originally a football field and track. Football is no longer a part of the campus, but the track is still utilized. The entire location is surrounded by an earthen berm approximately 50 feet high. This location is still the darkest location on campus, but what was originally a rural environment has now become a suburban environment as the city of Rohnert Park has expanded to nearly surround the campus. Furthermore, the campus built the Beaujolais and Tuscany Residence Halls adjacent to this location. Light pollution has now substantially limited our ability to observe and study faint astronomical objects. For example, the Milky Way was a prominent naked eye object in the past from SSUO, while it is now virtually unidentifiable because of the sky glow from the campus and the surrounding communities.

The observatory instrumentation consists of two main, pier mounted telescopes with capable drives and computer control, as well as one additional large (16" diameter) portable Newtonian as well as other small telescopes for use on public viewing nights. The Epoch telescope, a 10-inch Newtonian f/5 optical system intended to be used for (relatively) wide field digital photometry rests on the west pier. And the Mathis is a Celestron 14" Schmidt-Cassegrain telescope that rests on the east pier and is used for visual observing and spectroscopy. The CCD instrumentation consists of the aforementioned SBIG spectrometer and a modest format but fast SBIG CCD camera and astronomical filters.

Since the time of the last Program Review in 2008 the Epoch telescope has been rescued from near death. The Epoch would occasionally tries to drive itself into its pier. A student project to contact the original designer of the mount led to the repair of the system. The controller remained an old DOS-based system, but is now in the process of being replaced through the work of another student replacing the serial connection to the mount.

2. Utilization

Throughout its history SSUO has been used to support classroom instruction, to support student-faculty research, and to provide Public Viewing Nights (PVNs) for the campus and for our surrounding communities.

Courses which regularly use the observatory include:

- A100 (Introductory Astronomy). All instructors require visiting an observatory and viewing the sky through a telescope as a class assignment.

- A231 (Introductory Observational Astronomy) Two or more lab projects always involve use of the observatory.

- A331 (Astronomical Imaging) Weekly projects throughout the semester.

- A482 (Advanced Observational Astronomy) Weekly projects throughout the semester.

Research projects which have utilized the observatory include:

- Monitoring Seyfert galaxies
- Monitoring other forms of active galaxies (AGNs, particularly the blazars)
- Monitoring cataclysmic variable stars (CVs)
- Monitoring brightness variations for Be stars
- Searching for new variable stars
- Timing minima for eclipsing binary systems
- Determining and solving lightcurves for eclipsing binary stars
- Determining magnitudes and lightcurves for minor planets
- Detecting and timing transits for extrasolar planets
- Monitoring and measuring the strength of emission for Be stars
- Measuring Dark Matter through galaxy rotation curves
- Measuring the relative albedo of the Earth via Earthshine off of the Moon
- Measuring Supernova light curves to be used as standard candles
- Three color imaging to build a portfolio of astronomical images
- Spectroscopy of Jupiter's moon Io
- Measurement of atmospheric turbulence via Hartmann differential images

3. Public Viewing Nights

Public Viewing Nights have been scheduled once a month during the academic year since the dedication of the observatory in 1976. At that dedication ceremony it was announced that PVNs would continue to be scheduled as long as people kept attending. People have continued to attend. We maintain a public mailing list and send out announcements before each viewing. We have posters, which are posted around campus. And we require Astronomy 100 students to attend one viewing during the semester. With current Astronomy 100 enrollment per semester between 375 and 500 students, that means the events can become quite crowded!

These PVN events are very informal. Faculty, staff and paid student assistants and volunteers staff the events. The telescopes are pointed to various objects and the staff

describes the nature of the objects and answer questions. We have Instructionally Related Activity funding that pays for the typically three paid student assistants as well as cocoa and cookies at the events.

The Public viewing Nights has seen substantial growth in attendance in recent years. Currently there tend to be between 75-150 people who attend each event, where it used to be as low as 30-40 people. People come and go throughout the evening. There is generally always a mix of students and people from the community. The historical record attendance is 400 people who showed up for a special viewing of Halley's comet. Unfortunately, this viewing was clouded out. Weather always forces cancellation of some fraction of PVNs.

It is an important addition that volunteers such as Lecturer Wes Farriss, and Lab Manager Steve Anderson bring additional personal telescopes. Combined with a low-light slide projection of astronomical images, these events are a festive addition to the campus life.

The October 23 2014 Solar Eclipse. The observatory building is in the back right.

4. Support

There has never been a formal observatory budget or faculty assigned time for the campus observatory. However, there has been an extended history of the purchase of item of instrumentation or equipment, or a needed repair provided by the Department, the School, or the University. There has always been a steady stream of student volunteers.

Without these students it would not have been possible to offer the programs that the observatory has provided. It seems clear that the observatory has served as a kind of magnet to induce students to come to Sonoma State University. Some of the most dedicated students to work at the observatory have been physics majors, some astronomy minors, and sometimes they have not even been science majors. Astronomy in general, and an observatory in particular, provide an excellent means to generate enthusiasm in science and math. With the acquisition of the student assistant funding through the IRA program, we are able to reward these dedicated students and provide them funding for work within the department.

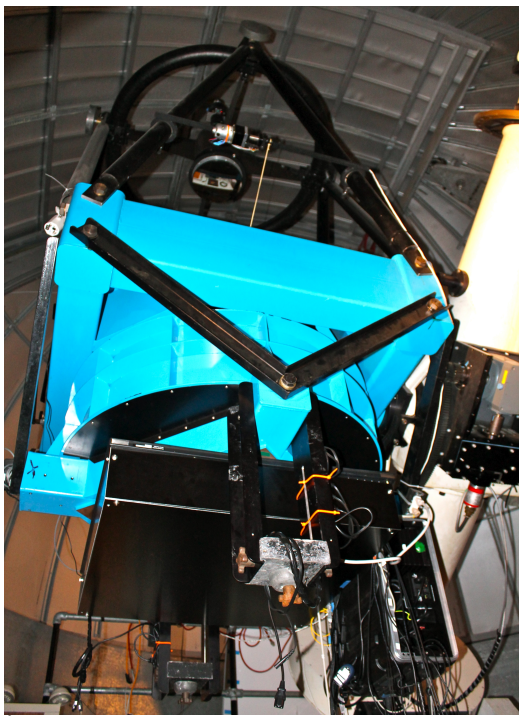
We have now reached a point where substantial additional resources are needed for the repair and renovation of this ever-essential resource to the campus. The slide off roof needs repair, both in the sliding mechanism and the integrity of the roof. There has been water damage and mold in the interior because of the roof status. We have added a tarp to ameliorate the issue until a repair. Also there is some masonry damage to the cinderblock walls that needs repair.

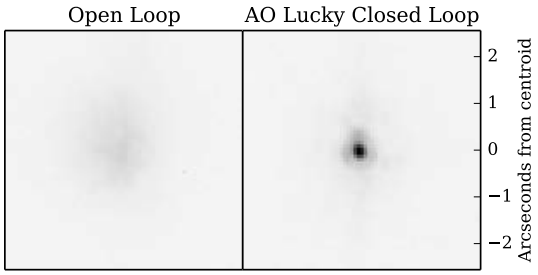
SSU Observatory Sliding Roof

Observatory Roof Water Damage

5. KAPAO

Another observing resource for the Department of Physics & Astronomy is access to the Table Mountain Observatory as part of the KAPAO collaboration. KAPAO is an Adaptive Optics system for the TMO 1-meter Telescope (see the figures below). The instrument, named KAPAO, was funded by a $637,138 National Science Foundation grant (SSU sub-award: $118,345). Built primarily by Dr. Scott Severson, Dr. Phil Choi of Pomona College, and undergraduate students, this system is located in the San Gabriel mountains in Southern California. This system has: a unique simultaneous IR+optical imager; automation systems to allow the use of the system remotely via the Internet; and the capability of diffraction-limited, high-speed imaging.





[Left]: KAPAO on the Table Mountain Observatory 1-meter Telescope.
The rectangular structure shown below the blue telescope is the Adaptive Optics system. Built with undergraduate student effort, this system includes advanced optics, electronics, and cameras to make images "sharper".

[Above]: KAPAO imaging at TMO
The star Eta Piscium shown without [middle] and with [right] the Adaptive Optics system working to correct for atmospheric blur. The star, which is far enough away so as to appear as a single spot, becomes a blur due to the Earth's atmosphere. AO corrects this to make the image sharper.

Current and planned work with the system includes: observations of crowded stellar clusters for population studies; monitoring of the volcanoes of Jupiter's moon Io; and the study of stellar systems known to contain extra-solar planets. PIs Severson and Choi will be proposing for research funds including student support in Fall 2015.

5. Galbreath Wildlands Preserve

A one-time planned development of a 1-meter telescope observatory in southern Mendocino County was derailed by the economic downturn and a change of priorities within the university. Recently, the department has been contacted by the director of the SSU preserves to resume study of the placement of a telescope at the 3600 Acre Galbreath Wildlands preserve. The GWP Observatory effort is centered on the construction of an advanced remotely operable 1-m class telescope built around ecologically sustainable techniques, including solar power generation and cutting-edge power storage technologies. The telescope will be host to an innovative Adaptive Optics (AO) system, which will provide high-resolution imaging by removing the "twinkle" from starlight. The development and use of this observatory will incorporate undergraduate student research in science, technology, engineering and mathematics (STEM) fields in a programmatic fashion. Although prior site-testing had been done back in 2007-2009, this effort is only recently seen again as a possibility, and is a large funding effort away from becoming a reality.

Sonoma State University
Department of Physics and Astronomy
Learning Objectives

All Physics and Astronomy courses are expected to incorporate critical thinking abilities, quantitative skills and communication skills as core objectives in their course material and course work. They will also be required to demonstrate knowledge, understanding and use of the principles of physics and/or astronomy. In addition, there are objectives specific to Physics and Astronomy discipline courses. Both our overall and course-specific learning objectives are listed below.

Overall Learning Objectives

Objectives Specific to Physics and Astronomy discipline courses
Students are required to demonstrate:

1) Knowledge, understanding and use of the principles of physics and/or astronomy

2) Ability to use reasoning and logic to define a problem in terms of principles of physics

3) Ability to use mathematics and computer applications to solve physics and/or astronomy problems

4) Ability to design and/or conduct experiments and/or observations using principles of physics and/or astronomy and physics or astronomical instrumentation

5) Ability to properly analyze and interpret data and experimental uncertainty in order to make meaningful comparisons between experimental measurements or observation and theory

General Skills for all Physics and Astronomy courses
Students are expected to acquire:

6) Critical Thinking Abilities

7) Quantitative Skills

8) Communication Skills

Astronomy Courses

Astronomy 100:

- Students will learn the composition and nature of the universe, from our own solar system, to stars and stellar evolution, interstellar matter, galaxies, and clusters of galaxies. Students will explore historic astronomy, some fundamental physics such as Newton's laws and the nature of light, and discuss how astronomers discover the nature of the universe.

Astronomy 231:

- Students will learn introductory astronomical concepts by engaging in hands-on laboratories.
- Students will practice data-taking skills such as making measurements with specialized equipment and computer applications.
- Students will gain experience interpreting data through the use of mathematical tools such as tables, graphs, and equations.
- Students will practice communicating scientific results in the form of written lab reports.
- Students will gain experience working collaboratively as they share the responsibility of conducting experiments and writing up their results

Astronomy 303:

- Students will understand that science is a creative process of discovery -- with new knowledge built on observations, evidence, and logical reasoning – and will be able to describe evidence that supports major scientific understandings as well as lack of evidence for ideas that are not founded in science.
- Students will be able to describe the major factors that contribute to the long-term habitability of Earth, and characteristics and needs of life (including some examples of life in extreme environments and artificial life).
- Students will be able to describe evidence of the potential for life on other worlds in our solar system, as well as how the potential for life on Earth and other worlds has evolved and will continue to evolve.
- Students will understand and be able to describe the methods we use for learning about the potential habitability of worlds and the possibility of intelligent life in the Universe. These methods include different methods of space travel, and different ways of observing and gathering information about other worlds.

Astronomy 305:

- Students will be able to describe the major research questions and methodologies of the most recent developments in the field of astronomy
- Students will be able to describe the nature of high-energy phenomena in the universe.
- Students will be able to read, understand and analyze scientific ideas communicated in a variety of formats with a variety of intended audiences.

- Students will be able to communicate scientific ideas in a variety of formats.

Astronomy 331:

- Students will learn the methods and techniques of astronomical imaging. The course will offer a practical approach to using charged- coupled device (CCD) detectors and computer-controlled telescopes to obtain images of the moon, planets, stars, and nebulae. Topics include telescope control, planning observing programs, identifying astronomical objects, determining image sizes and exposure times, and image processing techniques.

Astronomy 380:

- Students will learn the structure and evolution of stars, including stellar interiors and atmospheres, nucleosynthesis and late stages of stellar evolution.

Astronomy 482:

Students will understand/be able to … (Skills course, so concepts are mostly actually things students will "do")

- How to operate telescopes, learning the interface software, the coordinate systems, and the major object catalogs.
- How to control imaging cameras, including selecting appropriate parameters to maximize signal to noise, understanding gain, linearity, saturation etc..
- How to operate a spectrograph and obtain well sampled, high quality spectra of stars.
- How to process astronomical data to recover important physical quantities: luminosity, astrometry, color, distance, spectral energy distribution, age, etc.
- Prepare and curate a system of electronic logging to document work before, at, and after the telescope.
- How to read and comprehend the existing literature in the discipline.
- Present scientific results through written and verbal presentations, adhering to the standards of the field.

<u>Physics Courses</u>

Physics 100:

- Students will reexamine and redefine common science concepts related with mechanics.
- Students will apply the defined physics concepts and principles to their daily life examples.
- Students will practice thinking in a logical process, which is essential in science.
- Students will develop cognitive understanding of science concepts through in-class demonstrations and exercises.
- Students will discuss in pier groups to develop their cooperative skills and reinforce understanding of concepts.
- Physics 102:
- Upon completion of the course, the student should be able to:
- gain an understanding of some of the fundamental laws and principles governing the behavior of the physical world

- become familiar with the scientific method and how it can be applied to the solution of problems
- associate terms with the corresponding definitions and identify significant physical variables in given situations
- generalize the given application of physical principles to similar but novel situations
- describe physical relationships in the environment and identify appropriate applications
- discuss physical theories and their implications for humans and the Universe
- operate standard laboratory equipment, make measurements and analyze data
- write simple laboratory reports

Physics 114/ 116**:**

- Develop knowledge of scientific theories, concepts, and data about living and non-living systems.
- Understand how the scientific method is used to develop scientific principles and interpret evidence.
- Appreciate the value systems and ethics associated with scientific inquiry, and the potential limits of scientific endeavors.
- Demonstrate understanding of the scientific method through laboratory exercises.
- Read and understand mathematical arguments and data, and use mathematics effectively to analyze and solve problems that arise in ordinary and professional life.
- Gain an understanding of the fundamental laws and principles governing the behavior of the physical world.
- Understand the physical world through interpretation of results from experimentation and/or observation.
- Learn that there are interactions between matter and energy and use this knowledge to understand physical, chemical, or geological phenomena.
- Develop a basic understanding of physical matter and the scientific method so that they can apply this understanding to more complex systems.
- Operate standard laboratory equipment;
- Analyze laboratory data;
- Write comprehensive laboratory reports.

Physics 209A :

- We hope to engage you in experiments chosen specifically so that can clarify and reinforce the concepts you will encounter in lecture. Through working and observing hands-on, these abstractions will gain in relevance to your daily lives.
- Basic experimentation skills are encouraged in using multiple tools for data acquisition. Analytic software takes the process one step further. Exposure to these unfamiliar tools will enhance your flexibility in unfamiliar work environments.
- Basic statistical theory will be used to analyze results. We hope that you will see that there is a difference between ideal concepts in physics that result in exact solutions, and the lab environment that will introduce inevitable errors. All experimental results contain different levels of precision and accuracy; you will learn how to express them statistically.

- Not least of the goals is the hope that you will develop collaborative skills in a lab environment. To succeed you will adapt and grow in ability with unfamiliar people. Together you must work out the best ways to approach experiments and find ways to contribute equally. Together you will design alternative approaches to new tasks. This will easily translate and enhance your skills into a working environment later in life.

Physics 209B:

- Reinforce physics concepts learned from lectures with hand-on experiments.
- Develop an ability to design and perform physics experiments and use scientific instrumentation.
- Practice analyzing and interpreting experimental data within the context of theory.
- Your goal is not to blindly following lab procedures, generate preliminary results, and leave.
- You are the main operator in this lab. You need to know what you are doing during each step of your action.
- Always try to obtain the best results. Don't be satisfied with a proper/expected result. Think about how you can make your measurements better.
- The group with the best results (in an acceptable time frame) will be rewarded bonus points.
- When you obtain data from your measurement, think about what the results imply and what could have been errors in your measurements. How could you fix the possible source of error? If you can obtain logical scientific reasoning for your errors/and results, you will be also rewarded bonus points.
- Your laboratory manual and instructor are only for your guidance. The given procedure in the manual is only an outline and you are encouraged to upgrade/ modify.

Physics 210A:

- Perform calculations of kinematics problems in 1 and multiple dimensions.
- Understand and work with vectors
- Apply Newton's Laws of motion to mathematically solve physical situations in both linear and rotational environments.
- Work with Newton's law of gravitation.
- Understand and use mathematically the conservation laws of energy, momentum and angular momentum.
- Learn the fundamentals of temperature, pressure, and fluid flow.

Physics 210 B

- Perform calculations using Coulomb's Law in 1 and 2 dimensions.
- Use vector arithmetic in doing electric force, electric field, magnetic force and magnetic field calculations.
- Perform elementary DC and AC electric circuit calculations with series and parallel resistors and capacitors.
- Perform calculations of magnetic field induction and use Lenz's law correctly.

- Perform calculations and understand image properties with plane, concave and convex mirrors.
- Perform calculations with light refraction and Snell's law.
- Do problems with light interference and the double-slit experiment.

Physics 214/216:

- Students will have an opportunity to think like a physicist, including: how to identify problems, how to examine the identified problems using mathematical descriptions and experiments, how to propose possible solutions, and how to 2. predict the outcome of their proposed solutions.
- Students will practice thinking in a logical process, which is essential in science.
- Students will develop a cognitive understanding of science concepts through in-class demonstrations and exercises.
- Students will discuss in peer groups to develop their cooperative skills and reinforce their understanding of concepts.
- Students will practice problem-solving skills and be able to apply mathematical methods using appropriate technology.
- Operate standard laboratory equipment;
- Analyze laboratory data;
- Write comprehensive laboratory reports.

Physics 300:

- Students demonstrate a thorough understanding of both the science of sound and the relationship to the aesthetics of music.
- Students demonstrate an in depth understanding of the science and historical evolution of a particular musical instrument or similar topic within the scope of the syllabus
- Students will continue to develop their writing and presentation skills. The professor and the student will mutually agree upon a topic as discussed in goal #2. The student will prepare a written paper and subsequently share their research work with the class through an oral presentation.
- Students will continue to build a mathematical competency to allow them to better cope with the sophisticated technology driven world in which they live.
- The professor has a personal goal to demystify science to the non-science oriented student and allow the student to better appreciate the both the science and artistry of music.

Physics 340:

- Students will learn the properties of light from geometric and physical optics perspectives. Topics include ray optics, refraction, diffraction, coherence, interference, and polarization. Students will learn and use Fermat's principle, Huygens' principle and Fourier optics.

Physics 342:

- Students will be introduced to familiar optical phenomena and technology.
- Students should realize that physics is not a subject for the math or science oriented people but a subject of nature.
- Students should understand and be able to demonstrate their understanding of basic principles and ideas introduced.
- Students will practice thinking in a logical process, which is essential in science.
- Students will discuss in pier groups to develop their cooperative skills and reinforce their understanding of concepts.

Physics 450:

- Students will learn the following topics: ideal gases, heat capacities, entropy, enthalpy, the laws of thermodynamics: Boltzmann, Bose and Fermi statistics; applications such as engines, refrigerators and blackbody radiation.

Physics 494:

- Students will learn about active research topics in physics and astronomy through public lectures presented by professional scientists.
- Students will learn important research and critical thinking skills by preparing for the talks through web-based research and reporting.

Appendix K – Catalog for 2014-2015

K.1 Astronomy

K.2 Physics

ASTRONOMY

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Saeid Rahimi*
Scott A. Severson
Hongtao Shi
** Faculty Early Retirement Program*

Program Offered

Minor in Astronomy

Astronomy, offered as a minor in the Department of Physics and Astronomy, is the study of the planets, stars, and galaxies in the universe beyond the earth's atmosphere. The fields of astronomy and astrophysics, the application of physics principles to astronomical observations, today deal with essential questions, such as the origin and nature of the "Big Bang;" the subsequent creation of matter and the chemical elements; the eventual formation and evolution of structure in the universe; and the life cycles of stars, including the tremendous explosions which are often their death knells and can lead to the formation of black holes. Modern astronomy leans heavily on the concepts and techniques of physics and mathematics. Astronomers use ground- and space-based instruments that detect photons spanning the electromagnetic spectrum, as well as particles such as cosmic rays or neutrinos. An emerging branch of astronomy seeks to correct the effect of the Earth's turbulent atmosphere using adaptive optics, thus providing "sharper" views of the universe. As a result of astronomy's cosmic scope and dependence on physics, degrees in astronomy are generally granted at the graduate level. The minor in astronomy, with a B.S. in physics, is an excellent preparation for graduate study in astronomy or astrophysics.

Careers in Astronomy

Career fields for which an astronomy minor would be beneficial include aerospace, astronomy, atmospheric science, education, planetary geology, and geophysics.

A variety of courses are available within the minor, including intermediate and advanced laboratory work that utilizes the department's two observatories, and a number of descriptive courses for students whose major interests lie in other fields.

The SSU Campus Observatory, in operation since 1976, houses two telescopes, a 14-inch Schmidt-Cassegrain and a 10-inch Newtonian, with auxiliary instrumentation for CCD imaging and spectroscopy. Both telescopes are computer controlled. The observatory is used by students in laboratory and lecture courses, and is also available for faculty and student research projects. A NASA-funded research observatory, which saw "first light" in 2004, is located in the darker skies of northern Sonoma County. It includes a remotely controlled and operated 14-inch telescope mounted on a computer-controlled Paramount and equipped with a high quantum efficiency CCD detector and filter wheel. Equipment available for observational work in astronomy at SSU is ideally suited for studying objects that vary in time and space. This includes objects that vary in brightness such as pulsating, eclipsing, and cataclysmic star systems. This also includes the variable nuclei of active galaxies such as quasars and blazars, Gamma-ray Bursts (GRBs), and extrasolar planetary systems that exhibit planetary transits. Our equipment is also ideally suited for follow-up observations of Near Earth Objects (NEOs), which may threaten Earth.

The department is developing a remotely operable, approximately 1-meter telescope in southern Mendocino county: the Galbreath Wildlands Preserve Observatory. This will be a sustainable and ecologically sensitive facility, making the project innovative and cross-disciplinary. The department also houses a laboratory for experimental astrophysics research, where students can test and build cameras, spectrometers, and other equipment for SSU's telescopes. The laboratory includes an Adaptive Optics testbed, which uses advanced technology to measure and sharpen images. Faculty and students have built and use an astronomical Adaptive Optics system in collaboration with partner institutions.

All students are strongly encouraged to participate in the ongoing research programs of the department, and/or to propose student-initiated research programs.

Minor in Astronomy

Completion of a minimum of 20 units in astronomy and physical or life science courses, at least 12 of which must be in astronomy, constitutes a minor in astronomy. Courses that are used to meet requirements in a student's major may not be used toward the minor in astronomy. Supporting courses for the major may be used. Interested students should consult with an advisor in the Department of Physics and Astronomy.

ARTS 497 Directed Field Research Experience (1-4)

Travel to various destinations, which vary depending on type of field research being offered; consult semester schedule for specifics. Students will be responsible for a field research project(s), based on the trip. Fee required at time of registration. Prerequisites: major status and advanced standing or consent of instructor.

ARTS 498 Selected Topics in Art Studio (1-4)

A studio course dealing with intensive study of a particular art topic, which may vary by semester. May be repeated and applicable to requirements for a major in Art. Consult advisor and department chair. Prerequisites: major status, advanced standing, and instructor consent.

ARTS 499 Internship (1-4)

Students in the internship program will have an opportunity to gain practical skills by working in a variety of gallery and museum situations in the private and public sectors. Credit will be given for completion of 3 hours of work per week, per unit, by prior arrangement with department coordinator. Prerequisite: consent of instructor. A-F or Cr/NC. Course may be repeated for credit.

ARTS 595 Special Studies (1-4)

Prerequisites: graduate standing and consent of instructor.

Astronomy (ASTR)

ASTR 100 Descriptive Astronomy (3)

Lecture, 3 hours. A survey designed primarily for non-science majors, including an introduction to historic astronomy, Newton's Laws, gravitation, atomic structure, light, and telescopes. Take a tour of the solar system, learn about space flight, stars and stellar evolution, galaxies, and the structure of the universe. Satisfies GE Area B1 or B3 (Physical Sciences).

ASTR 231 Introduction to Observational Astronomy (2)

Lecture, 1 hour; laboratory, 3 hours. Principles of astronomical measurement techniques with field and laboratory studies of astronomical objects. Identification of constellations; astronomical coordinates; use of the telescope; and techniques in imaging, photometry, and spectroscopy. Satisfies GE Area B1 or B3 (Physical Sciences) and GE laboratory requirements. Prerequisite: previous or concurrent enrollment in ASTR 100.

ASTR 303 Life in the Universe (3)

Lecture, 3 hours. The course is an appraisal of the possibilities and prospects for life in the universe and travel beyond our Solar System. Topics to be covered include: the nature of life, habitability of Earth and other worlds within our Solar System, detection of planets beyond our Solar System, the search for life beyond Earth, and space travel. This course emphasizes the scientific method, especially the development of scientific theories founded in observational and experimental evidence. Satisfies GE AreaB3 (Specific Emphasis in Natural Sciences). Prerequisite: ASTR 100.

ASTR 305 Frontiers in Astronomy (3)

Lecture, 3 hours. A survey of recent developments in astronomy and how these breakthroughs are made: the discovery of planets orbiting other stars; the explosive deaths of stars and the creation of neutron stars and black holes; and the study of the origin and fate of the Universe, including the search to understand dark matter and dark energy. Satisfies GE Area B3 (Specific Emphasis in Natural Sciences). Prerequisite: one course in astronomy.

ASTR 331 Astronomical Imaging (2)

Lecture, 1 hour; laboratory, 3 hours. An introduction to the methods and techniques of astronomical imaging. The course will offer a practical approach to using charged-coupled device (CCD) detectors and computer-controlled telescopes to obtain images of the moon, planets, stars, and nebulae. Topics include telescope control, planning observing programs, identifying astronomical objects, determining image sizes and exposure times, and image processing techniques. Prerequisite: ASTR 231 or consent of instructor.

ASTR 350 Cosmology (3)

Lecture, 3 hours. A survey of what we know about the Universe and how scientists have learned it. Topics include the Big Bang, cosmic inflation, surveys of galaxies, the origin and evolution of structure in the Universe, dark matter, and dark energy. Satisfies GE Area B3 (Specific Emphasis in Natural Sciences). Prerequisite: ASTR 100.

ASTR 380 Astrophysics: Stars (3)

Lecture, 3 hours. A quantitative study of the structure and evolution of stars, including stellar interiors and atmospheres, nucleosynthesis and late stages of stellar evolution. Prerequisites: PHYS 314 and MATH 211.

ASTR 396 Selected Topics in Astronomy (1-3)

Lecture, 1-3 hours. A course of lectures on a single topic or set of related topics not ordinarily covered in the Astronomy curriculum. The course may be repeated for credit with a different topic. Prerequisite: consent of instructor.

ASTR 482 Advanced Observational Astronomy (2)

Lecture, 1 hour; laboratory, 3 hours. A study of advanced observing techniques including imaging and spectroscopy. Emphasis on the use of telescopes, instrumentation, and data processing including photometry and astrometry. Discussion of techniques across the electromagnetic spectrum. Statistical treatment of data and error analysis. Prerequisites: ASTR 231, PHYS 209B and 210B, and MATH 161; or consent of instructor.

ASTR 492 Instructional Design Project (2)

A directed project to develop at least one laboratory experiment and/or classroom activity that teaches basic concepts in undergraduate Astronomy. Both written and oral presentations (including a demonstration of the experiment or activity) will be required. Prerequisites: PHYS 214 and 216 or PHYS 210B and 209B; ASTR 231. Course may be repeated for credit.

ASTR 495 Special Studies (1-4)

The Department of Physics and Astronomy encourages independent study and considers it to be an educational undertaking. Students wishing to enroll for special studies are required to submit to their supervising faculty members proposals which outline their projects and exhibit specific plans for their successful completion. May be repeated for credit.

ASTR 497 Undergraduate Research in Astronomy (2)

Supervised research in an area of astronomy that is currently under investigation by one or more members of the Physics and Astronomy Department's faculty. This course may be repeated for up to 6 units of credit. Prerequisites: junior-standing and consent of instructor.

Biology (BIOL)

BIOL 110 Biological Inquiry (4)

Lecture, 3 hours; laboratory, 3 hours. A factual and conceptual exploration of the living world through presentation, student inquiry, and laboratory exercises. Topics include the bases of life; organization of living systems, from molecules to ecosystems, and their interactions; and genetics, evolution, and ecology. Satisfies GE Area B2 and the GE laboratory science requirement. Not applicable to the Biology major.

BIOL 115 Introduction to Biology (3)

Lecture, 3 hours. The unifying concepts of biology. Topics include the chemical and physical basis of life; cellular structure and function; molecular and Mendelian genetics; reproduction, development, structure, and function of representative plants and animals; and evolution and ecology. Satisfies GE Area B2. Not applicable to the Biology major.

BIOL 121 Diversity, Structure, and Function (4)

Lecture, 3 hours; laboratory, 3 hours. First in three-semester series required for biology majors. Introduces the extraordinary diversity of life and evolutionary relationships between groups of organisms, and compares body plans. Satisfies GE Area B2 or B3.

BIOL 122 Genetics, Evolution, and Ecology (4)

Lecture, 3 hours; laboratory, 3 hours. Second in three-semester series required for biology majors. Introduces mechanisms of inheritance, evolution, and ecology. Recent advances in understanding processes underlying ecological and evolutionary relationships will be emphasized. Satisfies GE Area B2 or B3. May be taken before BIOL 121.

BIOL 123 Molecular and Cell Biology (4)

Lecture, 3 hours; laboratory, 3 hours. Third in three-semester series required for Biology majors. Introduction to cell and molecular biology, with emphasis on molecular processes, cellular physiology, and regulatory mechanisms. For Biology majors, satisfies GE Area B2 or B3. Prerequisites: BIOL 121 and 122 or 121 and 130A or consent of instructor, and CHEM 115AB or 125A. Concurrent or prior enrollment in CHEM 335A recommended.

BIOL 220 Human Anatomy (4)

Lecture, 3 hours; laboratory, 3 hours. Survey of the body systems. Designed for pursuing careers in the allied health professions. Satisfies GE Area B3 and the GE laboratory requirement. Prerequisite: BIOL 110 or 115, or 121/122 or 130A.

BIOL 224 Human Physiology (4)

Lecture, 3 hours; laboratory, 3 hours. An integrated examination of the human body as an efficient system maintained by a complex of interacting, homeostatic mechanisms. Includes fundamental principles of function of major organ systems. Designed for those pursuing careers in the allied health professions. Satisfies GE Area B3 and the GE laboratory requirement. Prerequisites: BIOL 110 or 115 or 121/122 or 130A; and CHEM 115AB or 105.

BIOL 240 General Microbiology (4)

Lecture, 3 hours; laboratory, 3 hours. An introduction to the organization and characteristics of microorganisms, including bacteria, fungi, protists, and viruses. Topics include their role in agriculture, industry, and disease processes. Prerequisites: BIOL 110 or 115, and CHEM 115AB or 105.

BIOL 307 Human Nutrition (3)

Lecture, 3 hours. Concepts of modern nutrition, including some discussion of principal nutritional problems and modern food processing methods. Prerequisites: BIOL 110, 115, or BIOL 121 and 122; and one course in beginning chemistry.

BIOL 308 Environmental Toxicology (3)

Lecture, 3 hours. Information needed to formulate a philosophy of chemical use: the nature of the interaction of toxicants and living organisms; categories of toxicological activity; toxicological evaluation and environmental monitoring; and governmental regulations and procedures. Satisfies GE Area B3. Prerequisite: BIOL 110, 115, or 121 and 122.

PHYSICS

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**Faculty Early Retirement Program*

Programs Offered

Bachelor of Science in Physics

Bachelor of Arts in Physics

Minor in Physics

Teaching Credential Preparation

Physics is the most fundamental of all the scientific disciplines. Ranging from the applied to the abstract, from the infinitesimal to the infinite, and from quarks to the cosmos, the study of physics seeks to explain all the complicated phenomena in the natural world by providing a description of these phenomena in terms of a few basic principles and laws.

Physicists also use their knowledge of fundamental principles to solve concrete problems. Problems in understanding and utilizing the properties of semiconductors and other materials; in designing and building lasers, photonics, and telecommunications devices; and in designing and using instrumentation such as adaptive optics for astrophysics, are typically solved using the techniques of physics. Such applied physics problems often have a significant overlap with topics and techniques in engineering and computational physics. Indeed, many of the department's graduates are currently employed in engineering or computationally oriented positions.

In their most abstract work, physicists seek a unified mathematical description of the four known forces of nature (gravitation, electricity and magnetism, and the weak and strong nuclear forces). This quest for the "Theory of Everything" eluded Einstein and is continued today by many physicists, including those who study superstring theory. The ultimate goal is to correctly predict the fundamental forces and the masses and interactions of the elementary particles from which all matter is formed.

The department offers a traditional, mathematically rigorous program leading to a B.S. in physics; a more applied curriculum leading to a B.S. in physics with a concentration in applied physics; and a flexible B.A. program with two advisory plans (algebra and trigonometry or calculus). All programs stress fundamental concepts and techniques, offer an unusually rich laboratory experience and intensive use of computers, and require a capstone course as a culminating experience. Capstone projects may include experimental design, instructional design, or undergraduate research—personalized and unique opportunities to demonstrate the skills and knowledge acquired in the major.

The department is housed in Darwin Hall, which is well-equipped with lower-division teaching laboratories and facilities for intermediate and advanced laboratory courses, undergraduate research, special studies and capstone projects. The Darwin facilities include thin film fabrication systems such as thermal evaporation and electrodeposition; a Hall measurement system, a 17-Tesla superconducting magnet system, an adaptive optics and astronomical instrumentation development laboratory, and laboratories for building and testing small satellites (CubeSats). Physics majors also use the multidisciplinary Keck Microanalysis Laboratory in Salazar Hall which includes a scanning electron microscope, atomic force microscopes, an x-ray diffractometer, and a confocal microscope.

A substantial program in undergraduate astronomy includes many courses, listed in this catalog under Astronomy, which may be included in the B.A. or B.S. degree programs in physics. The department operates a teaching observatory on the SSU campus and a NASA-funded remotely operated research observatory at a darker site in northern Sonoma County. The department is also developing a new observatory at the Galbreath Wildlands Preserve in southern Mendocino County. Students are strongly encouraged to use all of the above facilities for special studies, undergraduate research, and capstone projects.

Careers in Physics

For information on what you can do with a bachelor's degree in physics, follow links from: http://phys-astro.sonoma.edu

Bachelor of Science in Physics

(See pages 223-224 for sample four-year programs.)

The B.S. program is a thorough introduction to the principles of physics, providing a strong foundation for graduate study or industrial research. It is also intended for those students who wish to prepare for interdisciplinary studies on the graduate level in fields such as astronomy, atmospheric science, biophysics, environmental science, geophysics, materials science, and physical oceanography.

Degree Requirements	Units
General education	50
Major requirements (may include 5 units in GE)	46
Supporting courses (may include 4 units in GE)	26
Electives	7
Total units needed for graduation	**120**

Major Core Requirements

PHYS 114 Introduction to Physics I (may be applied to GE)	4
PHYS 116 Introductory Laboratory Experience (may be applied to GE)	1
PHYS 214 Introduction to Physics II	4
PHYS 216 Introductory Laboratory	1
PHYS 313 Electronics	3
PHYS 313L Electronics Laboratory	1
PHYS 314 Introduction to Physics III	4
PHYS 320 Analytical Mechanics	3
PHYS 325 Introduction to Mathematical Physics	3
PHYS 340 Light and Optics	3
PHYS 366 Intermediate Experimental Physics	3
PHYS 381 Computer Applications for Scientists	2
PHYS 430 Electricity and Magnetism	3
PHYS 450 Statistical Physics	2
PHYS 460 Quantum Physics	3
Total units in the major core	**40**

Major Electives

To complete the major, select 6 units from the list below. At least one of the courses chosen must be a capstone course (*).

ASTR 380 Astrophysics Stars	3
ASTR 482 Advanced Observational Astronomy	2
*ASTR 492 Instructional Design Project	2
ASTR 495 Special Studies	1-4
*ASTR 497 Undergraduate Research in Astronomy	2
PHYS 100 Descriptive Physics	3
PHYS 445 Photonics	3
PHYS 466 Advanced Experimental Physics	3
PHYS 475 Physics of Semiconductor Devices	3
*PHYS 492 Instructional Design Project	2
*PHYS 493 Senior Design Project	2
PHYS 494 Physics Seminar	1
PHYS 495 Special Studies	1-4
*PHYS 497 Undergraduate Research in Physics	2

Certain selected-topics courses, ASTR or PHYS 396, may be approved by the advisor.

Total units in the major electives	**6**
Total units in the major	**46**

Required Supporting Courses

MATH 161 Differential and Integral Calculus I (3 units may be applied in GE)	4
MATH 211 Differential and Integral Calculus II	4
MATH 241 Differential Equations with Linear Algebra	4
MATH 261 Multivariable Calculus	4
CHEM 115AB General Chemistry (1 unit may be applied in GE) or CHEM 125AB Honors General Chemistry	10
Total units in supporting courses	**26**
Total units in the major and supporting courses (9 may be applied in GE)	**72**

Applied Physics Concentration

Students may earn a B.S. in physics with a concentration in applied physics. This program is intended for those students who desire an emphasis on laboratory work. It provides a rigorous, yet slightly less theoretical course of study, and a greater selection of hands-on electives. It is a good choice for students who wish to continue their studies in graduate engineering programs, or who wish to work in industry in engineering or computationally-oriented positions.

Degree Requirements	**Units**
General education	50
Major requirements (may include 5 in GE)	48
Supporting courses (may include 4 in GE)	17
Electives	14
Total units needed for graduation	**120**

Major Core Requirements

PHYS 114 Introduction to Physics I (may be applied to GE)	4
PHYS 116 Introductory Laboratory Experience (may be applied to GE)	1
PHYS 214 Introduction to Physics II	4
PHYS 216 Introductory Laboratory	1
PHYS 313 Electronics I	3
PHYS 313L Electronics I Laboratory	1
PHYS 314 Introduction to Physics III	4
PHYS 325 Introduction to Mathematical Physics	3
PHYS 340 Light and Optics	3
PHYS 366 Intermediate Experimental Physics	3
PHYS 381 Computer Applications for Scientists	2
PHYS 430 Electricity and Magnetism	3
PHYS 450 Statistical Physics	2
PHYS 460 Quantum Physics	3
PHYS 475 Physics of Semiconductor Devices	3
Total units in the major core	**40**

Major Electives

8 units selected from the following (must include at least one *capstone course):

ASTR 482 Advanced Observational Astronomy	2
*ASTR 492 Instructional Design Project	2
ASTR 495 Special Studies	1-4
*ASTR 497 Undergraduate Research in Astronomy	2
PHYS 100 Descriptive Physics	3
PHYS 320 Analytical Mechanics	3
PHYS 445 Photonics	3
PHYS 466 Advanced Experimental Physics	3
*PHYS 492 Instructional Design Project	2
*PHYS 493 Senior Design Project	2
PHYS 494 Physics Seminar	1
PHYS 495 Special Studies	1-4
*PHYS 497 Undergraduate Research in Physics	2

Certain selected topics courses, ASTR or PHYS 396, may be approved by the advisor.

Total units in the major electives	**8**
Total units in the major	**48**

Required Supporting Courses

MATH 161 Differential and Integral Calculus I (3 units may be applied in GE)	4
MATH 211 Differential and Integral Calculus II	4
MATH 261 Multivariable Calculus	4
CHEM 115A General Chemistry (1 unit may be applied in GE) or CHEM 125A Honors General Chemistry	5
Total units in supporting courses	**17**
Total units in the major and supporting courses (9 may be applied in GE)	**65**

Bachelor of Arts in Physics

(See pages 224-225 for sample four-year programs.)

The B.A. program allows considerable flexibility for the student who wishes to study physics as part of a liberal arts education. Two advisory plans are offered:

Bachelor of Arts in Physics with Advisory Plan C

This plan uses calculus. Students who choose this, the more popular B.A. advisory plan, have the prerequisites to take nearly all of the courses in the department. They find employment in scientific and engineering fields. Some go on to graduate school in interdisciplinary sciences. This degree program is appropriate for those who wish to earn a California Science Teaching Credential with a concentration in Physics.

Degree Requirements	Units
Major requirements (up to 9 in GE)	34-38
Required area of concentration	12
Supporting courses (may include 3 in GE)	12
General education	50
General electives	12-20
Total units needed for graduation	**120**

Major Core Requirements

PHYS 114 Introduction to Physics I (may be applied to GE)	4
PHYS 116 Introductory Laboratory Experience (may be applied to GE)	1
PHYS 214 Introduction to Physics II	4
PHYS 216 Introductory Laboratory	1
PHYS 314 Introduction to Physics III	4
PHYS 340 Light and Optics	3
Choose one of the following two programming courses:	*2-4*
PHYS 381 Computer Applications for Scientists	2
CS 115 Programming I	4
Capstone course; One of the following:	*2*
ASTR 492 Instructional Design Project	2
ASTR 497 Undergraduate Research in Astronomy	2
PHYS 492 Instructional Design Project	2
PHYS 493 Senior Design Project	2
PHYS 497 Undergraduate Research in Physics	2
The major must include a minimum of 24 upper-division units in physics and astronomy; with an advisor, choose 13-15 units in additional upper-division physics and astronomy courses. Physics 100 may be used to substitute for an advanced Physics elective course.	*13-15*
Total units in the major core	**34-38**

Required Area Of Concentration

Courses in one other field, chosen in consultation with an advisor.

Total units in area of concentration	**12**

Supporting Courses

MATH 161 Differential and Integral Calculus I (3 units may be applied in GE)	4
MATH 211 Differential and Integral Calculus II	4
MATH 261 Multivariable Calculus	4
Total units in supporting courses	**12**
Total units in the major and supporting courses (up to 9 may be applied in GE)	**58 - 62**

Bachelor of Arts in Physics with Advisory Plan T

This plan uses algebra and trigonometry. Students may select from upper-division courses, appropriate to careers as science or technical writers, scientific sales personnel, technicians, programmers, or other technical specialists. There is opportunity to take courses that lead to careers in the health sciences or environmental fields. This degree program is appropriate for those who wish to earn a California Multiple Subject Teaching Credential. Advisory Plan T is often taken as part of a double major.

Degree Requirements	Units
Major requirements (up to 9 in GE)	32-36
Required area of concentration	12
Supporting course (may include 3 in GE)	4
General education	50
General electives	18-31
Total units needed for the degree	**120**

Major Core Requirements	***8***
PHYS 209AB General Physics Laboratory	2
PHYS 210AB General Physics	6
Choose one of the following two courses in modern physics or astronomy:	*3-4*
ASTR 305 Frontiers in Astronomy	3
PHYS 314 Introduction to Physics III	4
Choose one of the following two courses in optics:	*3*
PHYS 340 Light and Optics	3
PHYS 342 Light and Color	3
An approved course in computer applications, e.g., PHYS 381 (2):	*2-4*
Capstone course; One of the following:	*2*
ASTR 492 Instructional Design Project	2
ASTR 497 Undergraduate Research in Astronomy	2
PHYS 492 Instructional Design Project	2
PHYS 493 Senior Design Project	2
PHYS 497 Undergraduate Research in Physics	2
The major must include a minimum of 24 upper-division units in physics and astronomy, so, with an advisor, choose 13-16 units in additional upper-division physics and astronomy courses. Physics 100 may be substituted for an advanced physics elective course.	*13-16*
Total units in the major core	**32-36**

Required Area of Concentration

Courses in one other field chosen in consultation with an advisor.

Total units in area of concentration	12

Supporting Course

MATH 160 Pre-calculus Mathematics (3 units may be applied in GE):	4
Total units in supporting course	4
Total units in the major (up to 9 may be applied in GE)	48-52

Minor in Physics

Completion of a minimum of 20 units in physics courses, including not more than one first course or more than one second course, constitutes a minor in physics. (First courses are PHYS 100, 210A, and 114, and their equivalents taught elsewhere. Second courses are PHYS 210B, 214, and their equivalents.) Interested students should consult with the advisor in the Department of Physics and Astronomy.

Teaching Credential Preparation

See the Teaching Credential Preparation in the Science Courses section of this catalog or contact the department advisor.

Sample Four-Year Program for Bachelor of Science in Physics

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
CHEM 115A (5)	CHEM 115B (5)
MATH 161 (4)	MATH 211 (4)
GE (3)	PHYS 114 (4)
PHYS 100 (3) (Recommended)	PHYS 116 (1)
	PHYS 494 (1) (Recommended)

SOPHOMORE YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
MATH 261 (4)	MATH 241 (4)
PHYS 214 (4)	PHYS 313 (3)
PHYS 216 (1)	PHYS 313L (1)
GE (6)	PHYS 314 (4)
	GE (3)

JUNIOR YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
PHYS 325 (3)	PHYS 320 (3)
PHYS 381 (2)	PHYS 340 (3)
GE (6)	PHYS 366 (3)
Elective (4)	GE (6)

SENIOR YEAR: 30 Units

Fall Semester (16 Units)	*Spring Semester (14 Units)*
PHYS 450 (2)	PHYS 430 (3)
PHYS 460 (3)	PHYS Capstone (2)
GE (8)	GE (9)
Elective (3)	

TOTAL UNITS: 120

See your advisor to discuss acceptable physics electives and when they will be offered. Nine of the 50 units of GE are met by required courses listed here (3 each in areas B1, B3 and B4).

Sample Four-Year Program for Bachelor of Science in Physics with Concentration in Applied Physics

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR: 30 Units

Fall Semester (16 Units)	*Spring Semester (14 Units)*
CHEM 115A (5)	MATH 211 (4)
MATH 161 (4)	PHYS 114 (4)
GE (4)	PHYS 116 (1)
PHYS 100 (3) (recommended)	GE (4)
	PHYS 494 (1) (recommended)

SOPHOMORE YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
MATH 261 (4)	PHYS 313 (3)
PHYS 214 (4)	PHYS 313L (1)
PHYS 216 (1)	PHYS 314 (4)
GE (6)	GE (7)

JUNIOR YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
PHYS 325 (3)	PHYS 340 (3)
PHYS 381 (2)	PHYS 366 (3)
GE (6)	GE (5)
Elective (4)	Elective (4)

SENIOR YEAR: 30 Units

Fall Semester (16 Units)	*Spring Semester (14 Units)*
PHYS 450 (2)	PHYS 430 (3)
PHYS 460 (3)	PHYS 475 (3)
PHYS Elective (2)	PHYS Capstone (2)
GE (3)	GE (6)
Elective (6)	

TOTAL UNITS: 120

See your advisor to discuss acceptable physics electives and when they will be offered. Nine of the 50 units of GE are met by required courses listed here (3 each in areas B1, B3, and B4).

Sample Four-Year Program for Bachelor of Arts in Physics with Advisory Plan C

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
MATH 161 (4)	MATH 211 (4)
GE (7)	PHYS 114 (4)
PHYS 100 (3) (recommended)	PHYS 116 (1)
PHYS 494 (1) (recommended)	GE (6)

SOPHOMORE YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
MATH 261 (4)	PHYS 314 (4)
PHYS 214 (4)	Elective (4)
PHYS 216 (1)	GE (7)
GE (6)	

JUNIOR YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
PHYS 381 (2)	PHYS 340 (3)
Area of Concentration* (3)	PHYS Elective (3)
GE (8)	Area of Concentration* (3)
Elective (2)	GE (3)
	Elective (3)

SENIOR YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
PHYS Elective (3)	PHYS Capstone (2)
Area of Concentration* (3)	Area of Concentration* (3)
GE (4)	PHYS Elective (3)
Electives (5)	Electives (7)

TOTAL UNITS: 120

**Area of Concentration = 12 units in one other subject. Nine of the 50 units of GE are met by required courses listed here (3 each in areas B1, B3, and B4).*

Sample Four-Year Program for Bachelor of Arts in Physics with Advisory Plan T

The sequential nature of the physics curriculum necessitates an early start with major requirements and the distribution of general education courses over four years.

FRESHMAN YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
MATH 160 (4)	PHYS 209A (1)
GE (7)	PHYS 210A (3)
PHYS 100 (3) (recommended)	GE (8)
PHYS 494 (1) (recommended)	Elective (3)

SOPHOMORE YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
PHYS 209B (1)	PHYS Elective (4)
PHYS 210B (3)	Elective (3)
GE (9)	GE (8)
Elective (2)	

JUNIOR YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
ASTR 305 (3)	PHYS 342 (3)
PHYS 381 (2)	PHYS Elective (3)
Area of Concentration* (3)	Area of Concentration* (3)
GE (3)	GE (3)
Elective (4)	Elective (3)

SENIOR YEAR: 30 Units

Fall Semester (15 Units)	*Spring Semester (15 Units)*
PHYS Electives (6)	PHYS Capstone (2)
Area of Concentration* (3)	Area of Concentration* (3)
Electives (6)	Electives (10)

TOTAL UNITS: 120

**Area of concentration = 12 units in one other subject. Nine of the 50 units of GE may be met by required courses listed here (3 each in areas B1, B3, and B4).*

Physics (PHYS)

PHYS 100 Descriptive Physics (3)

Lecture, 3 hours. A descriptive survey of the important principles of physics. Satisfies GE Area B1 or B3 (Physical Sciences). Registration for Chemistry, Physics, or Mathematics majors requires Physics and Astronomy Department consent.

PHYS 102 Descriptive Physics Laboratory (1)

Laboratory, 3 hours. Experimental demonstrations, exercises, and field trips illustrating the methods by which physicists have learned what they claim to know about the world. Instruction is at the PHYS 100 level. Satisfies GE Area B1 or B3 (Physical Sciences) and GE laboratory requirements. Prerequisite: previous or concurrent enrollment in PHYS 100 or ASTR 100, or consent of instructor.

PHYS 114 Introduction to Physics I (4)

Lecture, 4 hours. The first of three basic sequential courses in physics for science and mathematics majors. Introduction to vectors; classical mechanics, including particle dynamics and fluid mechanics; simple harmonic motion; thermodynamics and kinetics. Satisfies GE Area B1 or B3 (Physical Sciences). Prerequisite: MATH 161.

PHYS 114W Physics I Workshop (1)

A workshop designed to be taken with PHYS 114. Exploration of first-semester calculus based physics concepts through inquiry based learning and problem solving in a group setting. Cr/NC only. Corequisite: PHYS 114

PHYS 116 Introductory Laboratory Experience (1)

Laboratory, 3 hours. Demonstrations and participatory experiments are used to increase the student's familiarity with gravitational, electromagnetic, and nuclear forces in nature. Applications include biological, geophysical, medical, and environmental phenomena. Satisfies GE Area B1 or B3 (Physical Sciences) and GE laboratory requirements. Prerequisite: prior or concurrent enrollment in PHYS 114.

PHYS 209A General Physics Laboratory (1)

Laboratory, 3 hours. Laboratory experiments to accompany PHYS 210A and develop the student's ability to perform measurements of physical phenomena and to increase their appreciation of the sense of the physical universe gained through experimentation. 209A satisfies GE Area B1 or B3 (Physical Sciences) and GE laboratory requirements. Prerequisites: high school algebra and trigonometry and a high school physical science, and previous or concurrent enrollment in PHYS 210A.

PHYS 209B General Physics Laboratory (1)

Laboratory, 3 hours. Laboratory experiments to accompany PHYS 210B and develop the student's ability to perform measurements of physical phenomena and to increase their appreciation of the sense of the physical universe gained through experimentation. Prerequisites: PHYS 209A or PHYS 116.

PHYS 210A General Physics (3)

Lecture, 3 hours. A basic course in physics for students majoring in Biology, Geology, or preprofessional programs. Fundamentals of kinematics, Newton's laws, work, momentum, harmonic motion, and an introduction to fluids and concepts of temperature. Registration by Mathematics majors requires Physics and Astronomy Department approval. Satisfies GE Area B1 or B3 (Physical Sciences). Prerequisites: high school algebra and trigonometry or MATH 160.

PHYS 210B General Physics (3)

Lecture, 3 hours. A basic course in physics for students majoring in Biology, Geology, or preprofessional programs. Topics include: electric charges, potentials, fields and currents, magnetism, electromagnetic waves, and optics. Registration by Mathematics majors requires Physics and Astronomy Department approval. Prerequisite: PHYS 210A or PHYS 114.

PHYS 214 Introduction to Physics II (4)

Lecture, 4 hours. The continuation of PHYS 114. This course focuses on electrostatics, quasistatic fields and currents, and magnetostatics; electromagnetic induction; waves; and physical and geometric optics. Prerequisites: PHYS 114 and MATH 211.

PHYS 216 Introductory Laboratory (1)

Laboratory, 3 hours. Selected experiments to increase the student's working physical knowledge of the natural world. Prerequisites: PHYS 114 and 116 and MATH 211. Concurrent enrollment in PHYS 214 is strongly recommended.

PHYS 300 Physics of Music (3)

Lecture, 3 hours. Introduction to physical principles encountered in the study of music, applicable laws of mechanics and acoustics, harmonic analysis, musical scales, sound production in musical instruments, and elements of electronic music.

PHYS 313 Electronics (3)

Lecture, 3 hours. A comprehensive review of DC and AC circuit theory; applications of diodes, transistors and operational amplifiers; electronic test instruments; electronic transducers; waveform generators; noise; logic gates and Boolean algebra; number systems and codes; combinational logic circuits; and applications of circuit simulation programs. Concurrent enrollment in PHYS 313L is mandatory. Prerequisites: MATH 160, PHYS 210B, or 214; or consent of instructor.

PHYS 313L Electronics Laboratory (1)

Laboratory, 3 hours. Laboratory to accompany PHYS 313. Experiments in this lab are designed to address the major topics of the PHYS 313 lecture course. Students will experiment with physical and simulated circuits. Concurrent enrollment in PHYS 313 is mandatory. Prerequisites: MATH 160, PHYS 209B, or 216; or consent of instructor.

PHYS 314 Introduction to Physics III (4)

Lecture, 4 hours. The continuation of PHYS 214. This course focuses on special relativity, elementary quantum mechanics, the Bohr atom and deBroglie waves, the Schrödinger wave equation with applications to simple one-dimensional problems and to atomic structure, elementary nuclear physics, introduction to equilibrium statistical mechanics, the partition function, and Boltzmann statistics. Prerequisites: PHYS 214 and MATH 261.

PHYS 320 Analytical Mechanics (3)

Lecture, 3 hours. This course is an exploration into the principles of Newtonian, Lagrangian, and Hamiltonian mechanics. It also includes a treatment of noninertial reference frames, rigid body rotation, central force problems, and the dynamics of a system of particles. Prerequisites: PHYS 114 and PHYS 325.

PHYS 325 Introduction To Mathematical Physics (3)

Lecture, 3 hours. This course examines advanced mathematical methods and serves as a foundation for future courses. Topics include coordinate systems and vectors, vector calculus, series expansions, differential equations, orthonomal functions, solutions of systems of linear equations, matrices and tensors, complex numbers, eigenvalues and eigenfunctions, Fourier series and Fourier integrals, and use of mathematical symbolic processing software. Prerequisites: PHYS 214 and MATH 261, or consent of instructor.

PHYS 340 Light and Optics (3)

Lecture, 3 hours. An examination of the properties of light from geometric and physical optics perspectives. Topics include: ray optics, refraction, diffraction, coherence, interference, and polarization. The course will present Fermat's principle, Huygens' principle, and Fourier optics. Prerequisite: PHYS 314 or 325.

PHYS 342 Light and Color (3)

Lecture, 3 hours. A descriptive, nonmathematical, but analytical treatment of the physical properties of light, the camera, telescope, microscope, and laser; holography, mirages, rainbows, and the blue sky; colors in flowers, gems, and pigments; and human and animal vision and visual perception. Satisfies GE Area B3 (Specific Emphasis in Natural Sciences). Prerequisite: any physical science course or consent of instructor.

PHYS 366 Intermediate Experimental Physics (3)

Lecture 2 hours; laboratory 3 hours. An introduction to contemporary techniques and problems in physics. Selected topics in lasers and photonics, materials science (including high-magnetic field measurements and surface analysis using scanning electron and atomic force microscopy), X-ray analysis, applied nuclear physics, and adaptive optics. Prerequisites: PHYS 314 and 216, or consent of instructor.

PHYS 381 Computer Applications for Scientists (2)

Lecture, 1 hour; laboratory, 3 hours. A survey of problem solving techniques including computer modeling and simulation for the physical sciences. The student is introduced to high-level programming languages such as C++ and various mathematical tools such as Excel, Mathematica, and MatLab. Topics include modern programming techniques, use of graphics and mathematical function libraries, linear least squares data fitting techniques, numerical solution of algebraic and differential equations, and error analysis. Prerequisites: PHYS 114 and MATH 211.

PHYS 395 Community Involvement Program (1-2)

CIP involves students in basic community problems related to physics and astronomy — performing such tasks as tutoring; reading to the blind; service to local, county, and state agencies; and service as teacher aides to elementary schools. Students receive 1-2 units, depending on the specific task performed. Not more than 4 CIP units will be applicable to the Physics major requirements. May be taken by petition only.

PHYS 396 Selected Topics in Physics (1-4)

A course of lectures on a single topic or set of related topics not ordinarily covered in the Physics curriculum. The course may be repeated for credit with a different topic. Prerequisite: consent of instructor.

PHYS 430 Electricity and Magnetism (3)

Lecture, 3 hours. An investigation into the fundamentals of electromagnetic theory and its applications. Topics include vector analysis, electrostatics, method of images, magnetostatics, electric currents, electromagnetic induction, electric and magnetic fields in matter, Maxwell's equations, electromagnetic waves, potentials, and fields. Prerequisites: PHYS 214 and PHYS 325. Cross-listed as ES 430.

PHYS 445 Photonics (3)

Lecture, 3 hours. A practical examination of Gaussian beams; guided-wave optics; fiber optics; optical resonators; resonant cavities; laser oscillation and amplification; laser excitation; optical pumping; solid state, gas, dye, chemical, excimer, and free electron lasers; semiconductor lasers; laser spectroscopy; fiber optic communication; photomultiplier and semiconductor radiation detectors including photoconductors and junction photodiodes; p-i-n diodes and avalanche photodiodes; and detector noise. Prerequisite: PHYS 314 or consent of instructor. Cross-listed as CES 430 and ES 445.

PHYS 450 Statistical Physics (2)

Lecture, 2 hours. An introduction to statistical methods. Topics include ideal gas, heat capacities, entropy, enthalpy, and the laws of thermodynamics; Boltzmann, Bose, and Fermi statistics; and applications such as engines and refrigerators. Prerequisite: PHYS 314.

PHYS 460 Quantum Physics (3)

Lecture, 3 hours. This course examines the Schrödinger equation and its solution for free particles, potential wells, harmonic oscillators, central potentials, and the hydrogen atom. Other topics may include Hilbert space, Hermitian operators, Dirac notation, angular momentum and spin, scattering, wave function symmetry, and elementary perturbation theory. Prerequisites: PHYS 314 and 325.

PHYS 466 Advanced Experimental Physics (3)

Lecture, 2 hours; laboratory, 3 hours. Advanced topics in lasers and photonics, materials science (including high-magnetic field measurements and surface analysis using scanning electron and atomic force microscopy), X-ray analysis, applied nuclear physics, and adaptive optics. Prerequisites: PHYS 314 and 216, or consent of instructor.

PHYS 475 Physics of Semiconductor Devices (3)

Lecture, 3 hours. A detailed study of semiconductors and their applications. Topics include semiconductor materials, crystal structure and growth, energy bands and charge carriers, conductivity and mobility, metal-semiconductor and p-n junctions, p-n junction diodes, bipolar junction transistors, field-effect transistors, CCDs, photonic devices, and integrated circuits. Conductivity and contact resistance measurements, I-V and C-V characteristics of diodes, and characterization of transistors are also discussed. Prerequisite: PHYS 314 or consent of instructor. Cross-listed as CES 432 and ES 432.

PHYS 492 Instructional Design Project (2)

A directed project to develop at least one laboratory experiment and/or classroom activity that teaches basic concepts in undergraduate physics. Both written and oral presentations (including a demonstration of the experiment or activity) will be required. Prerequisites: PHYS 214 and 216 or PHYS 210B and 209B. Course may be repeated for credit.

PHYS 493 Senior Design Project (2)

A directed project to develop either a working prototype or a detailed conceptual design for an operational laboratory device. Both written and oral presentations (including a demonstration) will be required. Prerequisite: PHYS 313L. Application form required prior to enrollment. Course may be repeated for credit.

PHYS 494 Physics Seminar (1)

A series of lectures on topics of interest in physics, astronomy, and related fields. May be repeated for credit up to 3 units maximum. Prerequisite: consent of instructor.

PHYS 495 Special Studies (1-4)

The Physics and Astronomy Department encourages independent study and considers it to be an educational undertaking. Students wishing to enroll for special studies are required to submit proposals to their supervising faculty members that outline their projects and exhibit concrete plans for their successful completion. May be repeated for credit.

PHYS 497 Undergraduate Research in Physics (2)

Supervised research in an area of physics that is currently under investigation by one or more members of the Physics and Astronomy Department's faculty. This course may be repeated for up to 6 units of credit. Both written and oral presentations will be required. Prerequisites: junior-level standing and consent of instructor.

Appendix L – Advising

L.1 Academic Progress Report Overview

L.2 Current Advising Forms

L.3 Physics Major Pre-requisite flowchart

L.4 Student Planning Forms

Office of the Registrar

- Office of the Registrar Home
- Academic Calendar
- Academic Disqualification
- Course Repeat
- CSU Course Match
- Enrollment Verification
- FERPA
- Forms & Petitions
- GPA Calculator
- Grade Information
- Graduation
- Residency Reclassification
- Transcripts
- Transfer & Test Credit
- Waitlist FAQs
- Withdrawals
- Contact Us

Where to Find

- Degrees Offered
- Office of Admissions
- Online Services
- Student Charges/Fees
- Veteran's Affairs

Reading Your Academic Requirements Report

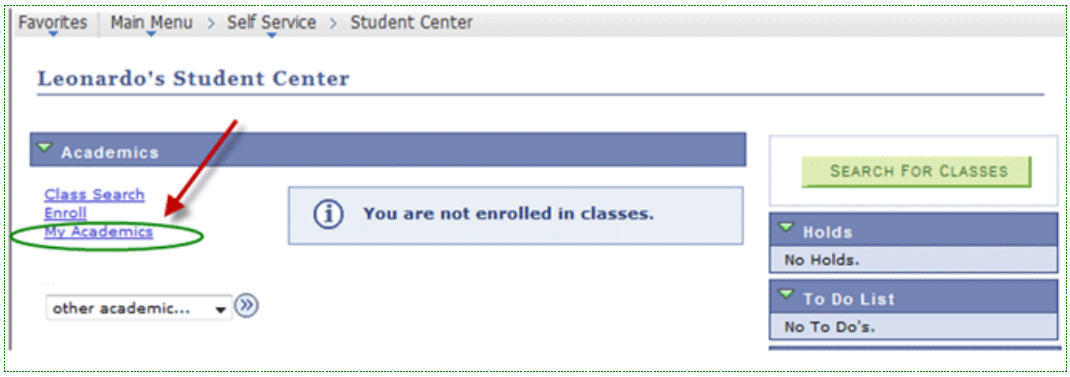
These are instructions for students. FACULTY: Go to [to www.registration/faculty_help/faculty_arr.html](www.registration/faculty_help/faculty_arr.html) for instructions on how to run the ARR from the Advisor Center, but you can use this page to learn how to read the ARR.

Overview

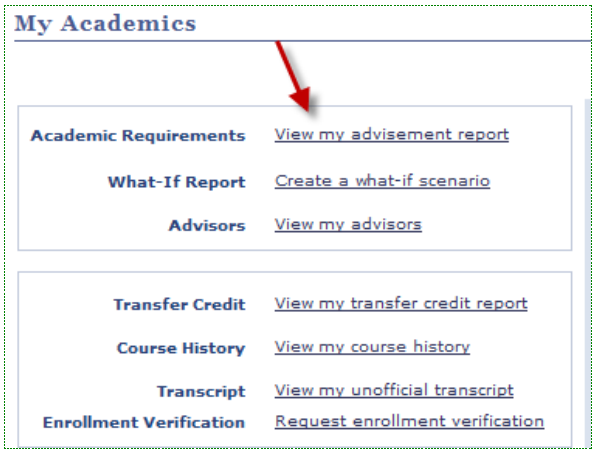
From your Student Center, you can view your Academic Requirements Report (formerly known as the DPR). This report tracks the completion of all degree requirements.

- *The ARR is a report that tracks the completion of ALL degree requirements in one place*
- *Lists all courses completed at SSU, uses courses in-progress, and any transfer or test credit courses that have been submitted on official documents*
- *The ARR is dynamic and displays new information:*
  - *After registration*
  - *After grades are posted and Records runs their repeat checking process*
  - *After a major or minor is changed*

1.) From your Student Center page, click on "My Academics" from your Student Center



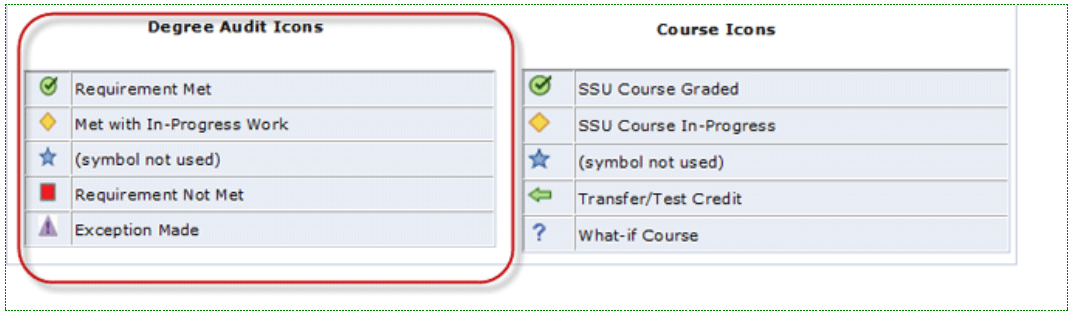
2.) Getting to ARR: From the My Academics page, find "Academic Requirements" and click on "View my Advisement Report".



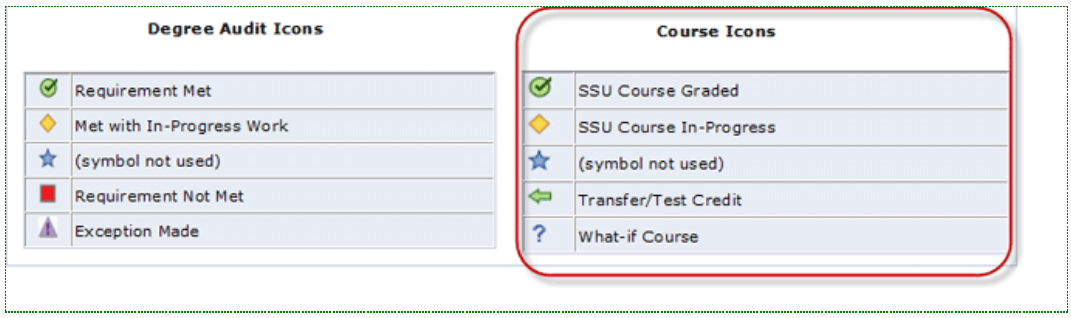
3.) NOTE: Faculty, Advisors and Students. At this point you should be viewing the Academic Requirement Report. See figure below.

1. *Current Academic Objective contains all officially declared Majors and Minors.*
2. *Requirement Term refers to Catalog year requirements.*

4.) The "Degree Audit icons" (left area) will indicate completion status of requirements throughout the report.

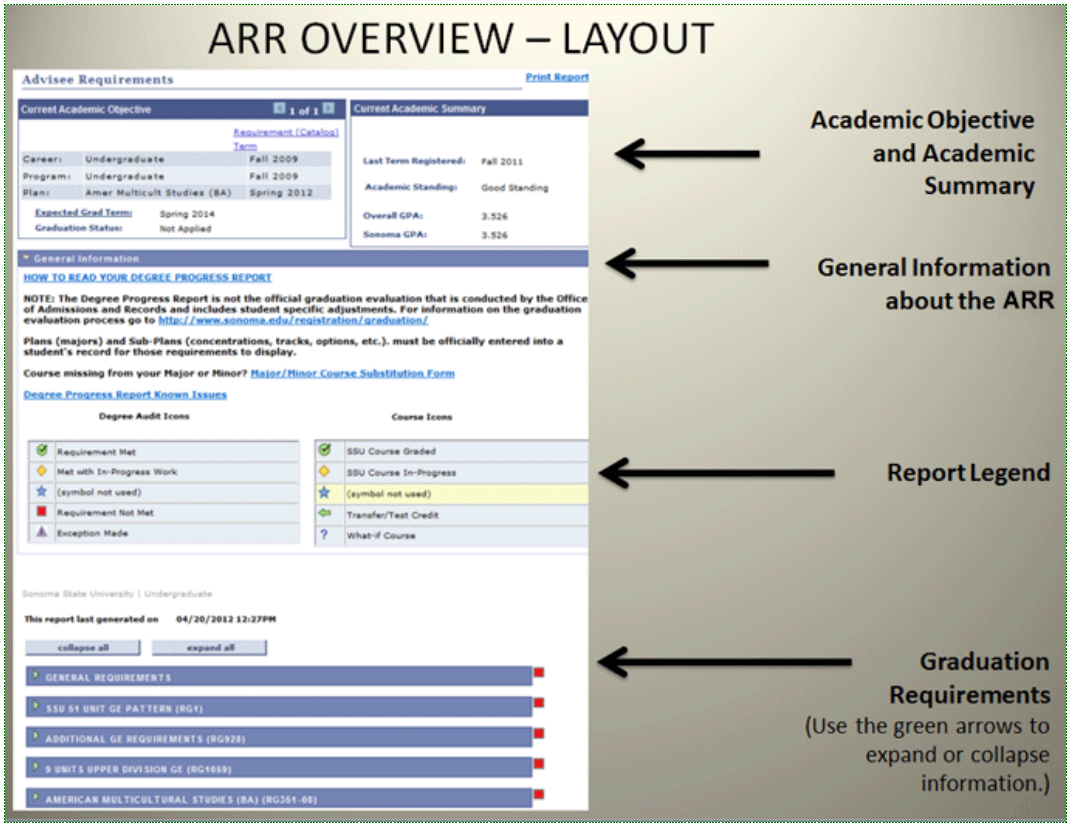


5.) The "Course Icons" (right area) indicate what kind of course was used towards that requirement

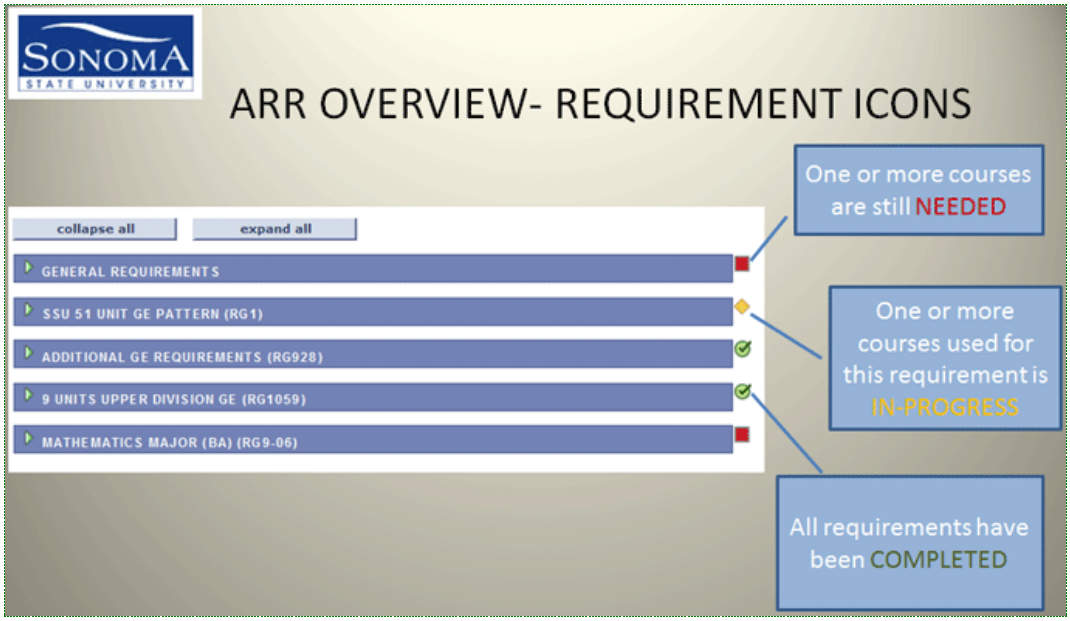


SSU Course Graded	*A course taken at and Completed with a Grade at SSU*
SSU Course In-Progress	*A course being taken at SSU, but still needs to be graded before it clears any requirements*
Transfer/Test Credit	*Transfer or Test Credit that has been posted to your student record, submitted to SSU on official documents*
What-if Course	*Course being used during a What-If report simulation*

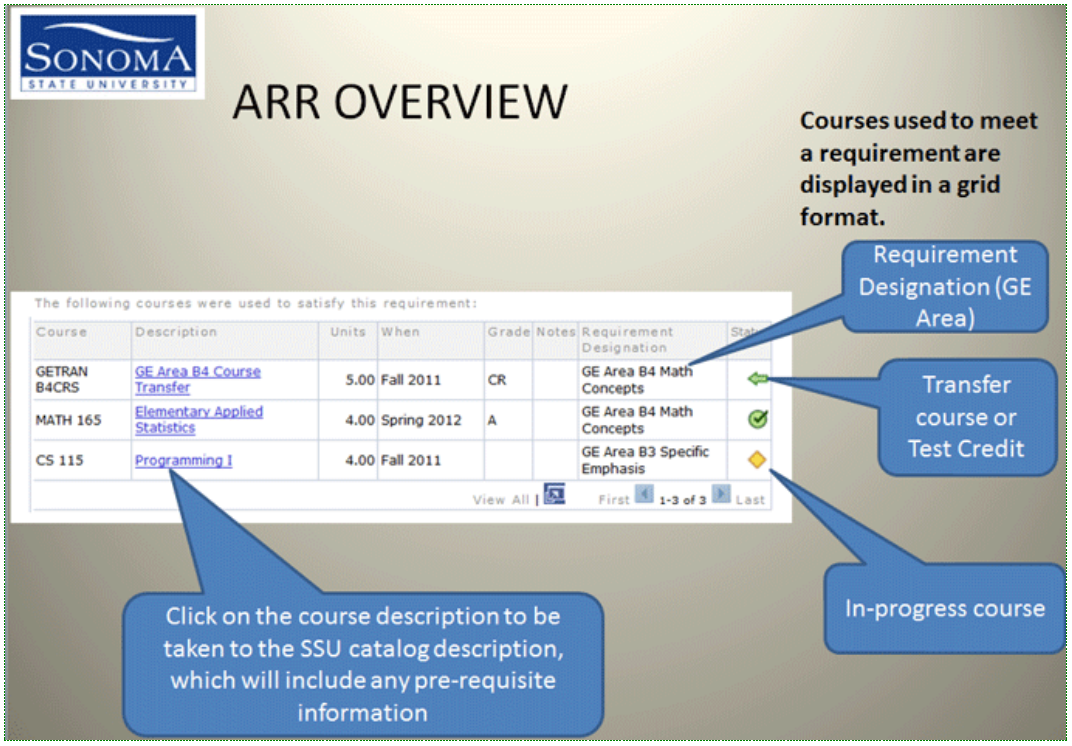
6.) You can view different sections of your ARR. These include: Academic Objective and Academic Summary, General Information about the ARR, Report Legend and Graduation Requirements. See figure below:



7.) Below are the requirement icons:



8.) Below is an example of courses that are being used to meet a requirement. Note that a course must receive a Grade before it will satisfy the requirement:



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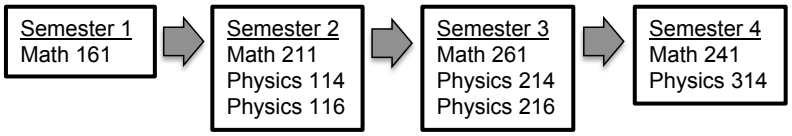
Bachelor of Science in Physics
Department of Physics and Astronomy, SSU

Advising Dates _____ _____
_____ _____
_____ _____
_____ _____

Name _____

Example Starting Sequence:
(See advisor for details)



Required Core Courses

Course		Units	Semester ‡	Grade
Phys 114	Physics I	4	F/S	
Phys 116	Phys I Lab	1	F/S	
Phys 214	Physics II	4	F/S	
Phys 216	Phys II Lab	1	F/S	
Phys 313	Electronics	3	S	
Phys 313L	Electr. Lab	1	S	
Phys 314†	Physics III	4	S	
Phys 320	Mechanics	3	S	
Phys 325†	Math Physics	3	F	
Phys 340	Optics	3	S	
Phys 366	Interm. Lab	3	S	
Phys 381	Comp. for Sci.	2	F	
Phys 430	Elec. And Mag.	3	S	
Phys 450	Stat. Physics	2	F	
Phys 460	Quantum	3	F	

† Phys 314 and 325 are important prerequisites for most upper-division physics courses, see catalog for details.

Required Supporting Courses

Course		Units	Semester	Grade
Chem 115A	Gen. Chem I	5		
Chem 115B	Gen Chem II	5		
Math 161	Calc. I	4		
Math 211	Calc. II	4		
Math 241	Diff Eq+Lin Alg	4		
Math 261	Multiv. Calc.	4		

Please take Math in this sequence: 161, 211, 261, then 241

Major Electives - 6 Units Advanced Electives
One of the courses must be a capstone (*) course.

Course		Units	Semester ‡	Grade
Astr 380	Astrophys.	3		
Astr 482	Observ. Astr.	2		
Astr 492*	Instruct. Design	2	F/S	
Astr 495	Special Studies	1-4	F/S	
Astr 497*	Astr. Research	2	F/S	
Phys 100	Desc. Phys.	3	F	
Phys 445	Photonics	3		
Phys 466	Adv. Lab	3		
Phys 475	Semiconductors	3	S	
Phys 492*	Instruct. Design	2	F/S	
Phys 493*	Senior Design	2	F/S	
Phys 494	Phys. Seminar	1 (≤3x)	F/S	
Phys 495	Special Studies	1-4	F/S	
Phys 497*	Phys. Research	2	F/S	

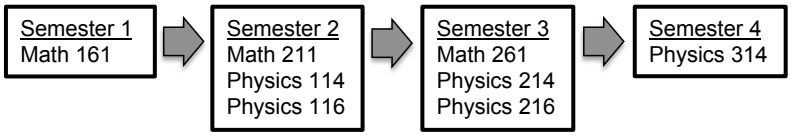
* Capstone courses, preferably taken in final Spring semester.
‡ Semester the course is typically offered is shown in gray type: F=Fall, S=Spring, F/S=both. (Subject to Change.)

B.S. in Physics with Concentration in Applied Physics
Department of Physics and Astronomy, SSU

Advising Dates _____ _____
_____ _____
_____ _____
_____ _____

Name _____

Example Starting Sequence:
(See advisor for details)



Required Core Courses

Course		Units	Semester ‡	Grade
Phys 114	Physics I	4	F/S	
Phys 116	Phys I Lab	1	F/S	
Phys 214	Physics II	4	F/S	
Phys 216	Phys II Lab	1	F/S	
Phys 313	Electronics	3	S	
Phys 313L	Electr. Lab	1	S	
Phys 314†	Physics III	4	S	
Phys 325†	Math Physics	3	F	
Phys 340	Optics	3	S	
Phys 366	Interm. Lab	3	S	
Phys 381	Comp. for Sci.	2	F	
Phys 430	Elec. And Mag.	3	S	
Phys 450	Stat. Physics	2	F	
Phys 460	Quantum	3	F	
Phys 475	Semiconductor	3	S	

† Phys 314 and 325 are important prerequisites for most upper-division physics courses, see catalog for details.

Required Supporting Courses

Course		Units	Semester	Grade
Chem 115A	Gen. Chem I	5		
Math 161	Calc. I	4		
Math 211	Calc. II	4		
Math 261	Multiv. Calc.	4		

Please take Math in this sequence: 161, 211, then 261

Major Electives - 8 Units Advanced Electives
One of the courses must be a capstone (*) course.

Course		Units	Semester ‡	Grade
Astr 380	Astrophys.	3		
Astr 482	Observ. Astr.	2		
Astr 492*	Instruct. Design	2	F/S	
Astr 495	Special Studies	1-4	F/S	
Astr 497*	Astr. Research	2	F/S	
Phys 100	Desc. Phys.	3	F	
Phys 320	Mechanics	3	S	
Phys 445	Photonics	3		
Phys 466	Adv. Lab	3		
Phys 492*	Instruct. Design	2	F/S	
Phys 493*	Senior Design	2	F/S	
Phys 494	Phys. Seminar	1 (≤3x)	F/S	
Phys 495	Special Studies	1-4	F/S	
Phys 497*	Phys. Research	2	F/S	

* Capstone courses, preferably taken in final Spring semester.
‡ Semester the course is typically offered is shown in gray type: F=Fall, S=Spring, F/S=both. (Subject to Change.)

B.A. in Physics with Advisory Plan C
Department of Physics and Astronomy, SSU

Advising Dates _____ _____

Name _____

Example Starting Sequence:
(See advisor for details)

Semester 1	Semester 2	Semester 3	Semester 4
Math 161	Math 211 Physics 114 Physics 116	Math 261 Physics 214 Physics 216	Physics 314

Required Core Courses

Course		Units	Semester ‡	Grade
Phys 114	Physics I	4	F/S	
Phys 116	Phys I Lab	1	F/S	
Phys 214	Physics II	4	F/S	
Phys 216	Phys II Lab	1	F/S	
Phys 314†	Physics III	4	S	
Phys 340	Optics	3	S	

† Phys 314 and 325 are important prerequisites for most upper-division physics courses, see catalog for details.

Choose One Required Programming Course

Course		Units	Semester	Grade
Phys 381	Comp. for Sci.	2	F	
CS 115	Programming I	4		

Required Supporting Courses

Course		Units	Semester	Grade
Math 161	Calc. I	4		
Math 211	Calc. II	4		
Math 261	Multiv. Calc.	4		

Please take Math in this sequence: 161, 211, then 261

Concentration: courses in one other field.
Chosen in consultation with advisor. (12 Units)

Course	Units	Semester	Grade

Capstone Course* - Choose One

Course		Units	Semester ‡	Grade
Astr 492*	Instruct. Design	2	F/S	
Astr 497*	Astr. Research	2	F/S	
Phys 492*	Instruct. Design	2	F/S	
Phys 493*	Senior Design	2	F/S	
Phys 497*	Phys. Research	2	F/S	

* Capstone courses, preferably taken in final Spring semester.

‡ Semester the course is typically offered is shown in gray type: F=Fall, S=Spring, F/S=both. (Subject to Change.)

Major includes a minimum of **24 upper-division units in physics and astronomy.** With an advisor, **choose 13-15 units** in additional upper-division physics and astronomy courses. Phys 100 may be substituted for an advanced physics elective.

Course		Units	Semester ‡	Grade
Astr 303	Life in Universe	3	F	
Astr 305	Front. In Astron.	3	F	
Astr 350	Cosmology	3	S	
Astr 495	Special Studies	1-4	F/S	
Phys 100	Descriptive Phys.	3		
Phys 300	Phys. Of Music	3	S	
Phys 313	Electronics	3	S	
Phys 313L	Electr. Lab	1	S	
Phys 320	Mechanics	3	S	
Phys 325†	Math Physics	3	F	
Phys 366	Interm. Lab	3	S	
Phys 381	Comp. for Sci.	2	F	
Phys 430	Elec. And Mag.	3	S	
Phys 445	Photonics	3		
Phys 450	Stat. Physics	2	F	
Phys 460	Quantum	3	F	
Phys 466	Adv. Lab	3		
Phys 475	Semiconductor	3	S	
Phys 494	Phys. Seminar	1 (≤3x)	F/S	
Phys 495	Special Studies	1-4	F/S	

B.A. in Physics with Advisory Plan T
Department of Physics and Astronomy, SSU

Advising Dates _____ _____

Name _____

Example Starting Sequence:
(See advisor for details)

Semester 1	Semester 2	Semester 3
Math 160	Physics 209A	Physics 209B
Physics 100 (recommended)	Physics 210A	Physics 210B

Required Core Courses

Course		Units	Semester ‡	Grade
Phys 209A	Gen Phys I Lab	1	F/S	
Phys 210A	Gen Phys I	3	F/S	
Phys 209B	Gen Phys II Lab	1	F/S	
Phys 210B	Gen Phys II	3	F/S	

Choose one course in Modern Physics

Course		Units	Semester	Grade
Astr 305	Fron. In Astron.	3	F	
Phys 314†	Physics III	4	S	

† Course includes calculus-based prerequisites, consult catalog

Choose one course in Optics

Course		Units	Semester	Grade
Phys 340†	Optics	3	S	
Phys 342	Light & Color	3	F	

Required supporting course

Course		Units	Semester	Grade
Math 160	Precalculus	4		

Choose an approved course in Computer Applications

Course		Units	Semester	Grade
Phys 381	Comp. for Sci.	2	F	

Concentration: courses in one other field.
Chosen in consultation with advisor. (12 Units)

Course	Units	Semester	Grade

Capstone Course* - choose one

Course		Units	Semester ‡	Grade
Astr 492*	Instruct. Design	2	F/S	
Astr 497*	Astr. Research	2	F/S	
Phys 492*	Instruct. Design	2	F/S	
Phys 493*	Senior Design	2	F/S	
Phys 497*	Phys. Research	2	F/S	

* Capstone courses, preferably taken in final Spring semester.

‡ Semester the course is typically offered is shown in gray type: F=Fall, S=Spring, F/S=both. (Subject to Change.)

Major includes a minimum of **24 upper-division units in physics and astronomy.** With an advisor, **choose 13-16 units** in additional upper-division physics and astronomy courses. Phys 100 may be substituted for an advanced physics elective.

Course		Units	Semester ‡	Grade
Astr 303	Life in Universe	3	F	
Astr 305	Front. In Astron.	3	F	
Astr 350	Cosmology	3	S	
Astr 495	Special Studies	1-4	F/S	
Phys 100	Descriptive Phys.	3		
Phys 300	Phys. Of Music	3	S	
Phys 313**	Electronics	3	S	
Phys 313L**	Electr. Lab	1	S	
Phys 381**	Comp. for Sci.	2	F	
Phys 494	Phys. Seminar	1 (≤3x)	F/S	
Phys 495	Special Studies	1-4	F/S	

** These, and additional upper-division courses in physics and astronomy are available, but include calculus-based prerequisites, or instructor consent

Minor in Physics
Department of Physics and Astronomy, SSU

Name _____

Advising Dates

_____	_____
_____	_____
_____	_____

20 units of physics courses
Not more than one first or second course

Course		Units	Semester	Grade
Phys 100	Descr Physics	3	F/S	
Phys 210A	General Physics	3	F/S	
Phys 114	Introduction to Physics I	4	F/S	
Phys 210B	General Physics	3	F/S	
Phys 214	Introduction to Physics II	2	F/S	
Phys 116	Intro Lab Experience	1	F/S	
Phys 216	Intro Lab	1	F/S	
Phys 300	Physics of Music	3	S	
Phys 313/L	Electronics and Lab	4	S	
Phys 314	Intro to Physics III	4	F/S	
Phys 342	Light and Color	3	F/S	
Phys 381	Computer Applications	2	F	
Phys 495	Special Studies	1 - 4	F/S	

Other Physics Courses

_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Minor in Astronomy
Department of Physics and Astronomy, SSU

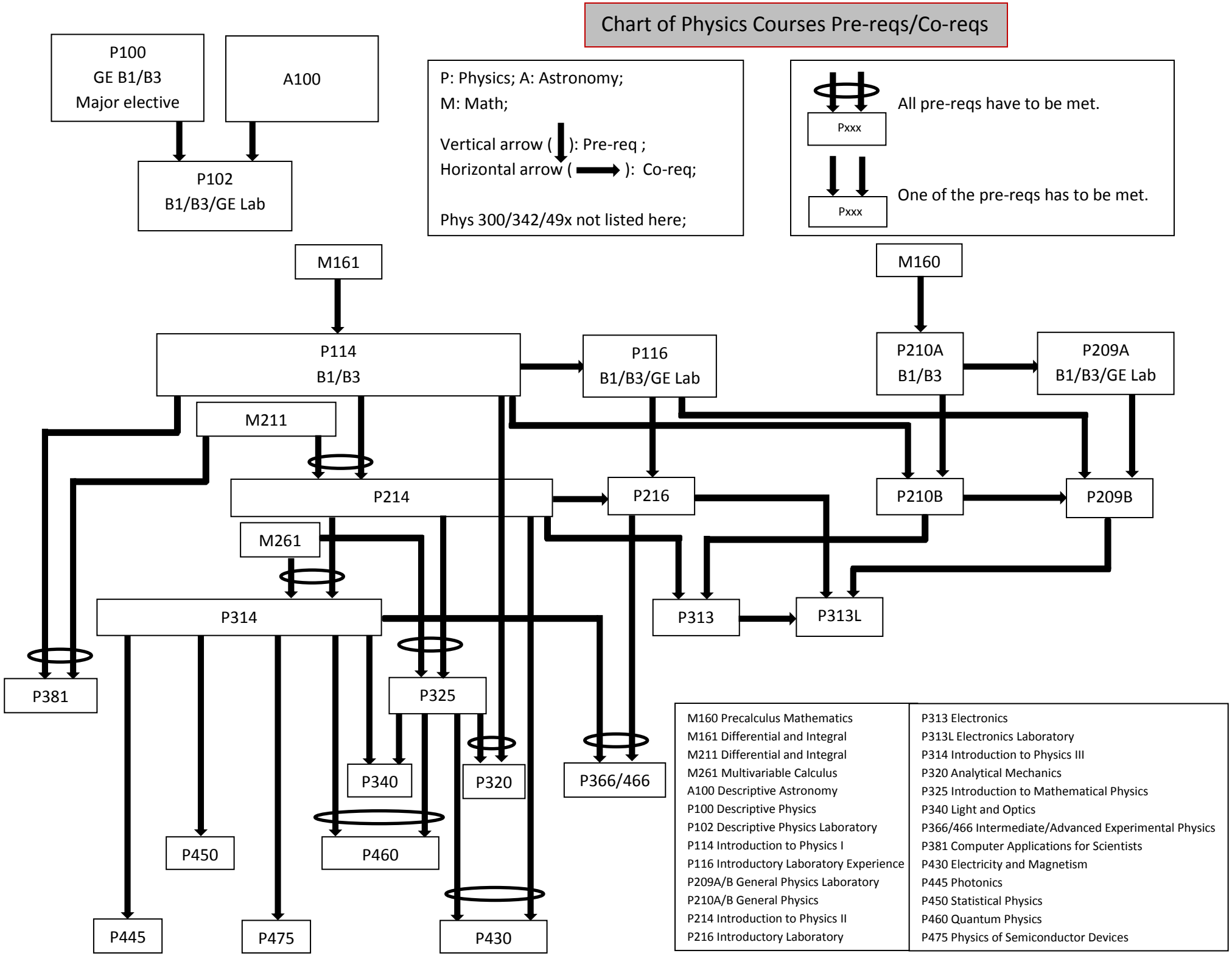
Name _____

Advising Dates

20 units of Astronomy and other physical or life sciences courses
12 units must be in Astronomy
Courses used to meet major requirements may not be used as minor requirements
Supporting courses for major may be used

Course		Units	Semester	Grade
Astr 100	Descr Astro	3	F/S	
Astr 231	Intro Obs Astro	2	F/S	
Astr 303	ET and Interstellar Travel	3	F	
Astr 305	Frontiers in Astro	3	F	
Astr 331	Astronomical Imaging	2		
Astr 350	Cosmology	3	S	
Astr 380	Astrophysics: Stars	3		
Astr 396	Selected Topics	1 - 3		
Astr 482	Adv Obs Astr	2		
Astr 492	Instr Design Project	2		
Astr 495	Special Studies	1 - 4		
Astr 497	Undergrad Research	2		
Other courses in Physical or Life Sciences				

Chart of Physics Courses Pre-reqs/Co-reqs



Four-Year Degree Plan Worksheet

The purpose of this sheet is to give you the opportunity to plan out the sequence and timing of the courses you'll need to complete your degree here at SSU. When planning out your degree be sure to pay attention to the requirements of the SSU general education pattern and your major (plus minor if you have one). You'll also need to pay close attention to any pre-requisites or special requirements for each course in your plan. You can find this information Listed in the SSU catalog at the following URL: http://www.sonoma.edu/catalog/ This exercise is intended for general planning purposes only. Once completed schedule an appointment with an advisor (for your major if you have already declared) who will go over this worksheet with you and will provide you with feedback on the overall accuracy of your plan. Have advisor sign before returning.

Freshman Year Fall Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Freshman Year Spring Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Freshman Year Intersession/Summer/Other College (Must fill out Dual Enrollment Form At Admission and Records)

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Total Freshman Units (Fall+Spring+Other) = _____

Freshman Year Notes:

1) Actively find a major. 2) Make an appointment with an advisor to discuss this plan.

Sophomore Year Fall Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Sophomore Year Spring Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Sophomore Year Intersession/Summer/Other College (Must fill out Dual Enrollment Form At Admission and Records)

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Total Freshman Year Units = _____

Total Sophomore Year Units = _____

Total Units = _____

Sophomore Year Notes:

1) Approved Upper Division courses only count towards GE if taken during, or after, the semester you have 60 or more units.

Junior Year Fall Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Junior Year Spring Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Junior Year Intersession/Summer/Other College (Must fill out Dual Enrollment Form At Admission and Records)

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Total Freshman Year Units = _____
Total Sophomore Year Units = _____
Total Junior Year Units = _____
Total Units = _____

Junior Year Notes:

Junior Year Notes:

1) Take WEPT ASAP after obtaining upper division status (60 units).
2) Make sure to include in Junior and Senior year plans 9 units of Upper Division GE classes.

Senior Year Fall Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Senior Year Spring Possible Registration Backup Courses:

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Senior Year Intersession/Summer/Other College (Must fill out Dual Enrollment Form At Admission and Records)

Course	Prerequisites (if any)	Number of Units	Check All That Apply + Note On Lists			
			Major	GE Area	UE*	Minor
Total Semester Units =						

Total Freshman Year Units = _____
Total Sophomore Year Units = _____
Total Junior Year Units = _____
Total Senior Year Units = _____
Total Units = _____

Senior Year Notes:

Senior Year Notes:
s1) Make sure to apply for graduation by deadline.

UE* = University Elective

Important Note: Attach correct GE pattern with all requirements listed in above plan checked off. Attach degree requirements for major as listed in the SSU catalog with all requirements listed in above plan checked off.

Advisor Signature: _____ Date: _____

Society of Physics Students (SPS) and Skills Lab at SSU

Hongtao Shi, Advisor, SSU Society of Physics Students

The SPS chapter at SSU has done a tremendous amount of work over the last few years. The club has been making every effort to recruit new members and to inform students about its activities: by visiting all lower division physics and astronomy classes, participating in the on-campus welcome event "Big Night", and staffing a booth at the Club Fair as each semester starts. Our chapter has also continued to hold study and tutoring sessions in order to help one another with homework and tests, but also hold times every week to tutor non-majors on campus. This has become a great way to reach out to those in need of additional help in their physics and astronomy courses. To showcase what the Department has been doing, SPS also hosts Physics and Astronomy tables on Seawolf Day and MESA (Mathematics, Engineering, and Science Achievement) Day.

Fig. 1: SPS competes during Geek week.

In addition to a rich social schedule, recently our club made a trip to the Stanford Linear Accelerator Center (SLAC), which greatly increased knowledge and interest in potential job fields related to the science majors, and was a wonderful bonding experience for the club members and students from other departments that joined as well. In 2009, SPS organized a camping event at Yosemite National Park. Later that year, a few members visited the then brand new California Academy of Sciences in San Francisco. Since 2011, our club has been participating and competing in Geek Week (an event organized by the chemistry club, taking place every spring semester) against other science and engineering majors in the School of Science and Technology for the Darwin Trophy (See Figure 1).

To foster an interest and excitement about the key concepts that lie at the heart of the study of Physics and Astronomy, the club has been involved in many local outreach activities over the years. In fall 2010, members visited the Roseland Accelerated Middle School in Santa Rosa and enjoyed sharing some cool physics demos with the students and watched them build their mousetrap cars. In fall 2011, SPS volunteered at Bellevue Elementary School in Santa Rosa, where we brought multiple demos to show motion, angular momentum, and fun low temperature experiments using liquid nitrogen. We also conducted presentations for an after-school program, hoping to increase the interest of young children in the sciences before reaching higher grade-levels. In fall 2012, on behalf of the SSU SPS chapter, Jack Horowitz, Travis Pappa and Amandeep Gill submitted a proposal to the national SPS Office, which later was granted the Marsh White Award – an award given out to SPS chapters with some of the best ideas in the nation to take physics education to the public. The physics lesson that SPS members presented to the fourth-grade class of Roseland Elementary School in Santa Rosa indicated that engaging students in science at an early age is possible by allowing them to participate actively in hands-on learning processes.

Fig. 2: SPS members interact with fourth-grade students from Roseland Elementary School.

The lesson involved assisting the students in building simple electric motors, showing the fun and exciting aspect of electricity and magnetism (See Figure 2). Our club also provided more materials (such as wires and magnets) for the students to take home to further deepen their understanding, in the hope of helping to inspire a new generation of scientists.

In November 2013, the Physics and Astronomy department hosted the American Physical Society's Far West Regional Meeting at SSU. SPS members not only volunteered in large numbers to help run the event smoothly, several students also presented their work on the various research projects in the department, two of whom (Kevin Zack and Stephan Jackowski) won the first and second places for the Steven Chu Undergraduate Research Award. In addition, our club hosted a Halloween reception party the night before the conference started to welcome visiting SPS members and scholars from around California, which was well received.

In order to expand the club's outreach effort and broaden student research experience, our club applied for three different grants through the National SPS organization in fall 2013. This is the first time in the history of the department that we won all three in the same school year! SPS, in partnership with MESA, won the SPS Future Faces of Physics Award to present a two-day long hands-on lab on microcontrollers, after which attendees were loaned starter kits for the semester to further explore microcontrollers on their own. For a second year running, we received the Marsh White Outreach award to promote physics and science in the local community. The outreach event was held during the last Public Viewing Night of the spring 2014 semester when SPS put on a physics fair with demos explaining concepts to our students and the general public such as sizes and distances of the Solar System. In addition, SPS used the funds to digitize a collection of marvelous astronomical slides to present at that fair, making them more accessible. We were also very proud to receive the Sigma Pi Sigma Undergraduate Research Award for the first time to build a CubeSat ground station to complement the recently launched T-LogoQube satellite, designed and built by SPS members Kevin Zack, Hunter Mills, and Benjamin Cunningham (see Figure 3 and the following link: http://www.sonoma.edu/newscenter/2013/12/tiny-satellite-built-by-ssu-and-morehead-state-university-students-is-now-in-orbit.html).

Fig. 3: Team members that built the first satellite launched by SSU are (left to right) Ben Cunningham, Steve Anderson (SSU equipment technician), Kevin Zack (project student lead, holding satellite), Hunter Mills and Dr. Garrett Jernigan (mentor).

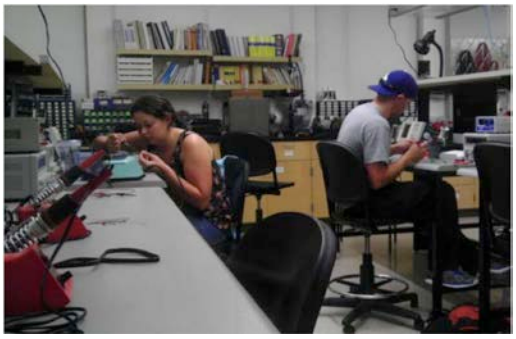


Fig. 4: Students working in the Skills Lab.

Another important thing to note is in fall 2013, SPS started to implement a new peer-teaching program called Skills Lab, in which upper division physics majors teach their fellow students skills such as soldering, photometry, and Arduino microcontrollers. The goal is to teach the research skills necessary for a successful senior capstone project, as well as to provide the peer-instructors a friendly setting to strengthen their understanding of the topic by presenting it to peers. The club continues to support educationally disadvantaged students by providing weekly tutoring, study sessions, and career workshops. In covering topics such as microcontrollers, the Arduino language, and soldering

on a printed circuit board (PCB) in a lab setting, SPS hopes to bridge the gap underrepresented students face upon entering a STEM major.

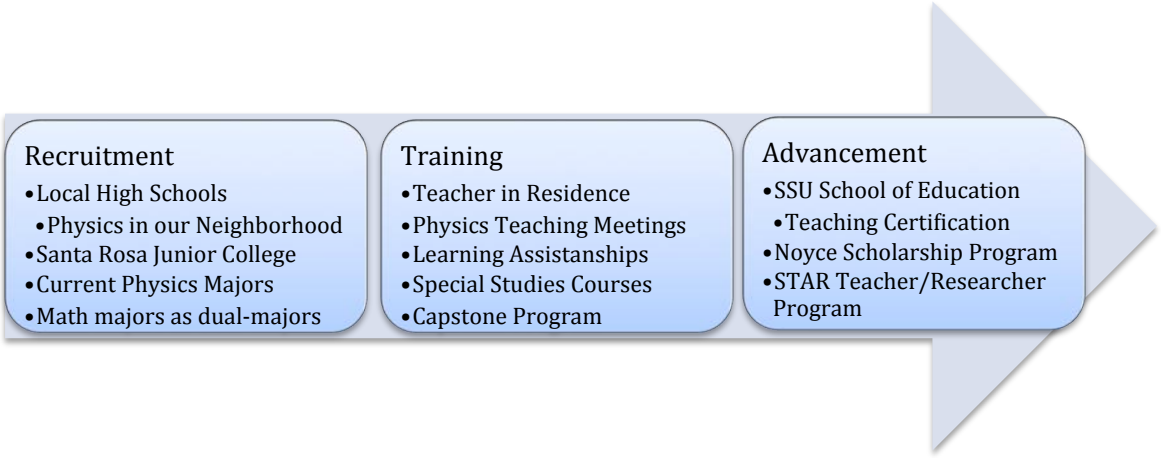
Fall 2014 saw the club win two of the national SPS awards again, Future Faces of Physics and Marsh White Outreach Award. Future Faces award continues the funding for the MESA and SPS joint Skills Lab, focusing on microcontrollers. The hands-on activities are being expanded to include soldering and PCB manufacturing labs. The Marsh White award is being applied to promoting SSU physics and astronomy to local junior colleges by mentoring program. This spring we will go on a joint camping trip to Robert Ferguson Observatory at the Sugarloaf Regional Park. The trip, entitled "A Night of Astronomy at Sugarloaf Ridge", will include an astronomy guest speaker and quality bonding time. We hope to see an increase at SSU in the number of transferred physics majors from junior colleges as a result of this program.

To summarize, what the SSU SPS chapter has been doing and accomplished over the years is simply a demonstration of our members' commitment to each other and to physics and astronomy. We have not only received every grant we applied to but also completed each to a high level of success.

Appendix N: Building the Sonoma State University Physics Teacher Pipeline – PhysTEC Grant

1. Project Summary

The purpose of this project is to establish a robust pipeline of Physics majors that become high school Physics teachers. We will center this effort on two major components: the recruitment of interested high school students, existing physics majors and majors in related fields; and the development of a supportive structure for students interested in teaching to gain teaching experiences during their undergraduate years. A key component is the inclusion of a part-time Teacher in Residence (TIR), a local high school teacher who will contribute first-hand knowledge and community connections. We will employ both proven and new strategies in increasing recruitment by first building connections with area high school and community college physics instructors at an annual department hosted event. Through these partnerships we will develop materials and a classroom presentation to use in the high schools to encourage student interest. We will leverage our existing Seawolf Day activities with an additional teacher-track component and expanded invitations to area physics classes. For existing undergraduates we will generate and support their interest in teaching by increasing our use of the Supplemental Instructor, tutoring, and special studies resources to give authentic teaching experiences. With the assistance of the TIR, undergraduate meetings in support of these students will present innovative pedagogy in a fun and inspiring atmosphere. Within the ecosystem of our existing programs, such as Noyce, MESA, S3, and SHIP this recruiting effort will build and assess a sustainable model of preparing more physics teachers at Sonoma State University. Grant award is $29,889 over three years.



Draft Promotional Poster for Upcoming PhysTEC sponsored meeting with local High School Physics Teachers.