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Optical Science & Engineering 2010 APR Self-Study & Documents

University of New Mexico

THE UNIVERSITY of NEW MEXICO

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SELF-STUDY ON

THE OPTICAL SCIENCE AND ENGINEERING PROGRAM

February 2010

OPTICAL SCIENCE & ENGINEERING
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List of Abbreviations and Acronyms

AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
APR	Academic Program Review
APS	American Physical Society
AIP	American Institute of Physics
A&S	College of Arts and Sciences
CAS	Center for Advanced Studies
CHTM	UNM Center for High Technology Materials
CS	Department of Computer Science
DoD	Department of Defense
DTRA	Defense Threat Reduction Agency
ECE	Department of Electrical and Computer Engineering
F&A	Facilities & Administration
GA	Graduate Assistantship
HSC	Health Sciences Center
HVAC	Heating, ventilation, and cooling
IARPA	Intelligence Advanced Research Projects Agency
I&G	Instruction & General
IGERT	Integrative Graduate Education and Research Traineeship
JPL	Jet Propulsion Laboratory
LANL	Los Alamos National Laboratory
MURI	Multidisciplinary University Research Initiative
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health UNM P&A Self-Study and Long-Range Plan December 23, 2009
NIST	National Institute for Standards and Technology
NRL	Naval Research Laboratory
NSF	National Science Foundation
NSMS	Nanoscience and Microsystems
OS	Optical Science
OSE	Optical Science and Engineering
OSEGC	Optical Science and Engineering Committee
OVPR	Office of Vice President for Research
P&A	Department of Physics and Astronomy
RA	Research Assistant
REU	Research Experience for Undergraduates (NSF)
SFI	Santa Fe Institute
SNL	Sandia National Laboratories
SoE	School of Engineering
SoM	School of Medicine
SCH	Student Credit Hours
TA	Teaching Assistant
UNM	University of New Mexico
WICHE	Western Interstate Commission

I. Executive Summary

Context and Background

Optics is an enabler of many scientific and engineering disciplines, providing an essential tool for high-precision tests of fundamental physical laws, modern communication and imaging systems, and biomedical and manufacturing technologies, to name just a few important application areas. Its pre-eminence as an interdisciplinary science has been unrivaled since the advent of the laser nearly forty years ago. That Optical Science and Engineering (OSE) at UNM has clearly demonstrated added value to the activities of the Electrical and Computer Engineering (ECE) and Physics and Astronomy (P&A) departments over the past twenty five years is a testament to its broad compass and the recognition by UNM of OSE's unique position in the state's industrial enterprise, including the national and federal laboratories and a burgeoning private sector.

This document embodies the self-study report for the spring 2010 academic program review (APR) of the OSE program. This is an interdisciplinary graduate program that does not have the status of either a department or a unit at UNM, but is administered jointly by the OSE-designated faculty in P&A and ECE departments. Founded in 1983, the program has grown from its initial affiliated faculty size of about 10 to 23 at present, with the student enrollment showing similar increases to the present size of 60. It developed and thrived as an Optical Science (OS) PhD program, but compelling arguments from both within the University and the local industrial/government sector led to the addition of the Master of Science (MS) degree to the graduate program in 2002. The program was re-christened as the OSE graduate program shortly thereafter. *Now, the OSE program is again seriously considering expansion by creating 2 new tracks in Optoelectronics and Imaging Science to complement its traditional curriculum*. Optoelectronics is currently a concentration within the ECE department that would transfer under the OSE program umbrella. The Imaging Science track would be entirely new to UNM. The resources needed to realize this plan, to fund and grow the OSE program, are a critical issue at this time.

The UNM OSE program is chronically under-funded. The only recurring revenue for OSE is $16,974/year that only covers 66% of the salary and benefits of the 0.5-time Program Advisor, who is the sole employee of the program. The shortfall is funded by the unrestricted spending account of Prof. Luke Lester, the General Chair of OSE. An annual budget for office supplies, events, society dues, and administrative compensation for the General Chair is renegotiated every year with the P&A and ECE departments and the Center for High Technology Materials (CHTM). This lengthy process yields a budget that is typically less than $9,000 for anticipated expenses. Section IV of this document outlines that a realistic budget for the UNM OSE program is approximately $120,000. Future revenue sources for this budget could potentially include supplemental tuition, F&A return from OSE RA contracts, and/or keeping the tuition generated from OSE RA contracts.

A decade ago the OSE program was inducted into the select list of about 200 Western Regional Graduate Programs (WRGP) from over 40 institutions in 15 participating western states under the Western Interstate Commission of Higher Education (WICHE), making it accessible for the residents of any of these states at the resident tuition rate. Nominated by their institutions, the

programs under WRGP undergo a rigorous peer review for distinction and quality by a committee comprised of faculty and staff from other western institutions before being approved for inclusion. One of only 5 full-fledged OSE graduate programs in the nation, which also includes the University of Rochester, University of Arizona, University of Central Florida, and University of Alabama-Huntsville, and one of only 2 in the entire western region, OSE at UNM provides high-quality educational, research, and career opportunities in a large number of OSE areas locally in NM. Its role in driving optics related activities and its position in the larger optics enterprise of the state are potentially invaluable.

The present APR is marked by two firsts. It is the first for the OSE program in spite of its long history. It is also one (and, by over two decades, the older) of only two interdisciplinary graduate programs at UNM across Colleges, and the first to be slated for an external review. These facts accord the present APR the special status of a pilot study into the desirability, viability, structuring, and impact of interdisciplinary programs at UNM. The self-study document is a portrait of its past record, its evolving administrative structure, and its future directions, but equally importantly a proposal of how best to structure the program so it serves as a pre-eminent model for other similar programs.

The following vision and mission statements capture the essence of the program:

Vision statement – to provide a top-flight graduate program of education and research in optics and photonics

Mission statement – to achieve the above vision, the UNM optical science and engineering program will strive to maintain and enhance its quality and impact

- by engaging faculty actively involved in optics education and research in the departments of Physics and Astronomy (P&A) and Electrical and Computer Engineering (ECE),
- by recruiting the best prepared students nationally and internationally,
- by producing a highly educated pool of potential employees for local and national optics industries, laboratories, and academia,
- by creating leaders and entrepreneurs in the fields of optics and photonics, and
- by serving as the pre-eminent model for a successful interdisciplinary program at UNM.

By building on its past successes and a relentless pursuit of the above goals, it aims to achieve high visibility and distinction among similar programs in optics and photonics worldwide.

Administration

The program is administered by an OSE Graduate Committee (OSEGC) comprised of three OSE faculty members each from P&A and ECE. The committee is led by a General Chair and a Co-Chair from the two departments, who work closely with each other and are assisted by a Program Advisor in initiating, shepherding, and delegating curriculum review, academic requirements, and other programmatic matters. Currently most of the oversight and resources for the program come from the two departments, but the OSEGC is now actively working with the upper UNM administration to help it develop a viable governance structure and allocate resources for the program so that OSE runs efficiently. To facilitate this task, the OSE program has formed an

Executive Committee consisting of the VP for Research, the Deans of the College of Arts and Science (A&S) and the School of Engineering (SoE), the Chairs of the ECE and P&A departments, the General Chair and Co-Chair of the OSE program, and the Dean of the Office of Graduate Studies (OGS).

Performance Metrics and the Added Value of OSE to the Departments

All interdisciplinary programs will have to demonstrate the added value they bring to the university's academic and research missions. OSE has been eminently successful in this respect, as seen via the following metrics:

1. ***High graduation rates*** – Based on the data shown in Fig. 9 for the past 3 years, the OSE program graduates 0.82 PhD/year/FTE and 0.92 MS/year/FTE. (The calculations are explained in more detail below in Section III). From a departmental perspective, OSE awarded 33 PhD degrees (35%) of a total of 95 PhD degrees awarded by the entire P&A dept over the period 1999-2008. A similarly healthy number of MS degree awards have been made since the inception of the MS degree program in 2002 as shown in Fig. 9. Over the 5-years from 2004-2008, OSE awarded 11 PhD degrees (13%) of a total of 86 PhD degrees awarded by the entire ECE dept.
2. ***Low drop-out rates*** – only 4 OSE students have dropped out of the program without receiving a UNM degree out of the 112 who graduated from the OSE program or transferred to another UNM degree program over the period 2001-2009.
3. ***High research funding*** – the OSE faculty generated about $610K/yr in research funding, well above the ECE average of about $400K/yr and the P&A average of about $275K/yr (* based on P&A APR self-study, graph Sec VII.3: $38.2M over the past 5 years and 28 P&A faculty)
4. ***Significant research impact and publication productivity***. The number of optics-related publications of the OSE faculty has risen from about 50/year in the early 90's to 75/year in the early 2000's to the current 80-100 publications/year in the 2005 to 2009 timeframe. These numbers compare well with the average departmental publication numbers during the same time frame of about 156/year in P&A. The h-index of the OSE faculty is a robust 75 and the citation count for the year 2008 was about 3,300.
5. ***Enhanced student research supervision*** – currently, in P&A the 4 core OSE-designated faculty support 19 RAs out of a total of 56 RAs; of these 19 RAs, 10 have passed their OSE-PhD qualifying exam and defended their dissertation proposals (* based on table in graph in Sec VII.3, P&A self-study document). This roughly $1/3^{rd}$ of the research supervision load of the department is carried by $1/7^{th}$ of the total P&A faculty numbers designated by the dept as core OSE faculty.

Future Directions

The program is presently at a crossroads. It is imperative that we develop a long-range plan that facilitates a well-structured expansion of the program. We may classify its goals broadly in terms of their immediacy and impact as follows:

Urgent Goals

1. To increase resource allocation for its administration, including the full funding of a program coordinator, an academic advisor, a laboratory coordinator, and operational expenses.

Critical Short-Term Goals – these need to be addressed and accomplished over the next 2-3 years for OSE:

1. Recruit well-prepared students
2. Improve its national and international visibility as well as its relevance to the overall optics/photonics enterprise of NM
3. Add two additional tracks called *OPTOELECTRONICS* and *IMAGING SCIENCE* for a more comprehensive OSE program;
4. Engage CHTM more actively in realizing the OSE program's vision that reaches well beyond its present critical support for graduate OSE research.
5. Work closely with the area's national/federal labs and industry invested in optics and photonics R&D to develop collaborative initiatives and relationships of mutual benefit.

Long-Term Goals

It also has two important longer-term goals:

1. To develop its own hiring plan that will be separate from P&A and ECE's and will serve as the long-range plan for OSE faculty hiring to be considered directly by the Executive Committee to which the program is to report; and
2. To explore, evaluate and assess the feasibility of the expansion of the program to the status of a department and eventually that of a college.

II. General Description of the OSE Program

The OSE program is a graduate program that grants the MS and PhD degrees to students meeting a common but flexible set of requirements for each degree. The subsections below describe the different components of the program.

II.1. The Admission Process

The students are admitted into the program based on their academic performance at the undergraduate and/or Masters level at their prior institution, their GRE scores, relevance of prior course work to OSE research areas, and their promise of graduate-level research, as assessed by means of their letters of recommendation. The specifics of the application process are described on the program's web site at http://optics.unm.edu. The applicants either self-identify themselves or are placed by the OSEGC in the P&A or the ECE pool.

The UNM OSE admissions data are shown on the next two pages for the past 9 years. The applicant pool has increased significantly over the past 4 years such that now at least 80 students are expected to apply each year to the program. The admissions percentage fluctuates from year to year depending primarily on the availability of research assistantships since the teaching assistantships have been constant or increased slightly over the past several years.

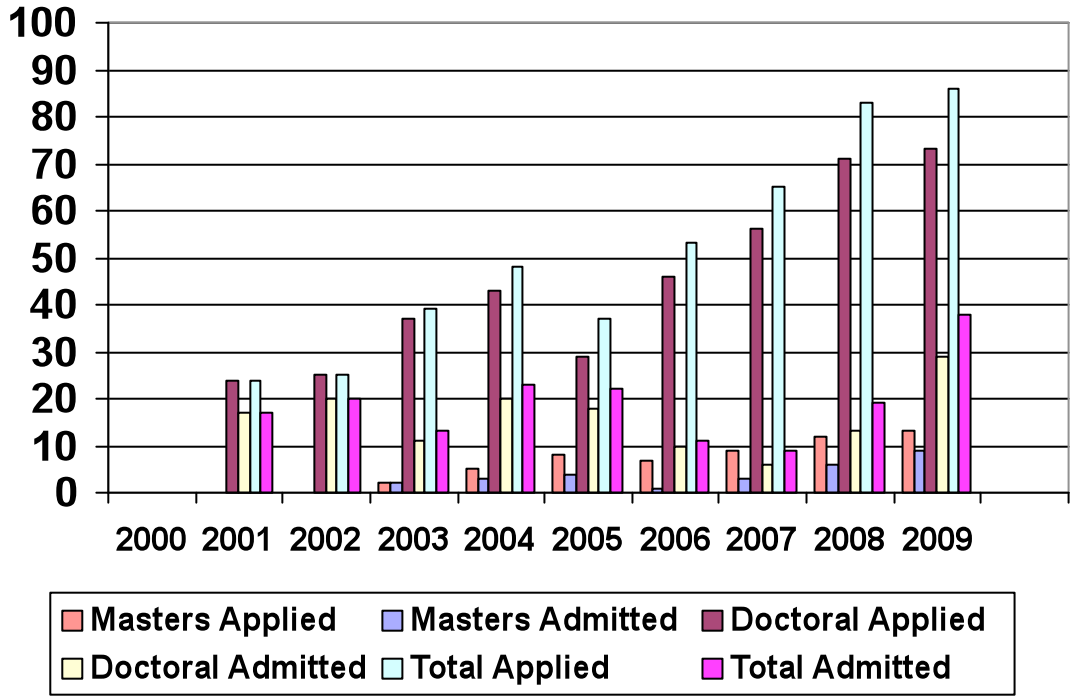
There are a number of teaching assistantships (TAs) and research assistantships (RAs) available for the financial support of applicants deemed outstanding by the OSEGC. The TAs are typically awarded for the OSE students entering the program through P&A, while the RAs are typically available through ECE and CHTM for the more advanced, MS degree holders. The P&A TA pool consists of OSE as well as non-OSE applicants, and the ultimate decision to award TAs to

the incoming OSE students is made by the P&A admissions committee which contains one or more P&A based members of the OSEGC. By contrast, the type and amount of RAs awards are determined by faculty members whose research grants pay for the awards. Rarely, a combination of the two types of assistantships make up the full financial support provided to the student. Each TA award is promised for two years subject to the student's maintaining a good academic standing in the program.

The total numbers of all assistantships in the years 2000-2009 are summarized in Table 1 below, averaging about 30 per year of which about 10 are TAs. The 10 OSE TAs are a healthy fraction of the on-average 32 TAs each year in all provided by P&A. Based on P&A's varied and large need for course assistants, many of the OSE TAs serve as graders or lab assistants for UG as well as graduate-level P&A courses that are not necessarily under the OSE program The P&A department has recently approved a reduction of the total number of TAs by 2 per year to effect an increase in TA salaries to the range $15K-$16K per annum plus tuition waiver and health insurance coverage, which brings them to par with the TA salaries offered by our peer institutions as of the next academic year.

Fig. 1. OPTICAL SCIENCE AND ENGINEERING
GRADUATE STUDENT APPLICATIONS AND ADMISSIONS
FALL SEMESTERS

OSE Graduate Student Application and Admissions:



Data Source: Dataset submitted to the Peterson's Annual Survey of Graduate and Professional Institutions
Office of Graduate Studies-Kenric Speed, Data Manager

Table 1. OPTICAL SCIENCE AND ENGINEERING
GRADUATE STUDENT APPLICATIONS AND ADMISSIONS
FALL SEMESTERS

Optical Science and Engineering

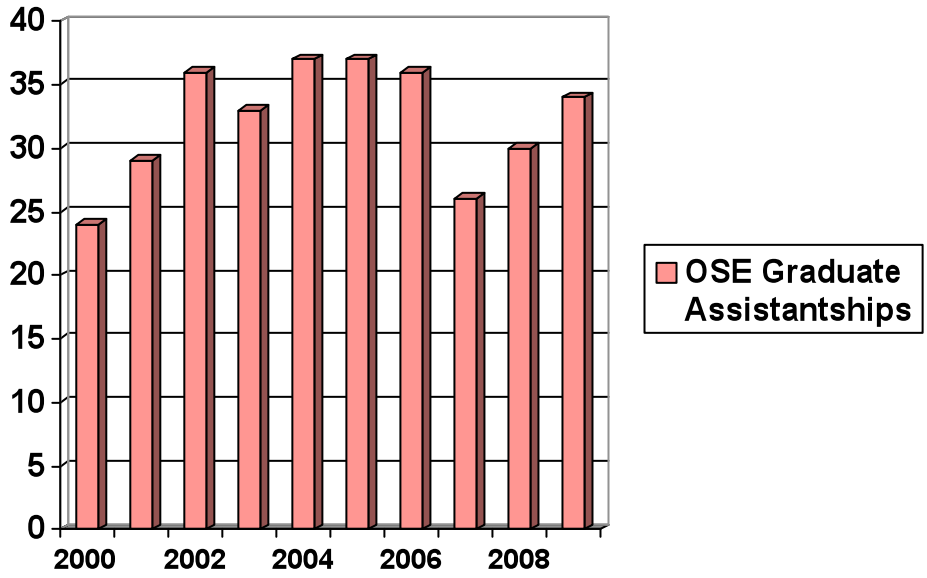
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Masters										
Applied				2	5	8	7	9	12	13
Admitted				2	3	4	1	3	6	9
% Admitted				100.00%	60.00%	50.00%	14.29%	33.33%	50.00%	69.23%
Ed Specialist										
Applied										
Admitted										
% Admitted										
Doctoral										
Applied		24	25	37	43	29	46	56	71	73
Admitted		17	20	11	20	18	10	6	13	29
% Admitted		70.83%	80.00%	29.73%	46.51%	62.07%	21.74%	10.71%	18.31%	39.73%
Professional										
Applied										
Admitted										
% Admitted										
Total										
Applied		24	25	39	48	37	53	65	83	86
Admitted		17	20	13	23	22	11	9	19	38
% Admitted		70.83%	80.00%	33.33%	47.92%	59.46%	20.75%	13.85%	22.89%	44.19%

Data Source:Data Compiled from extract from old IBM system (pre-2006) and Banner (2006 and since)

OGS/Ric Speed

Fig. 2. **OPTICAL SCIENCE AND ENGINEERING ASSISTANTSHIPS[1, 2] for GRADUATE STUDENTS ENROLLED IN OSE PROGRAM as of 10/31/09**

OSE Assistantships for Graduate Students Chart:



[1]Assistantships reported here are for graduate students in dept./program. Another unit may pay these assistantships.
[2]Assistantships include: Research Assistantships, Graduate Assistantships, Teaching Assistantships, and Project Assistantships.
Data source: Office of Graduate Studies Database
UNM Office of Graduate Studies-Kenric Speed, Data Manager

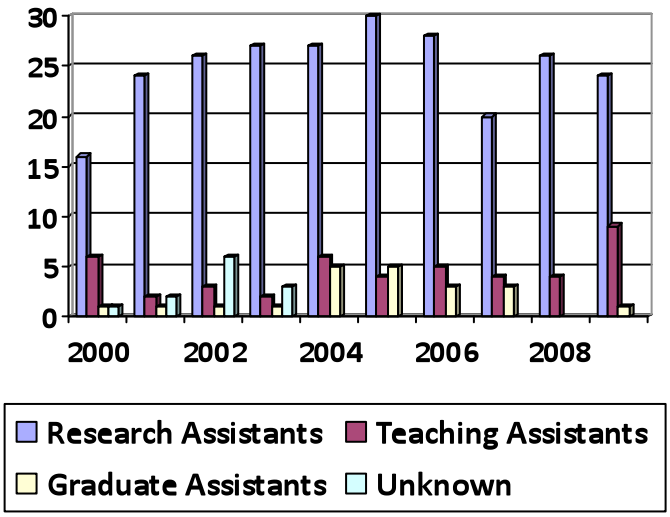
Table 2. **OSE Assistantships for Graduate Students:**

OPTICAL SCIENCE AND ENGINEERING ASSISTANTSHIPS[1, 2] for GRADUATE STUDENTS ENROLLED IN OSE PROGRAM as of October 31st

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
24	29	36	33	37	37	36	26	30	34

[1]Assistantships reported here are for graduate students in dept./program. Another unit may pay these assistantships.
[2]Assistantships include: Research Assistantships, Graduate Assistantships, Teaching Assistantships, and Project Assistantships.
Data source: Office of Graduate Studies Database
UNM Office of Graduate Studies-Kenric Speed, Data Manager

Fig. 3 OPTICAL SCIENCE AND ENGINEERING TYPE OF ASSISTANTSHIPS[1, 2] for GRADUATE STUDENTS ENROLLED IN OSE PROGRAM as of 10/31/09



[1]Assistantships reported here are for graduate students in dept./program. Another unit may pay these assistantships.
[2]Assistantships include: Research Assistantships, Graduate Assistantships, Teaching Assistantships, and Project Assistantships.
Data source: Office of Graduate Studies Database
UNM Office of Graduate Studies-Kenric Speed, Data Manager

Table 3. OPTICAL SCIENCE AND ENGINEERING TYPE OF ASSISTANTSHIPS[1, 2] for GRADUATE STUDENTS ENROLLED IN OSE PROGRAM as of 10/31/09

Assistantships	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Research	16	24	26	27	27	30	28	20	26	24
Teaching	6	2	3	2	6	4	5	4	4	9
Graduate	1	1	1	1	5	5	3	3	-	1
Unknown	1	2	6	3	-	-	-	-	-	-
TOTAL	24	29	36	33	37	37	36	26	30	34

[1]Assistantships reported here are for graduate students in dept./program. Another unit may pay these assistantships.
[2]Assistantships include: Research Assistantships, Graduate Assistantships, Teaching Assistantships, and Project Assistantships.
Data source: Office of Graduate Studies Database
UNM Office of Graduate Studies-Kenric Speed, Data Manager

TOTAL DOLLAR AMOUNTS IN RESEARCH ASSISTANTSHIPS FOR ACADEMIC YEAR FROM FALL 2009 TO SPRING 2010

OSE STUDENT	FTE OF RA	TOTAL SALARY OF RA FALL - SPRING
OSE Student 1	.25 FTE	$ 3,714
OSE Student 2	.5 FTE	$14,704
OSE Student 3	.5 FTE	$14,781
OSE Student 4	.5 FTE	$15,000
OSE Student 5	.5 FTE	$14,781
OSE Student 6	.5 FTE	$ 9,853
OSE Student 7	.5 FTE	$15,242
OSE Student 8	.5 FTE	$12,284
OSE Student 9	.13 FTE Fall & .5 FTE Spring	$ 8,592
OSE Student 10	.5 FTE	$18,014
OSE Student 11	.5 FTE	$15,242
OSE Student 12	.5 FTE	$16,628
OSE Student 13	.5 FTE	$14,781
OSE Student 14	.5 FTE	$10,000
OSE Student 15	.5 FTE	$ 6.000
OSE Student 16	.5 FTE	$10,174
OSE Student 17	.5 FTE	$12,000
OSE Student 18	.5 FTE	$14,000
OSE Student 19	.5 FTE	$13,000
OSE Student 20	.5 FTE	$12,980
OSE Student 21	.5 FTE	$15,000
OSE Student 22	.5 FTE	$13,000
OSE Student 23	.5 FTE	$13,052
	TOTAL	**$322,822**

*These students RA totals could only reflect one semester because the student received an RA for only part of a semester and not the full year or the student's aid was combined with another assistantship like a Graduate Assistantship or a Teaching Assistantship.

Data Source: Office of Graduate Studies Database
Kenric Speed, Data Manager

II.2 Advisement

Each entering student is assigned an academic advisor drawn from the OSEGC whose members are the most versed in the content, nuances, and any recent changes of the myriad academic requirements of the graduate degrees. After the initial advisement, the student meets with his or her advisor typically toward the end of each semester to plan the course work for the following semester until the student has completed his or her required course work. An important role of the advisor is to ensure that all gaps and deficiencies in the student's academic progress toward completing the required coursework are addressed in a timely manner. Students in the MS degree program under the thesis plan (Plan I) will at this point already have a thesis advisor under whose guidance he or she has been working on a research project toward the thesis requirement. On the other hand, the PhD seeking students will at this point be ready for the qualifying exam. After the student passes this exam, typically he or she will have already a dissertation advisor, ending thus the role of the academic advisor in the student's further progress toward the degree. The student works closely with his or her dissertation advisor to formulate a research proposal which he or she must successfully defend within one year of passing the comprehensive exam and thus be advanced to candidacy.

II.3. Curriculum

The two graduate degree programs have different academic requirements which students must meet before they are advanced to candidacy. We describe each separately below.

II.3.1. Requirements for the OSE-MS Degree

The MS degree program is designed with two distinct objectives, namely to prepare a student for the industrial workforce engaged in any area of optics and photonics and to prepare a student to meet the challenges of a more advanced research career in these areas. The program boasts three alternate plans under which a student can begin to fulfill his or her career goals within a highly flexible curriculum. Plans 1 and 2b are designed to launch the student on an industrial R&D career path. In particular, through its internship credits, Plan 2b allows for private companies, national/federal laboratories, and their contractors to partner with UNM in OSE areas in mutually beneficial ways by means of either a first look at potential recruits or a more interactive career advancement of their current employees. Plan 2a is a purely course-based option which a student typically intending to pursue the more advanced PhD degree is likely to avail of.

The different plans and their requirements are listed in Table 2 directly below the following two lists of courses from which all courses for the degree must be drawn.

Table 4. The Mandatory and Optional Courses for the OSE MS Degree

A. Mandatory Courses
• Advanced Optics I (PHYC 463 or ECE 463) • Advanced Optics II (PHYC 554 or ECE 554) • Laser Physics I (PHYC 464 or ECE 464) • Experimental Techniques of Optics (PHYC 476L or 477L) • Electrodynamics (PHYC 511 or ECE 561)
B. Optional Courses
• Quantum Mechanics I (PHYC 521) • Microelectronics Processing Lab (ECE 574L) • Nonlinear Optics (PHYC 568 or ECE 568) • Condensed Matter I (PHYC 529) or Semiconductor Physics (ECE 572) • Topics in Modern Optics (PHYC 569) or Special Topics (ECE 595) • Laser Physics II (PHYC 564) • Fundamentals of Semiconductor LEDs and Lasers (ECE 577) • Quantum Optics (PHYC 566) • Atomic and Molecular Structure (PHYC 531) • Optical Coherence Theory (PHYC 556) • Methods in Theoretical Physics I (PHYC 466 or Math 466) • Spectroscopy (Chem 566) • Advanced Techniques in Optical Imaging- (Bio 547) • Biosensors Fundamentals and Applications (ChNe 538) • Introduction to Electro-Optics and Optoelectronics (ECE 475) • Guided Wave Optics (ECE 564) • Optical Communication Components and Subsystems (ECE 565)

Table 5. The Credit Hour Requirements of the OSE MS Degree

:: Requirements (Credit Hours) ::

PLAN		Course (total)	A	B	Free Electives	Thesis (599)	Res. Seminar/ Problems	Internship
1	**Thesis**	**30**	**15**	**6**	**3**	**6**	**-**	**-**
2A	**Course**	**33**	**15**	**9**	**6**	**-**	**3 (2 in optics)**	**-**
2B	**Internship**	**33**	**15**	**9**	**6**	**-**	**-**	**3**

- 12 hours of coursework must be taken at 500 level or higher
- students in Plan 1 must submit and defend a thesis
- students in Plan 2A must pass an oral exam
- students in Plan 2A or 2B can take at most 6 hrs of 400 level courses excluding those that are cross-listed (ECE and Physics)
- students in Plan 2B should take an internship course (PHYC 559 or ECE 559) during their internship (industry or national labs). They are expected to describe their internship work by submitting a term paper and presenting a seminar at the end of this course. An evaluation form (Form 2) should be submitted by the instructor.

Including part-time students, the OSE MS degree-seeking student currently takes on average 3.7 years to complete the degree requirements depending on the chosen plan. The course work successfully completed for the MS degree may be applied toward the requirements of the OSE-PhD degree at UNM, allowing for improved flexibility in the student's career options mid-stream.

II.3.2 Requirements for the OSE-PhD Degree

The PhD degree is the most advanced graduate degree awarded by the OSE program and takes on average 5.8 years to complete. The typical student in the PhD program is seeking a leadership career path that combines advanced research in one of many different areas of optics and photonics with either an academic or industrial appointment. UNM's OSE program currently offers graduate research opportunities in the following research areas:

- Advanced Materials
- Atom Optics
- Biomedical Optics
- Fiber Optics
- Laser Cooling
- Laser Physics
- Lithography
- Nano-Photonics
- Nonlinear Optics
- Optics Education
- Optical Imaging
- Optical Sensors
- Optoelectronics
- Photonic Integrated Circuits
- Quantum Optics
- Spectroscopy
- Ultrafast Phenomena

Before students can advance officially to candidacy and perform dissertation research, they must however complete a number of academic requirements and demonstrate aptitude and ability to perform research, as follows:

1. 52 hours of course work for credit, including 30 hours in required courses. To account for the diversity of interests in Optics, the 30 credit hours of required courses have been divided into two categories (see A and B below).
2. 18 dissertation credit hours
3. Qualifying Exam (this is given annually in August)
4. PhD Candidacy exam (also called Dissertation Proposal Defense)
5. Dissertation and defense

Table 6. The Mandatory and Optional Courses for the OSE PhD Degree

A. Mandatory (27 credit hours)
• Advanced Optics I (PHYC 463 or ECE 463) • Advanced Optics II (PHYC 554 or ECE 554) • Laser Physics I (PHYC 464 or ECE 464) • Electrodynamics (PHYC 511 or ECE 561) • Experimental Techniques in Optics (PHYC 476L or 477L) • Methods in Theoretical Physics I (PHYC 466 or Math 466) • Quantum Mechanics I (PHYC 521) or Semiconductor Properties (ECE 572) • Nonlinear Optics (PHYC 568 or ECE 568) • 3 credit hours of seminar, including one Optics seminar
B. Option-based (3 credit hours)
• Condensed Matter I (PHYC 529) or Semiconductor Physics (ECE 572) • Topics in Modern Optics (PHYC 569) or Optical Communication Components and Subsystems (ECE 565) • Guided Wave Optics (ECE 564) • Methods in Theoretical Physics II (PHYC 467) • Laser Physics II (PHYC 564) or Fundamentals of Semiconductor LEDs and Lasers (ECE 577) • Quantum Mechanics II (PHYC 522) or Quantum Optics (PHYC 566)

Depending on the student, the remaining 22 course work credit hours can be satisfied with a combination of courses (500 level or above) including problems courses and research hours.

II.4 The PhD Qualifying Exam

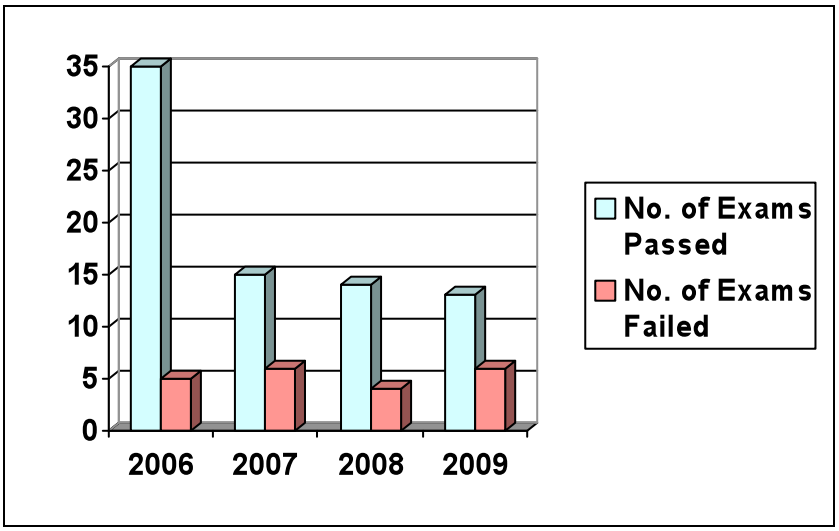
All PhD seeking students are required to attempt the PhD Written Qualifying Exam after their first complete academic year in the program. This exam is administered every August, the Thursday and Friday before the beginning of the fall semester. It consists of four individual 3 hour exams covering

- Advanced Optics (based on PHYC/ECE 463 and 554)
- Lasers (based on PHYC/ECE 464)
- Electromagnetics (based on PHYC 511 or ECE 561)
- General Optics Knowledge

Passing this exam with a 60% score in each of the above four areas is the second step in the process of advancement to candidacy. Each student is accorded up to two attempts to pass this exam at the requisite level, which in the second attempt can be taken in one or more areas individually in which the student may not have passed it in his or her first attempt. The exam is waived for those students who have secured an A in each of the following OSE core courses: Laser Physics I, Advanced Optics I and II, and Graduate Electromagnetism, while those unable to pass the exam fully in all areas are asked to leave the PhD program. If, however, some or all of these unsuccessful students do manage to pass each area exam at the 45% level, then they may substitute this exam for the oral exam required to be passed under Plan 2A for the MS degree in OSE and thus receive that degree if they meet all others of its requirements. This provides an important exit point for some OSE students, who would otherwise have to leave the university without a graduate degree and thus with adversely compromised career options. It also attains the important programmatic objective of reducing the overall drop-out rate from the graduate OSE program.

Fig. 4. PASSAGE RESULTS FOR OSE PhD QUALIFYING EXAMINATION

Passage Results[1, 2] for OSE Ph.D. Qualifying Exam Chart:



[1.]Each topic exam was counted separately in the above. Over this four- year interval, 24 students through qualifying: 2 failed, 18 passed, and still 4 uncertain (they will get second attempts next August.)

[2.] In 2009, two Students were required to sit for the exam and did not ; thus, their seven failed exams are not reflected in the totals.

Data Source: OSE database for Qualifying Ph.D. Exams

OSE/P and A – J. Thomas, Associate Professor

Table 7. Passage Results* for OSE PhD Qualifying Exam Table:

Passed/Failed	2006	2007	2008	2009	Cumulative Total
Passed Exams	35	15	14	13	77
Failed Exams	5	6	4	6	21
Total Exams	40	21	18	19	98

[1.]Each topic exam was counted separately in the above. Over this four- year interval, 24 students through qualifying: 2 failed, 18 passed, and still 4 uncertain (they will get second attempts next August.)

[2.] In 2009, two Students were required to sit for the exam and did not ; thus, their seven failed exams are not reflected in the totals.

Data Source: OSE database for Qualifying Ph.D. Exams

OSE/P and A – J. Thomas, Associate Professor

II.5 PhD Dissertation Proposal

A successful dissertation proposal defense, also called the candidacy exam, is the final step in the advancement of a PhD seeking student to candidacy. After having passed the PhD Written Qualifying Exam, a student must by the beginning of their fourth complete academic year formulate a research proposal in consultation with a potential Dissertation Advisor, and present and defend it to a potential Dissertation Committee. This completes the transition of the student to a PhD research investigation plan, at which the student begins dissertation research under the active guidance of a Dissertation Advisor.

II.6. PhD Dissertation Defense

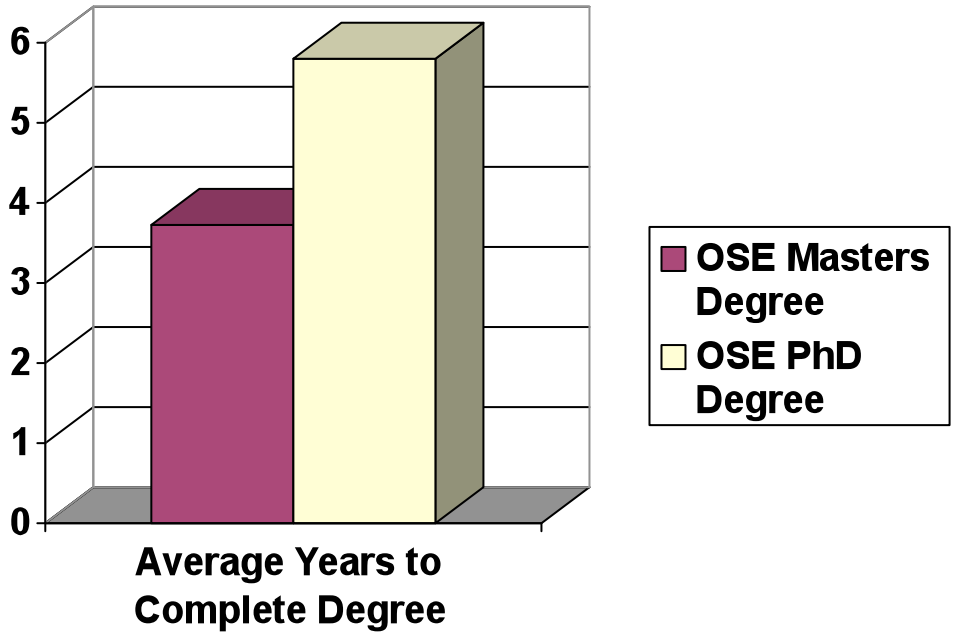
A student advanced to PhD candidacy must, within a reasonable period of time, create, write, and defend a body of original research publishable in a peer-reviewed journal in the chosen area of OSE research. The defense is based on a written dissertation and an oral presentation open to the public. A Dissertation Committee, of which the student's dissertation advisor is the chair, performs a detailed cross-examination of the PhD candidate on every aspect of the candidate's dissertation work before recommending it, often with suggestions for either a minor or major revision of the dissertation, for the PhD degree.

II.7. Time to Degree Completion

As seen on the following page, since Spring Semester 2005, the average time to complete an OSE MS degree and PhD degree is 3.7 and 5.8 years, respectively. The relatively long time for the MS reflects the significant number of part-time students in the OSE MS program. A full-time student can complete the MS degree in typically 2-2.5 years.

Fig. 5. OPTICAL SCIENCE AND ENGINEERING PROGRAM AVERAGE YEARS TO COMPLETE A PhD DEGREE AND MASTERS DEGREE

OSE Average Years of Completion of Degree[1, 2] Chart:



[1]The time to graduate for the M.S. degree is an average of 3.73 years taken from a sample size of 26 students graduating since Spring 2005.
[2] The time to graduate for the PhD degree is an average of 5.8 years taken from a sample size of 19 students graduating since Spring 2005.
Data Source: Enrollment Management dataset based on 21 day HED enrollment file.
Enrollment Management Reporting Unit – K. Ballard, Programmer

Table 8. OPTICAL SCIENE AND ENGINEERING PROGRAM AVERAGE YEARS TO COMPLETE A PhD DEGREE AND MASTERS DEGREE

OSE Average Years of Completion of Degree[1, 2] Table:

Completed Degree	Average Years to Complete
Masters Degree	3.73
PhD Degree	5.8

[1]The time to graduate for the M.S. degree is an average of 3.73 years taken from a sample size of 26 students graduating since Spring 2005.
[2] The time to graduate for the PhD degree is an average of 5.8 years taken from a sample size of 19 students graduating since Spring 2005.
Data Source: Enrollment Management dataset based on 21 day HED enrollment file.
Enrollment Management Reporting Unit – K. Ballard, Programmer

II. 7. Graduate Assessment

The success and impact of the OSE program owe substantially to rigorous assessment tools and criteria. From the initial advisement of incoming students to their regular monitoring of progress throughout their graduate study, the program emphasizes measurable criteria of performance and progress toward degree.

II.7.1. Assessment Tools and Criteria

A. The PhD Degree

Students must complete the required coursework with a grade of B- or better in each course while maintaining an overall GPA of 3.0 or better through all their courses. Those failing to meet this requirement are placed on probation, and measures must be put into place in consultation with their academic advisor to rectify this problem expeditiously. Since the set of required and optional coursework, while allowing for flexibility, is still reasonably tightly constrained, every student must negotiate a rigorous set of classes before being allowed to proceed further. Following immediately after the students have completed their required coursework, the PhD Qualifying exam provides for a more comprehensive testing of their course-based knowledge one more time before they are officially permitted to devise a research plan for their thesis or dissertation. This approach of requiring a more comprehensive examination of student's knowledge of core areas tends to prepare the student very broadly to undertake his or her research program.

As the next step of assessment for a PhD seeking student, the research plan, which a student develops in consultation with his or her dissertation advisor over the subsequent 18-24 months, is then subjected to a close scrutiny and approval by an OSE faculty committee headed by the advisor. A successful proposal defense, or the candidacy examination, is the demonstration of the student's ability, promise, and preparation to undertake dissertation research.

The final assessment step in a student's PhD career is the completion of a publishable body of comprehensive original research on an OSE topic, its composition in standard written form, and its successful defense conducted at a publicly advertised location. This is the culmination of the academic process certifying that all requirements of the most advanced degree have been fulfilled and that the student has earned the degree.

B. The MS degree

While as stringent as those for the PhD degree, the assessment criteria for the MS degree under Plan 1 (thesis option) do not include the dissertation proposal step. This is primarily due to the shorter time frame over which candidates for a terminal MS degree must receive their degrees before applying to enter the workforce or proceeding to another institution for PhD work. The course-based option, namely Plan 2A, requires more extensive coursework than the thesis-based plan; however, each required class must be passed with the same stringent B- grade or better as for Plan 1.

The internship-based MS option under Plan 2B is similar to Plan 2A with the critical difference that the student pursuing this plan must take up an internship of 3-6 months at either an industrial organization or a government/contractor laboratory. The internship must be arranged well in advance but after the required coursework has been completed with prior consultation and approval by a committee consisting of OSE faculty and at least one industrial POC, specifically the immediate supervisor of the internship. Successful completion of the internship requires specialized but not necessarily original OSE based work of practical interest and impact to the host organization as well as a technical report of the involved work, while meeting the rigorous standards of scholarship set out by the OSE program.

C. Exit Interview and Alumni Questionnaire

Each graduate of the OSE program must undergo an exit interview with either the General Chair or Co-chair or their designee. This accords the graduates an opportunity to critique the program and their experiences as a student at UNM and the program a portal into the students' perspectives on its effectiveness, strengths, and shortcomings.

The program regularly solicits feedback from its alumni as a survey of their workforce placement and how they have leveraged their academic experience at UNM for their professional career. Typically each year the questionnaire is sent to alumni who graduated from the program five years ago.

Both these modes of feedback are utilized constantly by the program to improve its scope, offerings, quality, and currency in the ever-changing professional world.

III. Institutional Data and Metrics for the UNM OSE Graduate Program

The following bulleted list summarizes the findings from the institutional data provided to the OSE program by the Registrar, Office of Graduate Studies, and the Office of Institutional Research. For each table, the data source is cited at the bottom of the figure.

- As shown in Fig. 6, the enrollment in the UNM OSE graduate program over the past decade has nearly doubled to the present level of 60 students. A small dip in enrollment occurred between 2006 and 2007, but this decrease was corrected in the Fall 2009 semester as a result of the vigorous recruitment of 17 new students.
- Fig. 7 shows that student body in the OSE program is about 10% female at this time. Increasing the female enrollment in the program represents a recruitment challenge for future growth of OSE at UNM.
- Fig. 8 reveals that the OSE program currently has about 50% international students, which seems typical for a graduate science and engineering program in the USA.
- Fig. 8 also shows that the number of minority students in the OSE program is negligible. Increasing the minority student enrollment is further recruitment challenge for future UNM OSE growth.
- From Fig. 9, we can see that the OSE program has graduated an average of 4.4 PhD/year over the past decade and 5 MS/year since the first UNM OSE MS degree was awarded in 2003. Based on the data shown in Fig. 9 for the past 3 years, the OSE program graduates 0.82 PhD/year/FTE and 0.92 MS/year/FTE. The number of faculty FTE's in the OSE program is calculated to be 6.5. The latter figure is found from adding the fraction of RA's for any given OSE faculty member that are OSE RA's. However, Profs. Diels, Sheik-Bahae, Rudolph, and Prasad are each considered to be 1.0 FTE as defined by the Chair of the P&A department.
- In Fig. 10 we show projections for OSE degree generation in the short term. The OSE program anticipates graduating 8 MS and 8 PhD students in the 2009-2010 Academic year. These figures would represent the most degrees the program ever graduated. The largest number so far in any academic year is 15 as shown for 2007-2008 in Fig. 9.
- Student credit-hour (SCH) generation as shown in Fig. 11 is 2671 over the past three academic years (fall'06-spring'09) for an average of 890 SCH per academic year. Inclusive of these SCHs, P&A and ECE together generated 3558 SCHs/yr (1817 SCH/yr from P&A, 1771/yr from ECE).
- (Data not plotted) Share of departmental colloquia – 23 of the 142, or roughly $1/6^{th}$ of, P&A colloquia given over the period Jan'05-Dec'09 have been in OSE research areas. While roughly in proportion to the fractional OSE faculty strength of the dept, these colloquia do not include a number of other research presentations and seminars in OSE delivered under the Optics seminar series, Center for Advanced Studies (now Center for Quantum Information and Control) seminar series, and the Center for High-Technology seminar series.

Fig. 6. OPTICAL SCIENCE AND ENGINEERING SUMMARY OF FALL STUDENT ENROLLMENT FOR YEARS 2000 to 2009

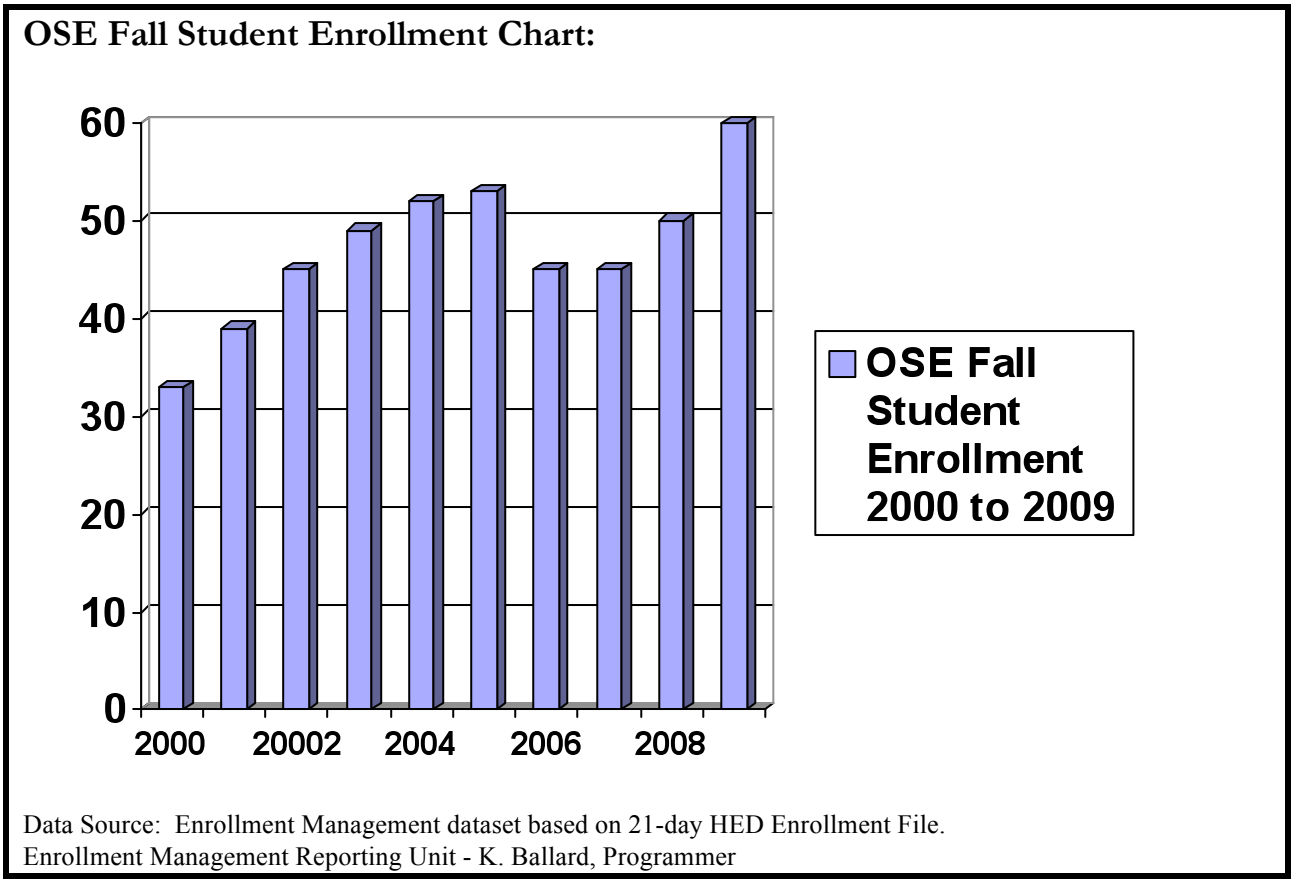


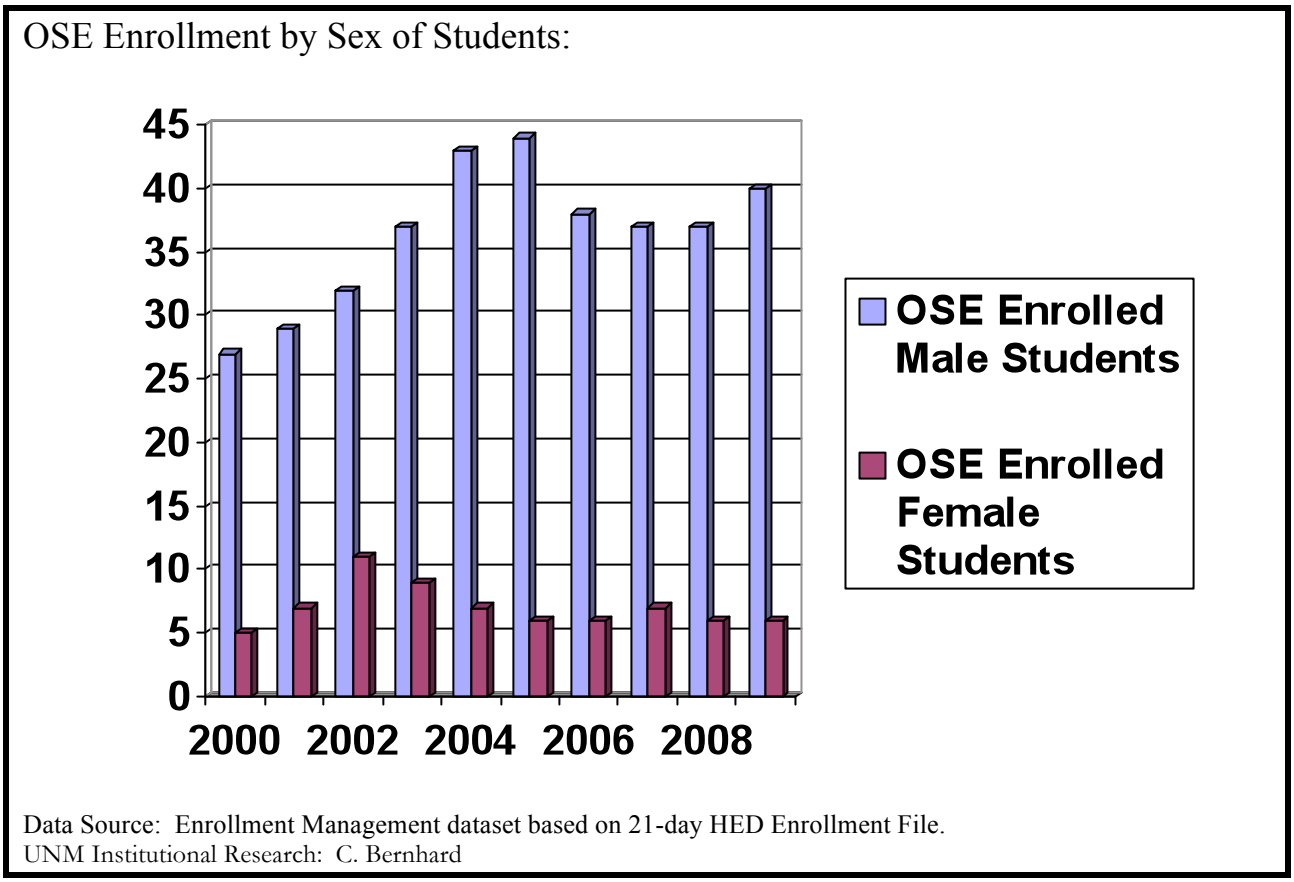
Table 9. OSE Fall Student Enrollment Table

Optical Science and Engineering Summary of Fall Student Enrollment for Years 2000 to 2009

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
33	39	45	49	52	53	45	45	50	60

Data Source: Enrollment Management dataset based on 21-day HED Enrollment File.
Enrollment Management Reporting Unit - K. Ballard, Programmer

Fig. 7. OPTICAL SCIENCE AND ENGINEERING ENROLLMENT BY SEX OF STUDENTS ADMITTED TO PROGRAM FALL 2000 TO FALL 2008



Data Source: Enrollment Management dataset based on 21-day HED Enrollment File.
UNM Institutional Research: C. Bernhard

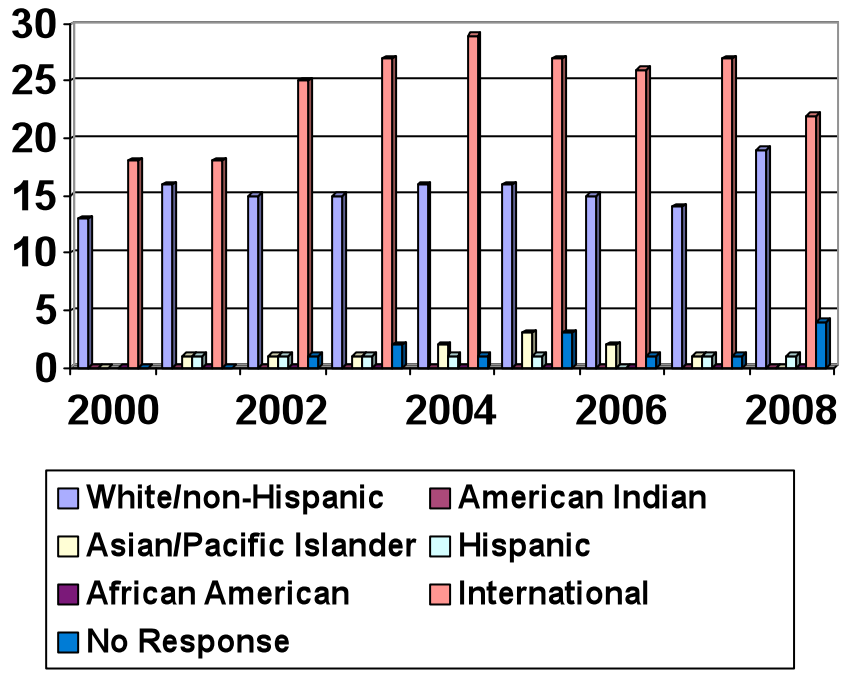
Table 10. Optical Science and Engineering Enrollment by Sex of Students Admitted to Program Fall 2000 to Fall 2008

SEX	2000	2001	2002	2003	2004	2005	2006	2007	2008
OSE Enrolled Male Students	27	29	32	37	43	44	38	37	40
OSE Enrolled Female Students	5	7	11	9	7	6	6	7	6

Data Source: Enrollment Management dataset based on 21- HED Enrollment file.
UNM Institutional Research: C. Bernhard

Fig. 8. OPTICAL SCIENCE AND ENGINEERING ENROLLMENT BY ETHNICITY OF STUDENTS ADMITTED TO PROGRAM
FALL 2000 TO FALL 2008

OSE Enrollment by Ethnicity of Students:



Data Source: Enrollment Management dataset based on 21-day HED Enrollment file.
UNM Institutional Research: C. Bernhard

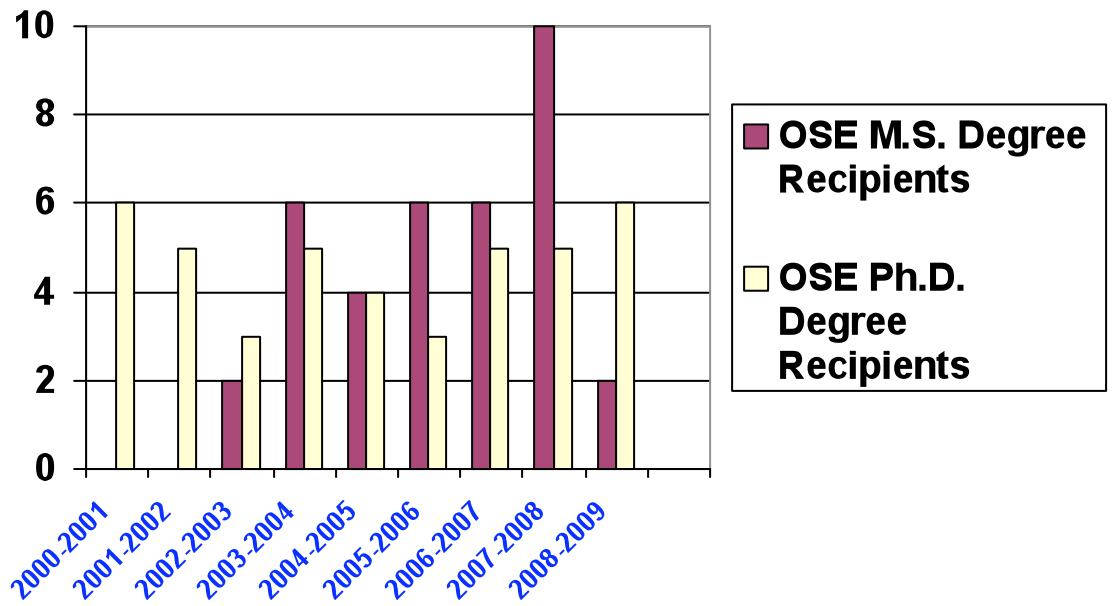
Table 11. OPTICAL SCIENCE AND ENGINEERING ENROLLMENT BY ETHNICITY OF STUDENTS ADMITTED TO PROGRAM Fall 2000 to Fall 2008

Students' Ethnicity	2000	2001	2002	2003	2004	2005	2006	2007	2008
White/non-Hispanic	13	16	15	15	16	16	15	14	19
American Indian	0	0	0	0	0	0	0	0	0
Asian/Pacific Islander	0	1	1	1	2	3	2	1	0
Hispanic	1	1	1	1	1	1	0	1	1
African American	0	0	0	0	0	0	0	0	0
International	18	18	25	27	29	27	26	27	22
No Response	0	0	1	2	1	3	1	1	4

Data Source: Enrollment Management dataset based on 21-day HED Enrollment file.
Source: UNM Institutional Research: C. Bernhard

Fig. 9. OPTICAL SCIENCE AND ENGINEERING TOTAL NUMBER OF DEGREE RECIPIENTS 2000-2001 to 2008-2009 ACADEMIC YEARS*

OSE Degree Recipient Chart:



*Academic Year - Begins in the fall semester and includes the next spring and summer semesters.
E.g. Academic Year 2000-2001 includes Fall 2000 semester, Spring 2001semester and Summer 2001semester.
Data Source: Enrollment Management dataset based on 21-day HED Enrollment File.
Enrollment Management Reporting Unit - K. Ballard, Programmer

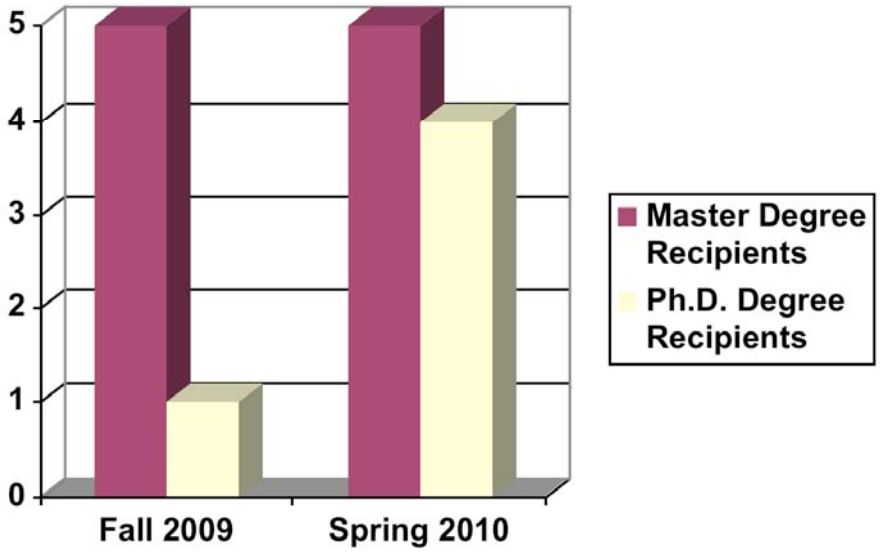
Table 12. TOTAL NUMBER OF DEGREE RECIPIENTS 2000-2001 to 2008-2009 ACADEMIC YEARS*

Degrees	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	Cumulative Degree TOTAL
Ph.D. Degrees	6	5	3	5	4	3	5	5	6	44
M.S. Degrees	0	0	2	6	4	6	6	10	2	36
Total Degrees Awarded	6	5	5	11	8	9	11	15	8	80

*Academic Year - Begins in the fall semester and includes the next spring and summer semesters.
E.g. Academic Year 2000-2001 includes Fall 2000 semester, Spring 2001semester and Summer 2001semester.
Data Source: Enrollment Management dataset based on 21-day HED Enrollment File.
Enrollment Management Reporting Unit - K. Ballard, Programmer

Fig. 10. OPTICAL SCIENCE AND ENGINEERING PROGRAM
PROJECTED DEGREE RECIPENTS* FOR FALL 2009 TO SPRING 2010

Projected Degree Recipients for OSE Chart:



*The Fall 2009 degree recipients have already been confirmed as graduated per the Office of Graduate Studies.
Data Source: Office of Graduate Studies graduated student list and proposed graduation list.
Office of Graduate Studies-T.Ellis, Senior Academic Advisor and H. Krupicka, Records Management Clerk

Table 13. Projected Degree Recipient Table:

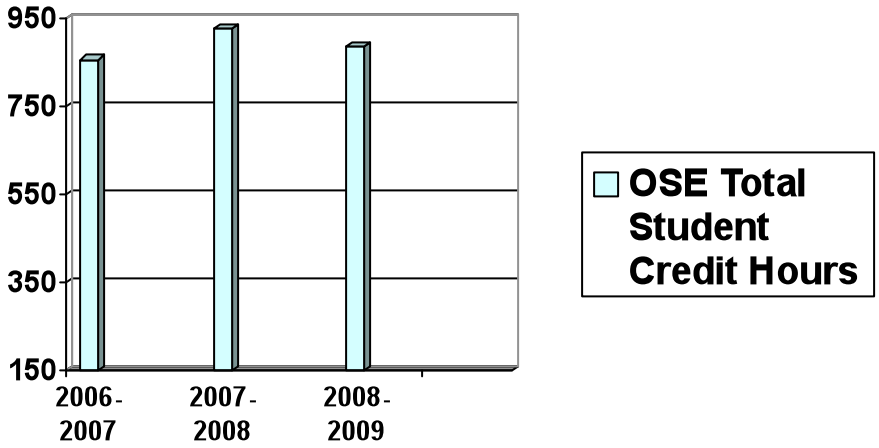
OPTICAL SCIENCE AND ENGINEERING PROGRAM
PROJECTED DEGREE RECIPENTS* FOR
FALL 2009 TO SPRING 2010

DEGREE	FALL 2009*	SPRING 2010	Total
Ph.D.	1	4	5
M.S.	5	5	10

*The Fall 2009 degree recipients have already been confirmed as graduated per the Office of Graduate Studies.
Data Source: Office of Graduate Studies graduated student list and proposed graduation list.
Office of Graduate Studies-T.Ellis, Senior Academic Advisor and H. Krupicka, Records Management Clerk

Fig 11. OPTICAL SCIENCE AND ENGINEERING TOTAL ACADEMIC YEAR STUDENT CREDIT HOURS[1] RESTRICTED[2] AND UNRESTRICTED 2006-2007 to 2008-2009 Academic Years[3, 4]

OSE Total Student Credit Hours Chart:



[1]Course numbers to derive student credit hours provided by OSE
[2]Restricted credit hours are those for which UNM receives no funding from the state. They are primarily connected to courses funded by non-I&G accounts or are credit hours delivered via the Internet to out-of-state students.
[3]Academic Year - Begins in the fall semester and includes the next spring and summer semesters.
[4]OIR experienced a data anomaly with the ECE student credit hours, (SCH). For academic years 2004-2005 and 2005-2006, there was no data for SCH for OSE-ECE courses. Thus, the data for these academic years are not included.
Data Source: HED End-of-Semester Course File, created by the Registrar's Reporting Team, maintained by the Office of Institutional Research, (OIR) & Enrollment Management dataset based on 21 day HED enrollment file 2006-2009.
UNM Institutional Research: C. Bernhard and Enrollment Management Reporting: K. Ballard, Programmer

Table 14. OSE Total Student Credit Hours Table: TOTAL ACADEMIC YEAR STUDENT CREDIT HOURS[1] RESTRICTED[2] AND UNRESTRICTED 2006-2007 to 2008-2009 Academic Years[3, 4]

Academic Year	2006-2007	2007-2008	2008-2009	Cumulative Total
Total Student Credit Hours	857	928	886	2,671

[1]Course numbers to derive student credit hours provided by OSE
[2]Restricted credit hours are those for which UNM receives no funding from the state. They are primarily connected to courses funded by non-I&G accounts or are credit hours delivered via the Internet to out-of-state students.
[3]Academic Year - Begins in the fall semester and includes the next spring and summer semesters.
[4]OIR experienced a data anomaly with the ECE student credit hours, (SCH). For academic years 2004-2005 and 2005-2006, there was no data for SCH for OSE-ECE courses. Thus, the data for these academic years are not included.
Data Source: HED End-of-Semester Course File, created by the Registrar's Reporting Team, maintained by the Office of Institutional Research, (OIR) & Enrollment Management dataset based on 21 day HED enrollment file 2006-2009.
UNM Institutional Research: C. Bernhard and Enrollment Management Reporting: K. Ballard, Programmer

Table 12. OPTICAL SCIENCE AND ENGINEERING COURSE CURRICULUM LIST*

Physics 463	Advanced Optics I
EECE 463	Advanced Optics I
Physics 554	Advanced Optics II
EECE 567	Advanced Optics II
Physics 464	Laser Physics I
EECE 464	Laser Physics I
Physics 476L	Experimental Techniques of Optics
Physics 477L	Experimental Techniques of Optics
Physics 511	Electrodynamics
EECE 561	Electrodynamics
EECE 475	Intro to Electro-Optics and Optoelectronics
Physics 521	Graduate Quantum Mechanics I
EECE 574L	Microelectronics Processing
Physics 555	Nonlinear Optics
EECE 568	Nonlinear Optics
Physics 529	Condensed Matter I
EECE 572	Semiconductor Physics
Physics 569	Topics in Modern Optics
Physics 564	Laser Physics II
EECE 577	Fundamentals of Semiconductor LEDs & Lasers
Physics 566	Quantum Optics
Physics 531	Atomic and Molecular Structure
Physics 556	Optical Coherence Theory
EECE 564	Guided Wave Optics
EECE 565	Optical Communication Components and Subsystems
Physics 522	Quantum Mechanics II
Math 466	Methods in Theoretical Physics I
Physics 466	Methods in Theoretical Physics I
Physics 467	Methods in Theoretical Physics II
Physics 559	Internship in Optical Science and Engineering
EECE 559	Internship in Optical Science and Engineering

***This is a list of the OSE Curriculum courses that were used by the Office of Institutional Research to derive student credit hours for the program.**

III.1. Research Impact: Funding, Publications, and h-index of OSE

For the past 5 years, 18 UNM faculty* who are affiliated with OSE, have collectively raised an average of $11.0M/year in external research support. This computes to an average of $610K/year/faculty, which is a very competitive figure nationally.

The number of publications and citations by the current OSE faculty has steadily risen over the past decade to the current levels of about 80-100 journal articles/year and 3,300 citations/year. Plots of this growth are shown in Appendix D. This computation was made using 23 affiliated OSE faculty** as a basis. For the journal and citation totals, ALL publications were considered (optics-related and not). The h-index (number of journal articles *X* with *X* or greater citations) for the *optics-related papers only* of these 23 OSE faculty is a robust 75. For comparison, the h-index of CHTM as of this writing is 57. The full h-index including all articles written by this group of OSE faculty is actually 86.

The 100 most highly-cited articles of the OSE program are available upon request. The number one paper in this list was recognized in 2007 as the most cited article in the 30-year history of the *IEEE Journal of Quantum Electronics*. The article, written by Prof. Sheik-Bahae and co-authors, has received 2,400 citations as of January 2010.

*For the research funding calculations, a faculty basis of 18 was used. These 18 faculty include the 4 P&A faculty who are core OSE (Diels, Prasad, Rudolph, and Sheik-Bahae) plus Profs. Lester, Brueck, Malloy, Osinski, Jain, Balakrishnan, Hossein-Zadeh, Koch, Krishna, Hayat, G. Lopez, Ghani, Christodoulou and Hersee. Grant award data was provided by the P&A dept. and by Karen Walker of CHTM (OSE 2004-2009 Awards Data rev.xls) and is available upon request.

**The faculty who formed the basis for the journal and citation metrics and the h-index calculation are Professors Lester, Stricker, Kenkre, Epstein, Caves, Hasselbeck, Christodoulou, Dawson, Malloy, Diels, Rudolph, Deutsch, Eliseev, Jain, Hossein-Zadeh, Balakrishnan, Hayat, Brueck, Prasad, Hersee, Krishna, Osinski, and Sheik-Bahae. (Thomas, Ghani, Geremia, and Lopez were not included in the database search given the search restrictions of Web of Science, the fact that co-authors captured their contributions, or that there optics-related papers did not impact the h-index calculation.)

IV. Revenue, Expenses and Proposed Budget of the OSE Program

Recurring revenue for the OSE program:

1) Salary line (index code 241000)	$16,974

Current Expenses for the OSE program

2) Salary and Benefits for the 0.5 FTE Program Advisor	$25,900
3) Special Admin. Compensation (SAC) for OSE General Chair	$3,000
4) Budget for supplies, events, society memberships	$6,000
5) Current Expense Total (Lines2-4):	$34,900
6) Current Shortfall in Recurring Funding (Line1 less Line4)	**($17,926)**

Additional Monies Needed:

7) Bring OSE Program Advisor from 0.5 to 1.0 FTE	$34,757
8) 0.5 FTE Administrative Assistant	$23,000
9) 0.5 FTE Laboratory Coordinator	$26,000
10) Proposed Budget Total (Lines5+7+8+9):	**$118,657**

Potential Future Revenue Sources for the OSE Program

a) **Supplemental Tuition**: with a basis of 90 students, supplemental tuition of $667/student/semester would cover the proposed OSE budget.
b) **F&A Return** from the 25 OSE RAs contracts is estimated at $200,000-$250,000 annually.
c) **Tuition** generated from the 25 OSE RAs contracts amounts to about $130,000 annually.

V. Faculty Research Areas and Facilities

V.1. Faculty Research Areas

The OSE faculty conduct research in the topics listed below in laboratories primarily located in the Physics Dept. building, the ECE building, and the Center for High Technology Materials (CHTM)

- Advanced Materials
- Atom Optics
- Biomedical Optics
- Fiber Optics
- Laser Cooling
- Laser Physics
- Lithography
- Nano-Photonics
- Nonlinear Optics
- Optics Education
- Optical Imaging
- Optical Sensors
- Optoelectronics
- Photonic Integrated Circuits
- Quantum Optics
- Spectroscopy
- Ultrafast Phenomena

V.2. Role Facilities of CHTM in the OSE program

About half of the ongoing 27 faculty in the OSE program are also members of the Center for High Technology Materials, which is a research center at UNM that reports directly to the Vice President for Research and Economic Development (VPRED) office. CHTM provides administrative and technical support in terms of research grant submission, accounting, execution and reporting. The F&A that is generated by grants that are run through CHTM flows through the VPRED office and then a portion of this F&A is returned to CHTM to support primarily the administrative staff of the research institute. The F&A generated by the center exceeds $1M/year. The CHTM/OSE faculty have laboratories located within the 60,000 sq. ft. CHTM building, which is situated in the Science and Technology Park of UNM. CHTM currently has only a small financial role in supporting the academic mission of OSE by supplying the office and supplies for the OSE Program Advisor, an RA contract, and a 1/3 fraction of the SAC for the General Chair.

Key components of CHTM's vertically integrated structure are its highly advanced facilities. Begun in 1992 with a bond issue approved by the State of New Mexico and dedicated in 1997, the Center for High Technology Materials was constructed in south campus, in an area called UNM Research Park. Housed in the main complex and in three satellite buildings are several laboratories devoted to the research of nanotechnology and advanced optics. The extensive

modern cleanroom in the main building allows for the fabrication of advanced semiconductor devices from epitaxial structures grown at CHTM. Also within the main building are nearly two dozen laboratories that house high power lasers, scanning electron microscopes, devices for molecular beam epitaxy, and advanced workstations for numerical simulations of atomic structures and beam propogation within laser cavities.

Research at the neighboring Crystal Growth Facility focuses on metalorganic chemical vapour deposition (MOCVD) epitaxial growth for advanced semiconductor device structures. Another building adjacent to CHTM houses the Mid-infrared Imaging Characterization and Application (MICA) laboratory, where testing of infrared focal plane arrays that are grown and fabricated at CHTM is performed. Finally, a newly constructed draw tower and cleanroom located nearby in UNM Research park enables the local fabrication of long optical fibers for research.

Roughly half of the OSE graduate students with an RA have their offices and laboratory experiments at CHTM.

VI. Governance Structure and Curriculum Plan

This section of the self-study document analyzes governance, degree emphases, faculty, and the future growth of the UNM OSE program.

VI.1. Governance Structure for OSE

In spite of its importance to the education and research activities of P&A and ECE, the OSE program has been run largely in an adhoc fashion with administrative resources provided by the two departments. This has stunted the ability of the program to expand its scope and reach, develop its own long-range plan, chart exciting new directions and priorities, and evolve a realistic budget plan that enables it to meet its essential goals and objectives. The reporting structure has hitherto been ill-defined, with the two departments providing courtesy oversight to the program without a well-planned strategy for its long-term growth and health. The OSE faculty are at present hired through their perceived fit in the larger departmental priorities which pay little attention to the specific needs and objectives of the OSE program. While charged fully with the administration of the program, OSEGC has been a body of dedicated OSE faculty who have been largely unable to leverage resources for the program because of the broader departmental concerns and constraints. The recent formation of the Executive Committee under the leadership of the Office of Graduate Studies (OGS) Dean provides a badly needed governance structure that will help improve the visibility, impact, and organization of the program while helping to sustain and develop its priorities, including a faculty hiring plan, in the broader institutional context.

Members of the Executive Committee to the OSE program:

Vice President for Research
Director of CHTM
Chair of ECE
Chair of Physics
Dean of Graduate Studies
Dean of the College of Arts and Sciences
Dean of Engineering
General Chair, OSE
Co-Chair, OSE

One of these members will act as the chair of the committee (currently the Dean of the OGS) and act as the point of contact for the General Chair and Co-Chair of OSE during the year. The OSE Executive Committee will meet at least twice per year to receive an annual report presentation from the General Chair and Co-Chair of OSE and to address issues for the program. At these meetings, the OSE Executive Committee will review and approve major changes to the program, evaluate performance of the program, ratify the OSE budget annually, and give OSE program feedback on its priorities for the upcoming year.
Major changes in the program would include changes in staffing level, budget size, and the General Chair or the Co-Chair.

The Chair of the OSE Executive Committee will assist the General Chair in identifying resources (financial and personnel) for student support, marketing of the program, and staff recruitment. The Chair will also assist in representing the interests of the OSE program for such major issues as new faculty hires.

VI.2. Expansion of OSE tracks to include optoelectronics and imaging science

VI.2.1 Background on the OSE student environment

Currently, there are approximately 100 "Optics" graduate students at UNM. They are distributed among the various graduate programs in the following manner:

1) *Optical Science and Engineering*, 60 students pursuing MS and PhD degrees who declare the Physics or ECE departments as their "home" department.

2) *Optoelectronics,* 30 students pursuing MS and PhD degrees, *Optoelectronics* is a separate concentration within the ECE department.

3) *Optics,* ~5 pursuing PhD degrees, *Optics* is a separate concentration within the Physics department consisting primarily of transfer students from Europe.

For the following reasons, it would be advantageous to bring these 3 groups under the Optical Science and Engineering umbrella:

1) Under a unified OSE program, students would receive consistent advisement by a single, dedicated OSE program advisor. Currently these "Optics" students are advised by 3 different staff members: The ECE graduate advisor, the Physics graduate advisor, and the OSE program advisor.

2) Admissions could be coordinated with common application due dates, acceptance decision dates, and financial aid decision dates. Currently the admission due date for OSE is January 15th and the ECE/Optoelectronics due date is February 15th for the Fall semester in any calendar year. A similar situation exists for the Spring admissions cycle, but the applicant number is roughly an order of magnitude smaller.

3) A common time period for the PhD written examinations. Currently faculty time is spread over many months servicing at least 3 different exams in August and January of every calendar year.

4) Eliminating undesirable switching of a student's graduate concentration across artificial departmental boundaries. Currently Optoelectronics students must "transfer" to OSE and vice versa. This process creates useless paperwork and an undesirable change in program advisor due to (1). Also the existence of separate OSE, Optoelectronics, and Optics programs allows students who have "flunked out" of one program to migrate into the other. This process inflates our student graduation rates for optics-related concentrations.

5) Substantially improved flexibility for OSE/Optoelectronics PhD students in their free elective choices. The OSE PhD student is required to have 52 coursework credit hours, 30 hours are well-defined by the OSE faculty and the remaining 22 are very open to student choice.

6) A robust revision of the "Optoelectronics" curriculum under the OSE umbrella that would focus the student's academic experience on courses that are essential for career success.

   This last point is the primary focus of the remainder of section V.2.2.

VI.2.2 The Proposed Optoelectronics Track

The new Optoelectronics emphasis within the OSE program would have the following required core courses for the MS degree:

Mandatory for the OSE/Optoelectronics MS:
ECE 572, Semiconductor Physics
ECE 570, Semiconductor Optical Materials and Devices
ECE 561 (or Physics 511), Electrodynamics
ECE 565, Optical Communications Components and Subsystems
Physics 476 or Physics 477, Experimental Techniques of Optics

–Plus 6 credit hours (thesis option), 9 credit hours (coursework option) OR 9 credit hours (internship option) from an approved, option-based pool of courses.
-The remaining curriculum requirements for the OSE MS degree with Optoelectronics emphasis would be identical to the existing OSE framework that can be found on the OSE website: www.optics.unm.edu
-The new Optoelectronics emphasis within the OSE program would have the following required core courses for the PhD degree:
-The baseline PhD course curriculum for the OSE/Optoelectronics would mirror that of the MS framework. OSE/Optoelectronics PhD students would also be required to take 3 credit hours of graduate seminar, including at least one Optics seminar. Again the remaining coursework structure for the OSE PhD student can be found at www.optics.unm.edu

Mandatory for the OSE/Optoelectronics PhD:
ECE 572, Semiconductor Physics
ECE 570, Semiconductor Optical Materials and Devices
ECE 561 (or Physics 511), Electrodynamics
ECE 565, Optical Communications Components and Subsystems
Physics 476 or Physics 477, Experimental Techniques of Optics
3 credit hours of Graduate Seminar

12 credits hours from the "Option-based" Pool must also be taken. Further there are 22 credit hours of free electives to satisfy a total of 52 credit hours.

Note: The "Option-based" pool of the current OSE program would be expanded to accommodate the optoelectronic and materials interests of the ECE/Optoelectronics students.

VI.2.3 The Proposed Imaging Science Track

A number of OSE faculty members and their students are actively engaged in research on topics in modern imaging science. In view of this high level of activity, we envision a third emphasis area for OSE, namely the imaging science (IS) track. Creating such a track will not only streamline a number of pertinent course offerings in ECE and their teaching schedules but also provide greater flexibility and structure for students seeking to do dissertation research in imaging. It will also help consolidate all ECE based OSE research areas at UNM under the two umbrellas of optoelectronics and imaging science, removing redundancies and conflicts between OSE and non-OSE degree programs. A final benefit of this track is the mechanism it would furnish for students engaged in imaging and image processing research outside P&A and ECE, such as the School of Medicine, to pursue a well structured graduate degree program in these areas. Many of the rationales used earlier to justify the proposed optoelectronics emphasis area apply to this track as well.

Credit-Hour Requirements for the MS Degree in OSE / Imaging Science:

Each of the three MS plans will have the same 15 credit hrs of mandatory course work as follows:

Mandatory Courses for OSE/Imaging Science MS (15 hrs):
P&A/ECE 463-Adv Optics I;
P&A 554 / ECE 567 – Adv Optics II;
ECE 541 - Probability theory and stochastic processes;
ECE 533 - Digital image processing;
ECE 517 – Pattern recognition;

The remaining credit hrs must be made up as set out in the table below, as is true currently. In the table, Group A refers to the above mandatory courses, while Group B consists of option-based courses derived from the pool of option-based /elective courses listed below under the PhD program and ECE 596 (Optimization theory)..

PLAN		Course (total)	A	B	Free Electives	Thesis (599)	Res. Seminar/ Problems	Internship
1	Thesis	30	15	6	3	6	-	-
2A	Course	33	15	9	6	-	3 (2 in optics)	-
2B	Internship	33	15	9	6	-	-	3

Credit-Hour Requirements for the PhD Degree in OSE / Imaging Science:

Students pursuing an OSE PhD in the new Imaging Science track must satisfy the following course requirements:

Mandatory Courses for OSE/Imaging Science PhD (27 hrs):
P&A/ECE 463-Adv Optics I;
P&A 554 / ECE 567 – Adv Optics II;
ECE 517 – Pattern recognition
ECE 541 - Probability theory and stochastic processes;
ECE 533 - Digital image processing;
ECE 596 - Optimization theory
ECE 595 – to develop and teach a course on Detectors and Hardware
ECE642 – Signal detection and estimation;
3 hrs of graduate seminar;

Option Based Courses + Elective Courses – to be drawn from
Phys 511 / ECE 561 - E&M,
Phys 566 – Optical Coherence Theory;
ECE 539 - Digital signal processing;
ECE 549 - Information theory and coding;
ECE 500 - Theory of linear systems;
ECE 475 - Introduction to electro-optics and opto-electronics;
ECE 516 - Computer vision;
ECE 570 - Semiconductor Materials and Optical Devices;
ECE 547 - Neural networks;
ECE 581 – Colloidal nanocrystals for biomedical applications
ECE 510 - Medical Imaging;
ECE 512 - Advanced image synthesis
ECE 511 – fMRI methods (being developed)

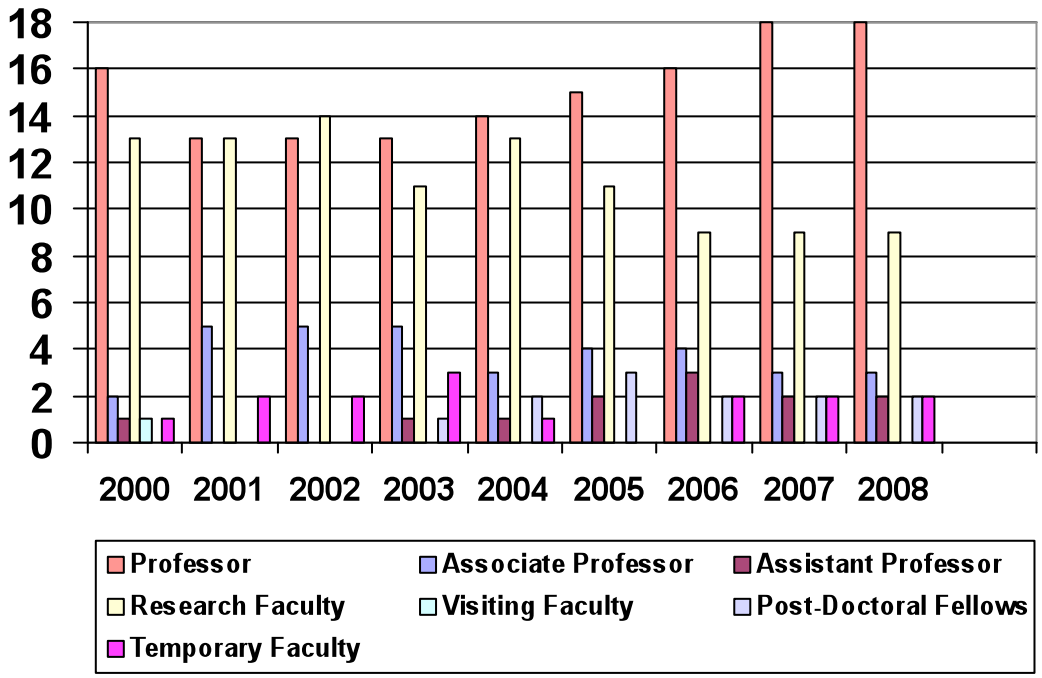
The option-based hours must comprise 3 hrs from the above pool, while the remaining 22 hrs must be free electives to be drawn from the rest of this pool and other approved graduate courses, including research and problems courses.

VI.3. The OSE Faculty and Future Hiring Plans

There are currently no female OSE faculty that are tenured or tenure track. This is a deficiency that should be addressed in any future OSE hiring plan. To ensure continued success of the OSE program, the current OSE program needs the proposed OSE Executive Committee to represent the interests of the degree program in the critical area of faculty hiring when faculty slots become available in the ECE and Physics departments.

Fig. 11. OPTICAL SCIENCE AND ENGINEERING AFFILIATED FACULTY[1, 2] as of 10/31/08

OSE Affiliated Faculty Chart:



[1] Faculty by department based on tenure department. Non-tenure track faculty, temporary faculty, and post-docs, department are based on assignment.

[2] The OSE faculty is affiliated with the OSE program. OSE affiliated faculty have appointments with either Electrical and Computer Engineering Department, the Biology Department, Chemical Nuclear Department, and the Physics and Astronomy Department.

Data source: Empcount database maintained by Institutional Research
UNM Institutional Research: C. Bernhard

Table 14. OSE Affiliated Faculty Table

OPTICAL SCIENCE AND ENGINEERING AFFILIATED FACULTY[1, 2] as of 10/31/08

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008
Professor	15	13	13	13	14	15	16	18	18
Associate Professor	2	5	5	5	3	4	4	3	3
Assistant Professor	1	0	0	1	1	2	3	2	2
Visiting Faculty	1	0	0	0	0	0	0	0	0
Research Faculty	13	13	14	11	13	11	9	9	9
Temporary Faculty	1	2	2	2	1	0	2	2	2
Post-Doctoral Fellows	1	2	2	3	3	3	2	2	2
TOTAL Faculty	34	35	36	35	35	35	36	36	36

[1] Faculty by department based on tenure department. Non-tenure track faculty, temporary faculty, and post-docs, department are based on assignment.

[2] The OSE faculty is affiliated with the OSE program. OSE affiliated faculty have appointments with either Electrical and Computer Engineering Department, the Biology Department, Chemical Nuclear Department, and the Physics and Astronomy Department.

Data source: Empcount database maintained by Institutional Research
UNM Institutional Research: C. Bernhard

Table 15. OPTICAL SCIENCE AND ENGINEERING PROGRAM
Affiliated Faculty by Contract Type and Category As of October 31, 2008
Data source: Empcount database maintained by Institutional Research
UNM Institutional Research: C. Bernhard

Faculty Category	Name	Job Title
ECE Tenure, Tenure Track Faculty by Rank	Balakrishnan, Ganesh	Assistant Professor
	Brueck, Steven R.	Director/Distinguished Professor
	Christodoulou, Christos	Professor
	Hayat, Majeed M.	Professor
	Hersee, Stephen D.	Professor
	Jain, Ravinder K.	Professor
	Lester, Luke F.	Professor
	Osinski, Marek	Professor
	Schamiloglu, Edl	Professor
	Ghani, Nasir	Associate Professor
	Krishna, Sanjay	Associate Professor
	Hossein-Zadeh, Mani	Assistant Professor
	Sen, Pradeep	Assistant Professor
Non-Tenure Track Faculty by Primary	Lavrova, Olga	Visiting Lecturer
	Dawson, Larry R.	Research Professor
	El-Emawy, Abdel-Rahman	Research Assoc Professor
	Gaudet, John A.	Faculty Working Retiree
	Grillot, Frederic	Research Assoc Professor
	Smolyakov, Gennady	Research Asst Professor
Physics Tenure, Tenure Track Faculty by Rank	Caves, Carlton M.	Distinguished Professor
	Deutsch, Ivan H.	Professor
	Diels, Jean-Claude M.	Professor
	Kenkre, Vasudev M.	Distinguished Professor
	Prasad, Sudhakar	Professor
	Rudolph, Wolfgang	Professor
	Sheik-Bahae, Mansoor	Professor
	Thomas, James L.	Associate Professor
	Geremia, John M.	Assistant Professor
	Koch, Steven J.	Assistant Professor
Non-Tenure Track Faculty by Primary	Epstein, Richard I.	Research Assoc Professor
	Hasselbeck, Michael P.	Research Asst Professor
	Nampoothiri, Vasudevan A V	Research Asst Professor
	Stintz, Andreas	Research Asst Professor
Other Faculty	Alsing, Paul M.	Temp Faculty
	Cardimona, David A.	Temp Faculty
Tenure, Tenure Track Faculty by Rank	Stricker, Stephen A.	Associate Chairperson Biology
	Lopez, Gabriel P.	Professor Chemical Engineering

OPTICAL SCIENCE STUDENT CHAPTERS AND PROFESSIONAL SOCIETIES AT UNM:

The OSE program has enjoyed strong ties and relationships with the Optical Science of America, (OSA) student chapter at UNM, SPIE student chapter at UNM, and The Albuquerque Chapter of the IEEE Photonics Society. Each of these groups has a very active organization that holds meetings, host events and recruits new membership. The OSE program has partnered regularly with these organizations in hosting and participating in their events.

A. The Optical Society of America UNM Student Chapter:

The Optical Society of America's main function is to spread information, interest, and use of the optical sciences. Hopefully this helps to build communication within the optical community, which in turn cooperates to solve research problems, pure or applied.

The OSA has established local student chapters to promote the cross-fertilization of ideas and efforts among student peers. From the OSA website:

> "Chapters also serve as an excellent vehicle for organizing optics programs, give you a global network of students at other colleges and universities, and is a great way to make career connections."

The Albuquerque Student Chapter has been very active in sponsoring guest speaker, hosting social events, and participating in community outreach projects. Here is a list of the 2009 Calendar of Events:

2009 Events for OSA Student Chapter – UNM Albuquerque, NM

March 6, 2009

OSA TALK BY KRAIG FREDRICKSON, SANDIA NATIONAL LABS
DEVELOPMENT OF LASER DIAGNOSTICS IN TURBULENT POOL FIRES AND LOW-PRESSURE PLASMAS

Computational simulations are frequently used to predict and understand the dynamics of many different systems. However, development of these simulations requires high-fidelity experimental data for validation and verification. The fire science and plasma physics communities have traditionally used physical probes, such as thermocouples or Langmuir probes as diagnostic tools, but these probes have limited spatial and temporal resolution and in many cases can be quite intrusive. Additionally, thermocouples may suffer from bias errors, such as thermal lag and radiative cooling, as large as 40% when employed in high-temperature (2000 K) fires, while the accuracy of Langmuir probes suffer from uncertainties on the same order of magnitude because of ion motion around the probe and ion interaction with the probe. As predictive simulations become more developed, the diagnostic techniques used must become more sophisticated to match the resolution needs of the modeling community. Laser-based diagnostics show the potential to acquire nonintrusive, high spatially and temporally resolved measurements within environments relevant to the fire and plasma communities. This seminar will present recent development of a joint temperature/soot and an electron density diagnostic within large-scale turbulent pool fires and low-pressure helium plasmas. The pool fire measurements utilize Coherent anti-Stokes Raman Scattering (CARS) and Laser-Induced Incandescence (LII) to determine the gas temperature and soot volume fraction, respectively. A Laser Collision-Induced Fluorescence technique is employed to extract the electron density and temperature within low-pressure helium plasmas.

Speaker Biography: Since 2007, Dr. Kraig Frederickson works as post-doctoral researcher at Sandia National Laboratories, doing development of laser-based diagnostics for large-scale turbulent pool fires (CARS/LII) and low-pressure plasmas (LCIF). Dr. Kraig Frederickson received his Ph.D in physical chemistry under the instruction of Dr. Walter Lempert, Ohio State University. His Ph.D research was about using optical/laser diagnostics to investigate plasma kinetics and plasma-based applications such as the Electric Discharge Oxygen Iodine Laser and isotope separation. Before that, he got his Bachelor's in chemistry and physics from Pacific Lutheran University.

May 22, 2009

OSA TALK BY DR. LUKE LESTER, OSE GENERAL CHAIR AND PROFESSOR, ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT, UNM

Reconfigurable Quantum Dot Photonic Integrated Circuits

The guiding principle of the work to be discussed is the concept of the Reconfigurable Cellular Block (RCB), which refers to a discrete physical arrangement of repeated elements organized in various dimensions from nanoscale to microscale. The most successful example of the RCB idea is the field-programmable gate array (FPGA), which allows a system designer to program logic blocks in an integrated circuit to perform specific user-defined functions. Our vision is to apply the RCB principle to nanoscale photonic devices to realize the benefits of compactness, low cost, and flexibility of function. In particular, we examine the quantum dot photonic integrated circuit configured to operate as a mode-locked laser. The small size, low power consumption, and direct electrical pumping of monolithic mode-locked lasers make them promising candidates for optical clock distribution, high bit-rate optical time division multiplexing, OCT, two-photon microscopy, and arbitrary waveform generation. Some unique advantages of quantum dot (QD) materials, such as ultra broad bandwidth, ultra fast gain dynamics, and easily saturated gain and absorption, make them an ideal choice for semiconductor monolithic mode-locked lasers. The fundamental design principles for using QDs in mode-locked lasers are presented to explain the observed results and to describe why QDs are particularly well-suited for reconfigurable laser devices. Concluding remarks will be given on a series of open problems and future applications for these kinds of photonic integrated circuits.

Speaker Biography: Dr. Lester is a Professor in the Department of Electrical and Computer Engineering, Microelectronics Endowed Chair and General Chair of the Optical Science and Engi- neering program a UNM. He received his B.S. in Engineering Physics and his Ph.D. in Electrical Engineering from Cornell University. Prior to his arrival at UNM, Dr. Lester worked as an en- gineer for General Electric Electronics Laboratory in Syracuse, New York. Dr. Lester has over 20 years experience in III-V semiconductor materials and devices and was a co-founder and Chief Technology Officer of Zia Laser, Inc., a startup company using quantum dot materials to develop quantum dot laser products for communications and computer/microprocessor applications. As a senior member of the IEEE since 2000, he is an active organizer of Lasers and Electro-Optics Soci- ety (LEOS) conferences, workshops and journals. He was an Air Force Summer Faculty Fellow in 2006 and 2007. Dr. Lester's other awards and honors include the 1998 UNM School of Engineering Research Award, the 1994 Martin Marietta Manager's Award, and the 2007 UNM ECE Teaching Award. He has published 80 journal articles and over 100 conference papers.

May 27, 2009

OSA CLEO 2009 PRACTICE TALKS

Mike Pochet
Methods for Improved 3dB bandwidth in an Injection-Locked QDash Fabry Perot Laser @ 1550nm
Li Wang
Surface-Plasmon Enhanced Fluorescence in CdSe/ZnS Semiconductor Quantum Dots
Luke A. Emmert
The Role of Native and Transient Laser-Induced Defects in the Femtosecond Breakdown of Dielectric Films
Daniel Mirell
Experimental evidence for both the Self-guiding and Bessel Beam models of filamentation using different initial conditions
Andreas Schmitt-Sody
Synchronously pumped OPO with two pulses per cavity for intracavity phase measurements
Andreas Velten
Stabilization of a Two Pulse Intracavity Pumped OPO

August 27, 2009

OSA, THE OPTICAL SCIENCE AND ENGINEERING PROGRAM AND SPIE OUTREACH – NM STATE FAIR

OSA, the OSE program and SPIE partnered together to host a booth at the New Mexico State Fair for Science and Technology Day.

On Friday, September 18, 2009, the UNM Optical Science and Engineering (OSE) Program participated in the New Mexico State Fair's Science and Technology Day or Celebra la Ciencia day at Expo NM. This is a day when industry's leading labs, government agencies and colleges share the wonders and mysteries of science with the children of New Mexico and their families. The State Fair organizers estimated approximately 2,000-3,000 people were in attendance.

The OSE program brought the science and technology from the field Optics to the Expo. A mixture of faculty and students demonstrated innovative and creative optical devices. UNM Professor Majeed Hayat performed a demonstration with infrared spectral sensors and imagers. Stephen Myers lead a beading exercise with the children using solar/UV beads. Maya Kutty performed a demonstration with kaleidoscopes and explains the optical science behind them. Andreas Velten and Koji Masuda had a demonstration creating a rainbow using light, prisms and water vapors. Brianna Klein had a hands-on solar cell demonstration and discussed its applications. Other student participants include Nishant Patel, Woo-Yong (Eric) Jang, Nutan Gautam, Xiang He, David Ramirez, Xuan Luo, Pankaj Ahirwar and Andreas Schmitt-Sody.

The OSE program is an interdisciplinary graduate program that is jointly administered by the Department of Physics and Astronomy and the Department of Electrical and Computer

Engineering and is affiliated with the Center for High Technology Materials (CHTM). The program is lead by Professor Luke Lester, General Chair OSE and Graduate Director of ECE, and Professor Mansoor Sheik-Bahae, Co-Chair OSE. CHTM is lead by Distinguished Professor Steven Brueck, Director, and Associate Professor Sanjay Krishna, Associate Director. The student participation at this event was made possible by the UNM student chapters of the Society of Photo-Optical Instrumentation Engineers (SPIE) and the Optical Society of America (OSA). This event was planned and organized by Doris Williams, OSE Program Advisor.

August 28, 2009

OSA/SPIE UNM CHAPTER STUDENT BARBARQUE

Join us as we rapidly oxidize organic fiber structures for the purpose of thermally modifying other organic based materials for the purpose of human consumption.

October 11, 2009
OSA STUDENT CHAPTER LEADERSHIP MEETING AT SAN JOSE (FRONTIERS IN OPTICS CONFERENCE)

Koji Masuda, OSA UNM Student Chapter President attended the Student Chapter Leadership Conference in San Jose California at Frontiers in Optics Conference.

October 23, 2009

OSA TALK BY DR. WOLFGANG RUDOLPH, GRADUATE CHAIR PHYSICS AND ASTRONOMY AND OSE AFFILIATED FACULTY, UNM

Ultrashort laser pulses are tools, sometimes called toys, with spectacular features in the hands of scientists and engineers. They can be as fast as one optical cycle, which amounts to a few femtoseconds (1 fs = 10-15 s) in the visible spectral region. Traveling with the speed of light these bullets have a geometrical length of only a few micrometers. When spatially focused the intensities can easily exceed 1018 W/cm2 and the corresponding electric field strengths are many orders of magnitude larger than the Coulomb field between electrons and the nucleus in an atom.Owing to these properties ultrashort laser pulses have continuously pushed the frontiers of current science and technology. They enable the observation of ultrafast processes in nature with unprecedented resolution. Novel microscopies for biological and medical applications have been invented that capitalize on nonlinear optical processes excited by femtosecond pulses. Micro and nanostructuring of materials has benefited from controlled interaction of fs pulses with materials under high excitation conditions.We will describe ongoing research of our group to understand laser induced breakdown of dielectric materials (laser damage), to produce fs beams with orbital angular momentum, and to explore fs four-wave mixing microscopy.

Speaker Biography: Dr. Rudolph is a Professor in the Department of Physics and Astronomy and the Department of Electrical Engineering and has been appointed as a Regents' Professor since 2006. Dr. Rudolph received his Ph.D. in Physics from Friedrich-Schiller-University Jena, Germany. Dr. Rudolph's awards and honors include Gustav Hertz Prize of the National Physical Society (1988), Prize of the Faculty of Natural Science (1989) and Fellow of the Optical Society of America. He has published more than 130 refereed and invited articles and co-authored two books including Ultrashort Laser Pulse Phenomena. His current research interests include development of molecular mid-infrared lasers, microscopy with femtosecond light pulses and ultrafast processes and intense laser-material interactions.

November 13, 2009

OSA TALK BY DR. GANESH BALAKRISHNAN, ASSISTANT PROFESSOR DEPARTMENT ELECTRICAL AND COMPUTER ENGINEERING AND OSE AFFILIATED FACULTY, UNM

Department of Electrical and Computer Engineering,University of New Mexico

In the case of certain highly mismatched semiconductors such as GaSb grown on GaAs the transition from a lattice constant of 5.65 Å to 6.09 Å can be achieved without growing as much as a single mono-layer of GaSb on GaAs. This is realized through the use of certain multi-layer surface reconstructions of Sb on GaAs that form complete planar layers of the Sb-sublattice on the GaAs substrate, thus surpassing the critical thickness for the materials involved. Such a reconstruction results in a periodic 90º-misfit interfacial misfit-dislocation array (IMF) in the Sb layer to accommodate the strain. We have identified through experiments that the (2 x 8) Sb on Ga-terminated GaAs is one such reconstruction that possesses the ability to pack Sb atoms two-dimensionally on the GaAs substrate, in the process forming an array of 90º misfit dislocations. Since these periodic misfit dislocations allow Sb atoms on GaAs to take on the lattice constant of GaSb, the ensuing GaSb growth on such a reconstructed surface is similar to GaSb homoepitaxy. The reconstruction's ability to self-assemble and dynamically change its coverage on the substrate allows for a monolayer of completely relaxed GaSb to be realized across the entire GaAs substrate. We have realized very high quality IMF layers for growth of GaSb on GaAs. The growth of the III-Sb alloys using the IMF technology has already resulted in the demonstration of electrically injected, room temperature, edge-emitting lasers on GaAs at wavelengths of 1.8 to 2 μm.

This presentation will overview the role of IMF technology in the development of a novel high-power vertical external cavity surface emitting lasers (VECSELs) for Mid-IR operation with an InGaSb QW active region (a0 = 6.09 Å) on a GaAs/AlGaAs distributed bragg reflector (DBR) (a0 = 5.65 Å). A comprehensive look at the factors that affect the residual threading dislocations in such a growth mode will be provided and strategies to achieve sub- 5 x 105 threading dislocations/cm2 will be discussed.

Speaker Biography: Dr. Ganesh Balakrishnan is an Assistant Professor with the ECE department at UNM. Prior to this he was the technical director of the Integrated Nanomaterials Core Group at the California Nanosystems Institute, UCLA. He has a PhD in Optical Sciences from the University of New Mexico, a Masters in Electrical Engineering from the University of Toledo, OH and an Undergraduate degree in Electrical Engineering from the University of Madras, India.

November 20, 2009

OSA FEMTOSECOND LASER TECHNOLOGIES FOR EUV AND X-RAY SOURCES DR. FRANZ X. KÄRTNER

MIT

Over the last few years, advances in femtosecond lasers have opened up the possibility to construct fully coherent soft and hard x-ray sources that range from table-top size to kilometer long seeded FELs. The later facilities will be combined laser and accelerator laboratories. In this presentation, we discuss some of the laser technologies and physics central to such sources. First,

a set of nonlinear optical techniques will be presented that enable long term stable timing distribution in large scale x-ray FELs with sub-10 fs and eventually sub-fs precision in the near future. Second, we discuss the scaling of seed radiation in the EUV and XUV generated via high harmonic generation. We have derived closed form analytical expressions for the achievable high harmonic conversion efficiencies both for the plateau region and the cutoff region as a function of laser and material parameters. Such sources can be stand alone or used for seeding of FELs. Third we discuss our progress in the development of large average power few-cycle optical parametric chirped pulse amplifiers in the 800 nm to 2 micron range for driving the harmonic generation process. First results on a 2 micron drive laser system and power scaling with cryogenically cooled Yb:YAG will be discussed.

B. SPIE

Chapter Goals:
We aspire to create a sense of community for our members through activities such as outreach projects, BBQ dinners and technical events. Our mission is also not to lose sight of the individual in an entire crowd, but to nurture intellectual growth especially in the field of light through talks, exposure to others in the field through SPIE conferences, journals, and digital libraries.

History of the Chapter:
Our SPIE chapter at UNM began in August 2006 with 12 students. This student body went on to elect 4 student officers in September 2006 that remained until December 2007 when a new set of officers were elected. Ever since then we have continued the tradition of officer elections in December. Our current officers are listed below. Throughout the existence of this organization we have had the honor of having Prof. Sanjay Krishna as our chapter advisor and mentor. His support and vision has been the driving force behind our success.

Chapter Events:
In 2009, we at the UNM chapter of SPIE have had the privilege of organizing two major events at UNM.

1. **South West Optics Student Conference (SWOSC):**

   The first annual Southwest Optics Student Conference was held this year at the University of New Mexico. This event was a great opportunity for students across the Southwest to interact with other students from numerous universities in the region. The conference also enabled interaction with industry and national lab representatives who were attending the Mirror Tech Days Workshop, which was held jointly with the student conference. The program contained many exciting events. First, there were lab tours at CVI Melles Griot, Emcore, AMO wavefront, and Schott Solar. Second, our key note speaker was Dr. Phillip Wyatt, who talked about the combination of research and industry. Third, our technical talks and poster sessions encouraged interaction with peers and professionals. The conference was concluded with a panel discussion about what future employers expect from students before they apply to work for them. In the future, we hope this event will continue, alternating among the different Southwestern universities. The panel included Professor Steven R. J. Brueck Director of the Center for High Technology Materials, Professor Luke Lester UNM General Chair for Optical Science and Engineering, Dr. Jim McNally Chairman for the New Mexico Optics Industry Association, Dr. Eileen V. Ryan Director of the Magdalena Ridge Observatory, Dan Rondeau Deputy Director of the Integrated Military Systems Development Center at Sandia National Laboratories, and the panel was moderated by Dr. David Wick an optical engineer working in Integrated Military Systems at Sandia National Laboratories.

2. **CHTM Silver Celebration Event:**

The Center for High Technology Materials (CHTM) celebrated its 25th anniversary this year in which there was organized a special technical symposium, a CHTM open house, and a social event for CHTM alumni. The SPIE student chapter organized the lab tours and CHTM along with a poster session to show case the work that is done at CHTM by graduate students.

Outreach:

New Mexico State Fair (September 18, 2009):
Each year the New Mexico State fair dedicates a day to science & technology. This year the UNM SPIE student chapter along with the OSA student chapter and the Optical Science and Engineering program hosted a booth and offered demonstrations of light and optics at the event. This day on average has an attendance of three thousand people. Kids of all backgrounds got the opportunity to experiment with beads that change color when exposed to UV light, a camera that sees infrared, the inner workings of a telescope, the mysteries of kaleidoscopes and much more.




SPIE 2009 Talks:

All the talks were hosted at CHTM's conference room based on the UNM south campus. A light lunch was provided at most of the talks by the SPIE-UNM chapter.

1. "Electron Spin Injection and Transport in Semiconductors" by Dr. Daryl Smith
2. "Untwinkling of the Stars: The History and Practice of Adaptive Optics" by Dr. Sergio Restaino0
3. "VCSELS for Atomic Clocks" by Dr. Darwin K. Serkland
4. "Introduction to FDTD and its Applications to Optics" by Jamesina Simpson
5. "Ultrashort laser pulses" by Dr. Wolfgang Rudolph
6. "Recent Success of SLS FPAs and MDA's new direction for development" by Dr. Meimei Tidrow
7. "III-Sb lasers on GaAs using interfacial misfit dislocation arrays" by Prof. Ganesh Balakrishnan
8. "Femtosecond Laser Technologies for EUV and X-ray sources" by Dr. Franz X. Kärtner (MIT)

SPIE Future Activities:

1. Outreach and Recruitment Event with OSE
OSE and SPIE will be partnering to do an outreach and recruitment event to UNM undergraduates this Spring.

2. Outreach Collaboration with SPIE/OSA Stanford Chapter:
We are currently partnering with the SPIE/OSA Stanford chapter on their 2010 Student Photography Contest. This contest has been an excellent outreach tool as it is geared towards pre-university students, bringing about an effective way of stimulating interest in optics.

C. THE ALBUQUERQUE CHAPTER OF THE IEEE PHTONICS SOCIETY

The Albuquerque Chapter of the IEEE Photonics Society is at the heart of the high-tech community of greater Albuquerque, New Mexico, a state also known as "The Land of Enchantment." The area is host to a number of power houses in the "Rio Grande Corridor" photonics, including Sandia National Laboratories (SNL), the Center for High Technology Materials (CHTM) of the University of New Mexico (UNM), and the Air Force Research Laboratory (at Kirtland AFB). In Albuquerque, the clean air and clear sky, along with the charm of the sky-scraping Sandia Mountains are enough to free the mind of any city dweller and open one's eyes to the beauty of a civilized desert.

The Photonics Chapter is hosted at CHTM, where the majority of technical meetings of the Chapter take place. I am proud to say that our Chapter is over 50 members strong, with 10 student members, 9 Senior Members and 4 Fellows. Along with my co-officers Yagya Sharma (CHTM Scientist), Gordon Keeler (SNL Scientist) and Gunny Balakrishnan (UNM Professor), we have organized in the 2008 fiscal year twelve technical meetings, including two presentations by Photonics Society Distinguished Lecturers (DLs) Dr. Weng Chow and Dr. Masaya Notomi and one presentation by Electron Devices Society DL Dr. Vikram Dalal. Among the lecturers this year (nineteen lectures to date, including three DLs) were Professor Bahaa E. A. Saleh, who gave a presentations titled "3D Imaging Through Dispersive Media: Classical & Quantum Approaches," and Professor Prem Kumar, who presented a lecture titled "Fiber-Optic Quantum Communications and Information Processing." I am extremely pleased with the level of attendance in these meetings, by both IEEE members and others, which shows the interest of the local technical community in photonics research and technology.

Through our Chapter activities we hope to attract greater involvement of students in IEEE and in the Photonics Society in particular. On December 18, 2008, our Chapter presented Mr. Ajit V. Barve with the Best Regional Student Paper Competition Award for his paper titled "Reduction in Dark Current using Resonant Tunneling Barrier in Dots-in-a-Well Long Wavelength Infrared Photodetectors." Ajit has presented his paper at the 21th Annual Lasers and Electro Optics Society Meeting in Newport Beach, CA. He is a doctoral graduate student at UNM working at the Center for High Technology Materials under the supervision of Prof. Sanjay Krishna. The award was comprised of a certificate from the Albuquerque Chapter, a $200 cash prize plus cost of IEEE student membership and Photonics Society membership for one year. We are looking forward to repeating this competition in 2009 and beyond.

A few members of the Albuquerque Photonics Society Chapter. Top Photo (UNM): Lower row from Left to right: Yagya Sharma, Sanjay Krishna (CHTM Assoc. Director), Ajit Barve, Majeed Hayat, Eric Jang, Marek Osinski; upper row from right to left: Mani Hossein-Zadeh, Steven Brueck (CHTM Director), Ganesh Balakrishnan, Luke Lester, and Steve Hersee.
Bottom Photo (SNL): Left to right: Mial Warren, Terry Stalker, Bob Kaplar, Gordon Keeler, Allen Vawter, Darwin Serkland.

We truly hope that you have a chance to visit Albuquerque in the near future. For more information please visit http://www.chtm.unm.edu/~yagya/LEOS/

Truly yours, Majeed Hayat, Chair of Albuquerque Chapter

VIII. UNM LIBRARIES OVERVIEW, FACILITIES AND SERVICES

Optical Sciences and Engineering APR

UNM UNIVERSITY LIBRARIES
OVERVIEW, FACILITIES, AND SERVICES

The mission: The University of New Mexico (UNM) University Libraries (UL) is a dynamic leader in connecting customers to information, collections, and instruction anyplace and anytime, as well as providing and maintaining exceptional facilities for the evolving education, research, and service needs of UNM and the wider community.

UNM UL is a member of the prestigious Association of Research Libraries. The UL is composed of four separate facilities: Centennial Science and Engineering Library; Parish Business and Economics Memorial Library; Fine Arts and Design Library; and Zimmerman Library, the Education, Social Sciences, and Humanities Library. In addition to the University Libraries, students and faculty also have access to the Health Sciences Library & Informatics Center and the Law Library.

The UL collections consist of over 2 million volumes, access to 300 online bibliographic/full text databases, and subscriptions to approximately 55,000 current journals. Where feasible we are moving exclusively to online formats.

Personalized services include instruction sessions, held in fully equipped classrooms in the libraries, teaching students and faculty how to utilize the library's resources and collections efficiently and effectively, and in-depth comprehensive research assistance. Introductions to library resources are provided through the UL's LibGuides subject pages. Individualized library instruction/tours are also available upon request. Reference services desks are open 60 hours per week and staffed with professionals who help with research problems, devising search strategies, and finding and using various print and electronic resources.

The Parish Business and Economics Memorial Library is now open 24 hours a day, 5 days a week. The UL provides numerous computers for student use and circulates laptops to students for use in the libraries. UNM affiliated users can use the UL resources from anywhere using their UNM network identification.

Borrowing of materials not held at UNM is done through Interlibrary Loan/Library Express. UNM belongs to a consortium of libraries which delivers most journal articles and book chapters within 24 hours and books within 4 days. This is a free service for students, faculty, and staff. Library Express is a new service that delivers scanned copies of articles or chapters held within the UL to users at no charge. Users request the materials by using the link for Interlibrary Loan/Library Express on the UL web page.

Optical Sciences and Engineering

The most important library branch for Optical Sciences and Engineering is the Centennial Science and Engineering Library (CSEL). The following LibGuides provide guidance in finding and using resources available to Optics researchers: http://libguides.unm.edu/physics, http://libguides.unm.edu/ece

Budgetary constraints have had a major impact on the UL's ability to retain and add important bibliographic databases and journal subscriptions. One positive note is that libraries and publishers are exploring new ways of paying for and providing access to journals. In 2010, for example, UL will be able to access the Elsevier Freedom Collection, which includes numerous important Optical Sciences and Engineering journals. New electronic book collections are also being explored.

IX. Questions for the APR team

The preceding sections make clear that the graduate OSE program at UNM has been a highly successful program in spite of a long history of limited resources under which it has operated. The proposed revision and expansion of the program, as detailed in Sec. V, make assumptions and projections based on our internal assessments of its past record, present status, and future potential. We solicit the opinion of the APR team on this matter which we encapsulate and focus into the following set of questions:

1. Are the resources dedicated to the UNM OSE Program sufficient?
Over the next 2-4 years OSE is poised to grow into an entity that would require its own full-fledged administrative infrastructure, including academic advisor, program coordinator, and a lab coordinator. This would de facto give it the status of at least a department. Should the program develop into a department-level entity by subsuming under it other optics related enterprises at UNM with much overlap with OSE, including the graduate optoelectronics program in ECE and a new Imaging Science track? Any such systemic development of the program will be a graduated one, with internal mid-term reviews of its growth and consequent re-alignment of resources performed over two or more phases. To compete nationally for students and research funding, is it necessary for the UNM graduate OSE program to become an autonomous department or college within the university?

2. Should the OSE program evolve its own hiring plan separate from the two administering departments?
Such a plan could be run through the Office of Graduate Studies and serve as a model for all current and future interdisciplinary programs at UNM. *Rationale:* Both in terms of the disproportionately large numbers of OSE students and RAs under the OSE faculty in P&A and ECE (latter if we also include the optoelectronics program under the OSE umbrella), we feel that the dept. hiring plans have not led to faculty load equity over the past decade. Faculty hiring-plan discussions at the departmental level have been necessarily too democratic, fragmented, and counterproductive for deserving OSE needs and interests. An example of this has been the lack of hire of an optics theorist into the OSE core faculty since 1995 even while P&A has added seven new faculty members over the past decade.

3. How can we improve the external visibility of the program and thus our student recruitment as well as program ranking?
As the nation's largest Hispanic serving, major research institution, it has not fully utilized more targeted minority hiring practices. This status could be a tremendous source of well qualified Hispanic students and federal/state funded fellowships that could greatly benefit the OSE program. Also, related to Question 6, we have not explored ways in which the area's national and industrial laboratories can commit some resources to the program for student and staff development.

4. **Should the OSE program have a Bachelors level undergraduate degree program in OSE with participation form Physics and ECE?**
An optics concentration of the BS/Physics degree, created in 2006, seems to have good subscription without much effort to publicize it among local industry and national/federal labs. A

similar move is afoot in ECE to explore the prospects of an undergraduate program in optoelectronics but so far without any involvement from the OSE faculty. Any undergraduate curriculum in OSE will have to be highly flexible and possibly include far more credit hours than a normal degree program to accommodate the different interests and preparation of the students enrolled in an undergraduate OSE degree program through the two departments. Furthermore, this degree is the only rung missing from Albuquerque's optics ladder, a comprehensive offering of optics and photonics career advancement options and programs, with multiple exit points, from the high school academies to two-year technical vocational colleges to UNM.

5. Should OSE expect stronger participation from CHTM in the administration and oversight of the OSE program?

CHTM is an important stakeholder in the health and wellness of the OSE program, since traditionally a large number of students in this program have worked with CHTM-based researchers. The ECE side of the program, in particular, has been run largely by CHTM based faculty over the past 20 years. Nevertheless, the dilemma we all face is that CHTM is an independent research center for excellence with presently little or no academic mission, but because of its stature it can potentially play an exceptional role in leveraging resources and visibility for the OSE program both externally and internally.

6. Should OSE have an external advisory board?

It seems desirable to have an external advisory board to include national-level members, including those from Rochester, Arizona, and/or Central Florida. However, a board consisting of a balanced mix of members from academic institutions and local industry may serve better the dual purpose of raising the program's broader external visibility while leveraging local industrial interests, resources and infrastructure efficiently. We would prefer the latter structure, but we would very much appreciate the review team's opinion on this matter based on your experiences in developing successful OSE or related programs elsewhere.

The interest in UNM's OSE program from both the industrial and government sectors remains high. One approach seems to be to involve them more integrally into the advisory structure of the program. It seems that an external advisory board consisting of members of the labs and industry could serve to provide the initial partnership that has been lacking from the program to date. This has been tried in the past but the lack of administrative support has meant little continuing dialogue with them to evolve the program to address their changing needs and perspectives even as we maintain and improve the quality of the program.

APPENDICES

Appendix A: Summary of Department Contributions to OSE

Appendix B: OSE Alumni -Highlighted OSE Alumni & OSE Alumni from 2000 to 2009

Appendix C: Proposed Revisions to Content of OSE Courses

Appendix D: Citation Metrics

Appendix E: OSE Program Diagram

Appendix F: OSE Affiliated Faculty Resumes and Curriculum Vitae

APPENDIX A

Appendix A: Summary of Department Contributions to OSE

OPTICAL SCIENCE AND ENGINEERING
SUMMARY OF DEPARTMENT CONTRIBUTIONS SUMMARY
FALL 2009

NAME	Assistantships Donation*	Credit Hours	Tuition Donation in Dollars+
CHTM TOTAL	$5,142.84	12	$2,779.40
ECE TOTAL	$6,857.00	12	$2,779.40
PHYSICS TOTAL	$66,136.50	78	$19,461.00
CHTM, ECE, Physics TOTAL	$78,136.34	102	$25,019.80

Data Source: Office of Graduate Studies Contracts and UNM Registrar's Office Tuition Rates
Office of Graduate Studies-E. Chavez-Salazar, Contracts Manager and Registrar's Office Published Tuition Rates Document.

*Department Contract totals from 8/24/09 to 12/31/09.
+Tuition amounts are based on in-state tuition rates by Registrar's Office.

OPTICAL SCIENCE AND ENGINEERING
DEPARTMENT SUPPORT DETAIL FOR FALL 2009

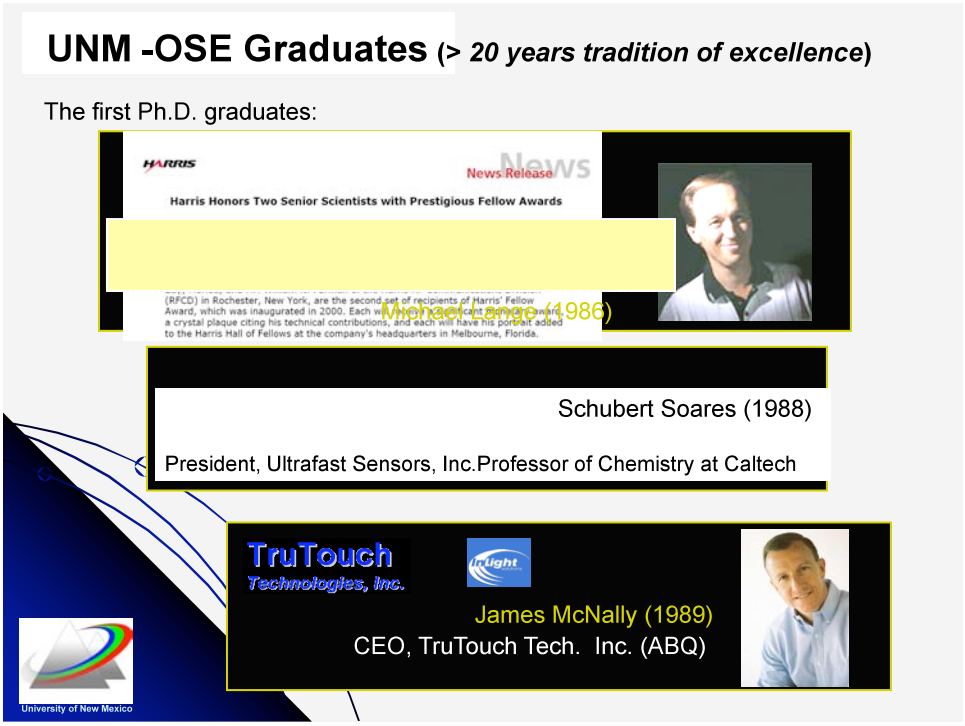
NAME	Assistantships Donation*	Credit Hours	Tuition Donation in Dollars+
CHTM			
OSE Student 1	$5,142.84	12	$2,779.40
CHTM TOTAL	**$5,142.84**	**12**	**$2,779.40**
ECE			
OSE Student 2	$6,857.00	12	$2,779.40
ECE TOTAL	**$6,857.00**	**12**	**$2,779.40**
PHYSICS			
OSE Student 3	$6,907.00	9	$2,098.50
OSE Student 4	$6,907.00	10	$2,332.00
OSE Student 5	$7,598.00	9	$2,098.50
OSE Student 6	$6,907.00	12	$2,779.40
OSE Student 7	$7,598.00	10	$2,332.00
OSE Student 8	$6,907.00	6	$1,399.20
OSE Student 9	$5,698.50/ .375 FTE	7	$1,632.00
OSE Student 10	$3,800.00/ .25 FTE	6 Dissertation Hrs	$594.00
OSE Student 11	$6,907.00	9	$2,098.50
PHYSICS TOTAL	**$66,136.50**	**78**	**$19,461.00**
CHTM, ECE, Physics TOTAL	**$78,136.34**	**102**	**$25,019.80**

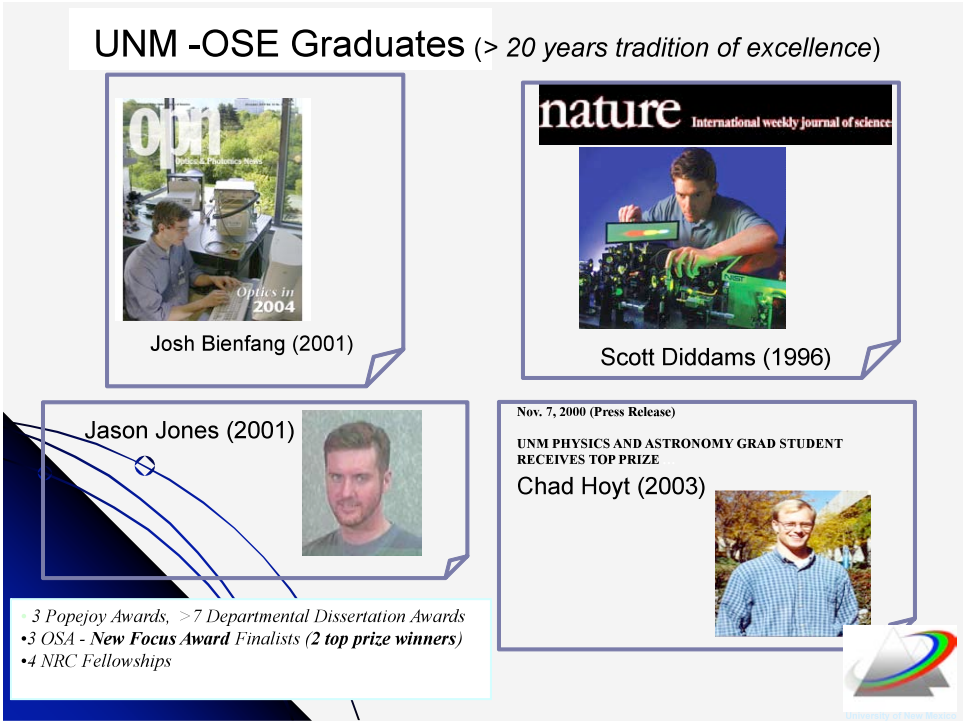
Data Source: Office of Graduate Studies Contracts and UNM Registrar's Office Tuition Rates
Office of Graduate Studies - E. Chavez-Salazar, Contracts Manager and Registrar's Office Published Tuition Rates Fall 2009 Document.

*Department Contract totals from 8/24/09 to 12/31/09.
+Tuition amounts are based on in-state tuition rates by Registrar's Office.

Appendix B: OSE Alumni -Highlighted OSE Alumni & OSE Alumni from 2000 to 2009

OSE HIGHLIGHTED ALUMNI





APPENDIX B

OSE Alumni List from Spring 2000 to Fall 2009*

*Data Source: Enrollment Management dataset based on 21-day HED Enrollment File and UNM Zimmerman Library Thesis and Dissertation Database. Enrollment Management Reporting Unit: K. Ballard, Programmer and Reference and Instruction Zimmerman Library-C. Desai, Associate Professor

Academic Period	Name	Degree	Thesis/Dissertation Title
Spring 2000	Teehan, Russell F.	PHD	Power scaling and frequency stabilization of an injection-locked laser
Fall 2000	Logofatu, Petre C	PHD	Sensitivity optimized scatterometry
Fall 2000	Rambo, Patrick K.	PHD	Laser-induced lightning
Fall 2000	Tyler, David W.	PHD	Noise reduction in astronomical spatial spectrum measurements
Spring 2001	Grondalski, John P.	PHD	Studies of atomic motion and atomic diagnostics in optical lattices
Spring 2001	Guo, Wei	PHD	Multiple scattering of light from optically trapped atoms
Spring 2001	Jasapara, Jayesh	PHD	Characterization of a femtosecond laser and its application to the study of breakdown in dielectric thin films (last name spelled Jaspara)
Fall 2001	Brilliant, Nathan A.	PHD	Ytterbium-doped, dual-clad fiber amplifiers
Fall 2001	Jones, Ronald J.	PHD	High resolution optical frequency metrology with stabilized femtosecond lasers
Fall 2001	Phipps, Stephen P.	PHD	Rotational relaxation in carbon monoxide
Spring 2002	Ackermann, Mark	PHD	Bi-photon techniques for absolute calibration of on-orbit photon detectors
Spring 2002	Obrien, Michael J.	PHD	Advancements in optics-based chemical and biosensors with array applications
Fall 2002	Berg, Vanessa S.	MS	Design and simulation of 3D-nonimaging angular transformer to improve power coupling efficiencies in a free-space optical communication system
Fall 2002	Thompson, William E.	PHD	Six-wave mixing theory of tilted-grating, broad area semiconductor lasers with supressed filamentation
Spring 2003	Hoyt, Chad W.	PHD	Laser cooling in thulium-doped solids
Spring 2003	Pease, Edwin A.	PHD	Mid-infrared GaInSb/AlGaInSb MQW laser grown on AlInSb metamorphic buffer layers
Summer 2003	Vretenar, Natasa	MS	Non-Thesis Degree
Fall 2003	Hirayama, Toshiyuki	MS	Non-Thesis Degree
Fall 2003	Meng, Xianmei	PHD	Ultra-short pulse optical parametric oscillator sensor
Fall 2003	Popescu, Paul	PHD	Spatially- and spectrally-resolved investigations of InAs quantum dot structures
Fall 2003	Schwarz, Christian J.	PHD	Extending the resolution in lithographic and microscopic imaging
Fall 2003	Stickford, Tanya	MS	Non-Thesis Degree
Spring 2004	Gilbert, Barbara L.	MS	Non-Thesis Degree
Spring 2004	Giuggioli, Luca A	PHD	Theory of transport in organic crystals and biological systems
Spring 2004	Massey, Steven M.	MS	Non-Thesis Degree
Summer 2004	Bernstein, Aaron C.	PHD	Measurements of ultrashort pulses self-focusing in air
Summer 2004	Ling, Hai	MS	Non-Thesis Degree
Summer 2004	Zhang, Yule	MS	Non-Thesis Degree

Academic Period	Name	Degree	Thesis/Dissertation Title
Fall 2004	Donati, Giovanni	PHD	Bandgaps and band offsets of GaSb lattice matched alloys
Fall 2004	Su, Hui	PHD	Dynamic properties of quantum dot distributed feedback lasers
Fall 2004	Ukhanov, Alexander	PHD	Study of carrier-induced optical properties in III-V quantum confined laser nano-structures
Fall 2004	Zhu, Xiushan	MS	All-fiber broadband polarization transformer
Spring 2005	Beckner, Charles C.	MS	Fundamental limits to noise reduction using support constraints and regularization : a Cramer-Rao bound analysis
Spring 2005	Dang, Thien T.	PHD	Towards a compact mode locked laser gyroscope : study of a fiber ring laser and a Nd:YVO4 ring laser
Summer 2005	Kletecka, Christopher S.	MS	Optically pumped mid-IR HBr cascade laser
Summer 2005	Sawruk, Nicholas W.	MS	Optically pumped carbon monoxide cascade laser
Fall 2005	Mero, Mark	PHD	Femtosecond laser induced breakdown in dielectric films
Fall 2005	Vankipuram, Venkatesh S	MS	Toward fabrication of a nano photonic device
Spring 2006	Balakrishnan, Ganesh	PHD	Interfacial misfit dislocation array based growth mode for demonstration of monolithically integrated optically-pumped antimonide lasers on silicon
Spring 2006	Navarro, Martha	MS	Non-Thesis Degree
Spring 2006	Xue, Liang	MS	Tunable high-power midwave-infrared distributed-feedback lasers
Summer 2006	Green, Steven W.	MS	Feasibility of the use of a confocal microscope to image a human fingernail bed as means for identification
Summer 2006	Kumar, Rakesh	MS	Non-Thesis Degree
Summer 2006	Wang, Zhipeng	MS	Non-Thesis Degree
Fall 2006	Greenberg, Melisa R.	MS	Synthesis and characterization of colloidal quantum dots
Fall 2006	Xin, Yongchun	PHD	Quantum dot multi-section light emitters
Spring 2007	Arissian, Ladan	PHD	Dark line resonance in Rb(87) due to coherent interaction with mode-locked lasers
Spring 2007	Clark, Waylon T.	MS	Analysis of a laser induced plasma in high pressure SF6 gas for high-voltage, high-current switching
Spring 2007	Haji, Alim	MS	Cramer-Rao bound analysis of multi-frame blind deconvolution
Summer 2007	Jallipalli, Anitha	MS	Structural, electrical characterization and simulation of periodic misfit dislocation arrays localized at the GaSb/GaAs interface
Summer 2007	Kuznetsova, Yuliya V.	PHD	Imaging interferometric microscopy : resolution to the limit of frequency space
Summer 2007	Nuntawong, Noppadon	PHD	Strain compensation technique in InAs/GaAs SAQD structure grown by metalorganic chemical vapor deposition
Summer 2007	Ratanavis, Amarin	MS	Non-Thesis Degree
Summer 2007	Rotter, Thomas J.	PHD	Growth and properties of self assembled InAs quantum dash laser active regions
Summer 2007	Wang, Quan	MS	Non-Thesis Degree
Fall 2007	Jing, Xiaomo	MS	Non-Thesis Degree
Fall 2007	Liu, Ye	PHD	Investigation of ultrashort OPOs as ultrasensitive optical

Academic Period	Name	Degree	Thesis/Dissertation Title
Spring 2008	Godsey, David C.	MS	Non-Thesis Degree
Spring 2008	Khoshakhlagh, Arezou	MS	Non-Thesis Degree
Spring 2008	Li, Yan	PHD	Techniques for high-speed direct modulation of quantum dot lasers
Spring 2008	Longbotham, Nathan W.	MS	Experimental characterization of Cr4+:YAG passively q-switched Cr:Nd:GSGG lasers and comparison with a simple rate equation model
Spring 2008	Patterson, Wendy M.	MS	Non-Thesis Degree
Spring 2008	Xu, Xiaozhen	MS	Non-Thesis Degree
Summer 2008	He, Xiang	MS	Non-Thesis Degree
Summer 2008	Jallipalli, Anitha	PHD	Structural, electrical characterization and simulation of periodic misfit dislocation arrays localized at the GaSb/GaAs interface
Summer 2008	Johnson, Nicholas A.	MS	Non-Thesis Degree
Summer 2008	Laghumavarapu, Ramesh Babu	PHD	InAs / GaAs and GaSb / GaAs quantum dot solar cells
Summer 2008	Lin, Chang-Yi	MS	Non-Thesis Degree
Summer 2008	Wong, Ping-Show	PHD	Controlled growth and device implementation of InAs quantum dots on nano-patterned GaAs pyramids by MOCVD
Summer 2008	Yeak, Jeremy Nai Jin	MS	Non-Thesis Degree
Fall 2008	Bender, Daniel A.	PHD	Precision optical characterization on nanometer length and femtosecond time scales
Fall 2008	Tiwari, Mukesh	PHD	Quasiparticle motion in some classical and quantum mechanical systems : investigations of nanoscale friction and polaron mobility
Spring 2009	Li, Chia-Yeh	MS	Non-Thesis Degree
Spring 2009	Liu, Xuejun	PHD	Imaging with and without time resolution using femtosecond laser pulses
Spring 2009	Mirell, Daniel J.	PHD	Experimental study of infrared filaments under different initial conditions
Spring 2009	Xue, Liang	PHD	Tunable high-power midwave-infrared distributed-feedback lasers
Summer 2009	Robin, Craig A.	MS	Non-Thesis Degree
Summer 2009	Zmuda, Michael W.	PHD	Stimulated Brillouin scattering effects and suppression techniques in high power fiber amplifiers
Fall 2009	Patterson, Wendy	PH.D.	Not Recorded Yet
Fall 2009	Reyes, Pablo	MS	Non-Thesis Degree
Fall 2009	Weber, Reed	MS	Not Recorded Yet
Fall 2009	Vergien, Chris	MS	Non-Thesis Degree
Fall 2009	Jilek, Brook	MS	Not Recorded Yet
Fall 2009	Kasarla, Satish	MS	Non-Thesis Degree

Appendix C: Proposed Revisions to Content of OSE Courses

PHYC-302) Introduction to photonics

1-Geometrical optics: Refraction/reflection through planar interfaces, Basics of ray tracing and imaging with mirrors and lenses.

2-Wave optics: Introduction to wave equation and propagation. Basics of diffraction, interference and polarization.

3-Optical instrumentation: microscope, telescope, optical fiber, camera, eye.

4-Lasers: Basic principles, Elements of laser: optical cavity, active material and pumping. Examples of laser systems: Gas (HeNe and CO_2), Solid-state (Nd: YAG and Ruby), Liquid (dye) and Semiconductor.

5-Introduction to advanced topics and modern applications: Examples of nonlinear optical effects: electro and magneto optical effects, harmonic generation. Examples of industrial and biomedical applications of laser: material processing, surgery, optical communication, optical data storage (CD).

PHYC/ECE-463) Advanced optics-I

1-Wave optics: (a) Maxwell equations and EM waves. (b) Maxwell's equations in matter, classical electron oscillator (Lorentz model), refractive index and dispersion. (c) Reflection and refraction/transmission through dielectric interfaces (Fresnel's equations). (d) Metal optics. (e) Pulse propagation in dispersive medium.

2-Geometrical optics: (a) Imaging (spherical and aspherical optical surfaces) and exact ray tracing. (b) Paraxial optics (thin lenses, mirrors). (c) Matrix method (principal planes, image formation). (d) Examples of optical systems (thick lenses, human eye, telescope, microscope,...). (e) Aberration theory.

3-Interference: (a) Basics (superposition of fields). (b) Two-beam (Young DS, Michelson,...). (c) Multi-beam interference (Fabry-Perot, Grating,…). (d) Matrix formalism (multiplayer thin films, coating). (e) Interferometry and spectrometers. (d) Application of interference effects.

5-Polarization: (a) States of polarization. (b) Polarizers, waveplates. (c) Matrix techniques (Jones Calculus). (d) Crystal optics: index ellipsoid and tensor properties, magneto-optic and electro-optic effects. (e) Application of crystal optics: modulators and switches.

PHYC/ECE-554) Advanced optics-II

1-Diffraction (a) Far-field (Fraunhofer) diffraction, diffraction gratings. (b) Near-field (Fresnel) diffraction: Huygen's principle, Cornu spiral, Fresnel zone plates.

2-Fourier optics: (a) Analysis of two dimensional signal and systems. (b) Foundation of scalar diffraction theory (Fresnel and Fraunhofer diffraction). (c) Wave-optics analysis of coherent optical systems. (d) Frequency analysis of optical imaging systems. (e) Application of Fourier optics: Holography, Beam optics, Analog optical information processing, Spatial filtering.

3-Optical waveguides: Slab waveguides, Rectangular waveguides, Optical fibers, introduction to photonic crystals.

4-Coherence and statistical optics: (a) Temporal coherence. (b) Statistical optics. (c) Spatial coherence. (d) Interference of partially coherent light. (e) Transmission of partially coherent light through optical systems: image formation, Van Cittert-Zernike theorem.

PHYC/ECE-464) Laser Physics

1-Ray tracing and Gaussian beams: a) Matrix method for ray tracing . b) Gaussian beams. c) Resonator optics.

2-Resonant optical cavities: a) General concepts (Q-factor, FSR, Potoni life time). b) Cavity modes and losses. C) Cavity with gain

3-Spontaneous and stimulated emission: a) Basics of radiation –atom interaction (Blackbody radiation, Einstein coefficients). b) Line shape and broadening mechanisms.

4-Laser oscillation and amplification: a) Rate equations. b) Laser oscillation and amplification. c) Gain saturation. d) Amplified spontaneous emission and line narrowing.

5-Laser characteristics: a) Efficiency. b) CW laser operation (traveling and standing wave lasers). C) Laser dynamics (modulation and pulsed excitation)

6-Pulsed techniques: a) Q-switching. a) Mode locking

7- Laser excitation and examples of laser systems: a) Pumping techniques. b) Laser systems (Solid-State, Gas, Dye, and Excimer lasers).

Catalog descriptions:

PHYC-302) Introduction to photonics

Geometrical optics, Wave optics, Optical instrumentation, Lasers, Introduction to advanced topics and modern applications (nonlinear optics, laser application, …)

PHYC/ECE-463) Advanced optics-I

Wave optics, Optical wave propagation in matter, Geometrical optics, Aberration, Interference, Polarization.

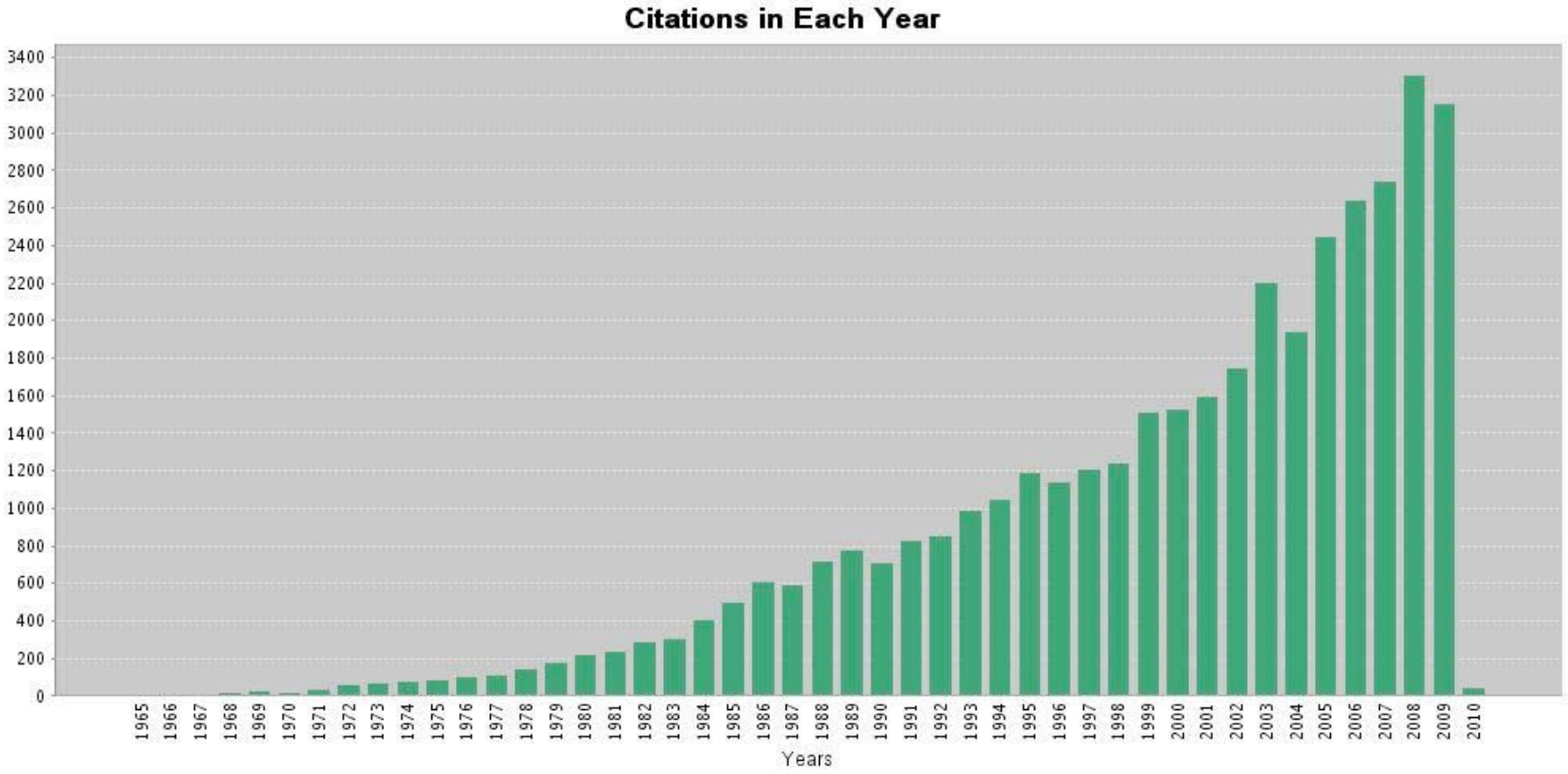
PHYC/ECE-554) Advanced optics-II

Diffraction theory, Diffraction grating, Fourier optics, Introduction to optical waveguides, Coherence and statistical optics.

PHYC/ECE-464) Laser Physics

Ray tracing and Gaussian beams, Resonator optics, Spontaneous and stimulated emission, Laser oscillation and amplification, Laser characteristics, Pulsed techniques, Laser excitation and examples of laser systems.

APPENDIX D: Citation Metrics


Citations in Each Year
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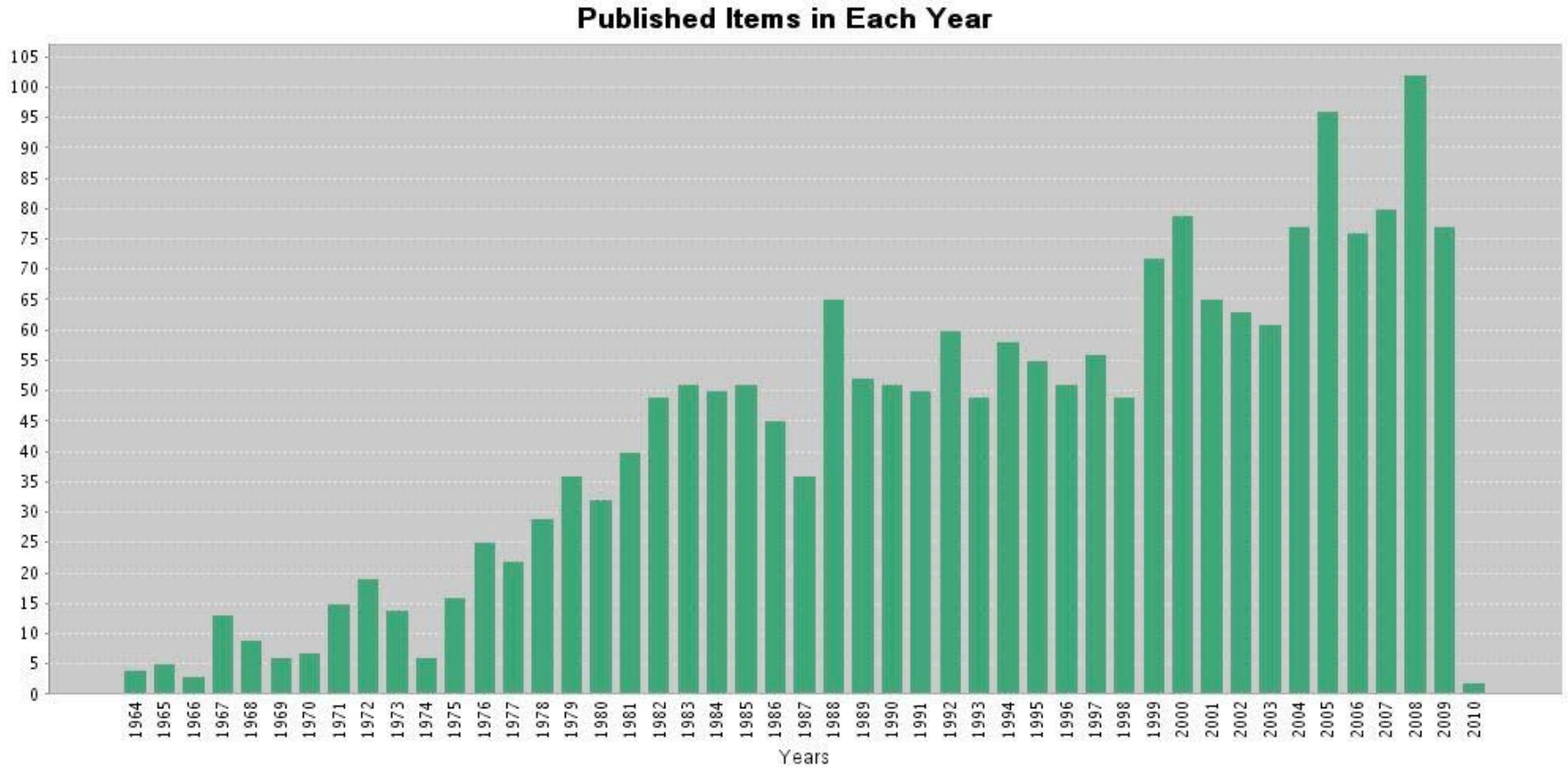
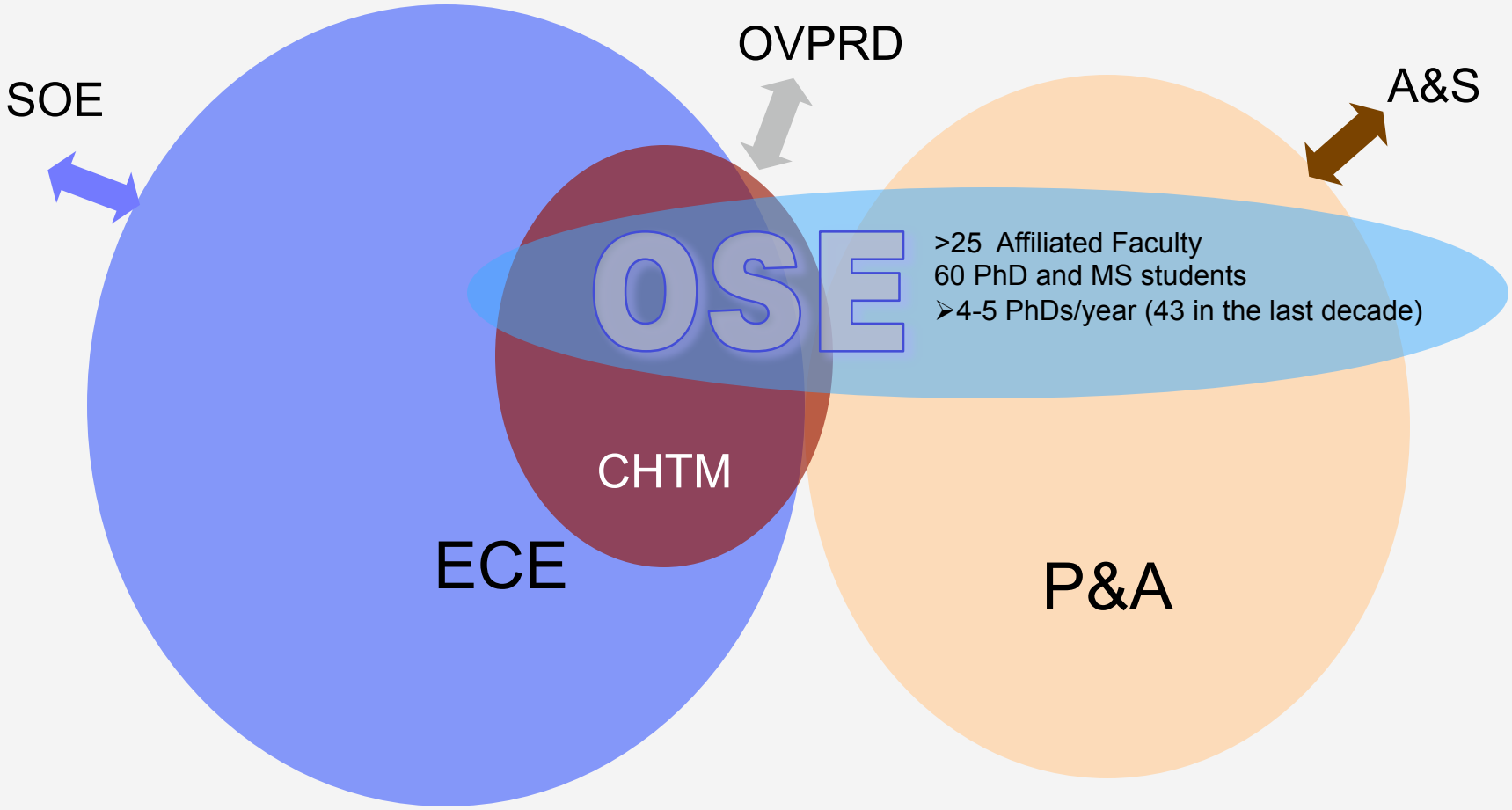
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Years


Published Items in Each Year
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Years

APPENDIX E

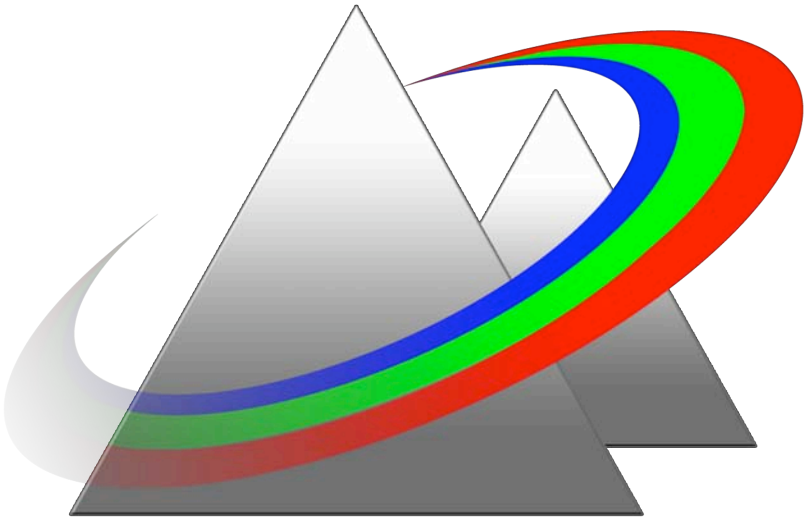
OSE PROGRAM DIAGRAM

OSE: *an interdisciplinary perspective*



no centralized administration / organization until now

APPENDIX F: OSE AFFILIATED FACULTY RESUMES AND CURRICULUM VITAE



Ganesh Balakrishnan

Address: Center for High Technology Materials, University of New Mexico
1313 Goddard SE, Albuquerque, New Mexico 87106-4343
Tel. (505) 259-6412; Fax (505) 272-7801; Email: gunny@unm.edu

Educational History:

• University of Toledo, OH	Electrical Engineering	M.S, 2001
• University of New Mexico, NM	Optical sciences and Engineering	PhD, 2006

Professional Appointments:
2008 - present, Assistant Professor, Electrical and Computer Engineering, Center for High Technology Materials, Univ. of New Mexico; 2007 – 2008 Technical Director, Integrated nonmaterial core lab, California nanosystems institute, UCLA; 2006 – 2007 Postdoctoral Researcher, University of New Mexico.

Classes Taught:
Materials and Devices (ECE 371)
Introduction to Optoelectronics (ECE 475)

Other Significant Publications:

1. Balakrishnan, G., S. Huang, et al. (2004). "2.0 m wavelength InAs quantum dashes grown on a GaAs substrate using a metamorphic buffer layer." Applied Physics Letters 84: 2058.

2. Balakrishnan, G., S. Huang, et al. (2004). "Analysis of atomic structure in InAs quantum dashes grown on AlGaAsSb metamorphic buffers." Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures 22: 1529.

3. Balakrishnan, G., S. Huang, et al. (2005). "Growth mechanisms of highly mismatched AlSb on a Si substrate." Applied Physics Letters 86: 034105.

4. Balakrishnan, G., A. Jallipalli, et al. (2006). "Room-Temperature Optically Pumped (Al) GaSb Vertical-Cavity Surface-Emitting Laser Monolithically Grown on an Si (1 0 0) Substrate." IEEE Journal of Selected Topics in Quantum Electronics 12(6 Part 2): 1636-1641.

5. Balakrishnan, G., J. Tatebayashi, et al. (2006). "III/V ratio based selectivity between strained Stranski-Krastanov and strain-free GaSb quantum dots on GaAs." Applied Physics Letters 89: 161104.

Thesis Advisor/Postgrad Supervisor: Natasa Vretenar (PhD student), Pankaj Ahirwar (PhD student), Paul Schjetnan (Undergraduate) and Stephen Clark (Undergraduate).

Post-doctoral researchers supervised: Dr. Alex Albrecht

Grants:
High Power Laser using Optically-Pumped Semiconductor Laser Concepts, AFOSR-JTO-MRI (180 K per year)

Patents:
Misfit dislocation forming interfacial self-assembly for growth of highly-mismatched III-Sb alloys.
DL Huffaker, LR Dawson, G Balakrishnan - US Patent App. 11/622,262, 2007

STEVEN R. J. BRUECK, Distinguished Professor, ECE and Physics, Director, Center for High Technology Materials, University of New Mexico, 1313 Goddard SE, Albuquerque, NM 87131 (brueck@chtm.unm.edu)

Education: Ph.D., EE, MIT, 1971; S.M., EE, MIT, 1967; B.S., EE, Columbia University, 1965.

Professional Experience: Director, Center for High Technology Materials (CHTM), *University of New Mexico*, 1986-present; Distinguished Professor ECE and Physics, *UNM*, 2006-present; Professor ECE and Physics, *UNM*, 1985-2006; Research Staff Member, Board of Directors, *LightPath Technologies, Inc.* 2001-present; Quantum Electronics Group, *MIT LL*, 1973-1985; Postdoctoral Researcher, Quantum Electronics Group, *MIT LL*, 1971-1973; Research Assistant, Applied Physics Group, *MIT LL*, 1967-1971.

Honors and Society Service: *Fellow*, Optical Society of America, IEEE and AAAS; Research Excellence Award, College of Engineering UNM, 1991; IEEE Third Millenium Medal 2000; General Chair *EIPBN*, 2008; Chair CLEO Steering, 2002-2003; General Co-Chair *CLEO* 2000; Program Co-Chair CLEO 1998; *IEEE Jour. of Quantum Electronics:* Editor (1988-1995), *IEEE Jour. of Selected Topics in Quantum Electronics*: Editor (1995); Assoc. Editor (1986-1988); *Optics Letters*: Assoc. Editor (1984-1986); Elected member, IEEE LEOS Board of Governors, 1989-1991.

National Academies Committees:

Committee on Developing Sensor Technology (chair)	2009-present
Standing Committee on Avoiding Technological Surprise (DIA)	2004-present
Committee on Nanophotonics and Technology Futures	2006-2008
Committee on the Implications of Micro and Nano Technology for the Air Force (chair)	2001-2002
Committee to Provide an Assessment of Science and Technology for the Army After Next with an Emphasis on Logistics (AAN-LOG)	1997-1999
Research Assistantship Committee	1989-1995

Principal Accomplishments

- First demonstration of CW stimulated Raman scattering (spin-flip scattering in InSb)
- Physics of spontaneous and stimulated spin-flip Raman scattering.
- Discovery of radiatively limited lifetime of 1 sec. for vibrational mode of liquid N_2.
- Importance of vibration-rotation coupling in the two-photon Q-branch (Raman) lineshape in liquids.
- Stimulated surface-plasma wave scattering leading to surface ripples in laser-material interactions.
- Enhanced coupling of light to nanostructures on the scale of the optical wavelength.
- Resonant-periodic-gain surface-emitting lasers.
- Discovery of large $\chi^{(2)}$ nonlinearity (~ 1 pm/V) in silica glass.
- Multiple-exposure interferometric lithography for extreme sub-micrometer lithography.
- Fabrication technology for large area Si quantum walls and wires; studies of optical properties.
- Moiré and speckle techniques for noncontact temperature measurement with 1°C resolution.
- Sub-feature speckle interferometry, a new technique for non-contact, sub-λ position measurement.
- Imaging interferometric lithography marrying optical and interferometric approaches to print arbitrary structures to ~ 70 nm scales.
- Nonlinear interferometric lithography – use of processing nonlinearities to exceed the linear systems limits.
- Nanoheteroepitaxy – growth of heterostructure materials using nanoscale seeds.
- Nanofluidics – ionic fluid transport in nanoscale structures for biological separations
- First mid-IR negative permeability material (analog of a split-ring resonator).
- First demonstration of a NIR negative index material.
- Second-harmonic generation in a plasmonic structure using a dipole-allowed nonlinear material.
- First demonstration of self-aligned spatial frequency doubling to 22 nm half pitch.
- Imaging interferometric microscopy – synthetic aperture approaches to extend microscopy to linear systems limits – resolution to ~ $\lambda/4n$ with low *NA* optics (to date: 150 nm *CD* structures, $\lambda/4.2$, demonstrated at a 633 nm wavelength and a modest 0.4 *NA* lens)

Publications and Patents: Over 350 refereed publications; 32 awarded and 17 pending patents (4,470 citations, h-index: 36).

Highly Cited Publications (Dec. 2009):

R. A. Myers, N. Mukherjee and S. R. J. Brueck, *Large Second-Order Nonlinearity in Poled Fused Quartz*, Optics Letters **16**, 1732-1734 (1991) (426 citations)

S. Zhang, W. Fan, N. C. Panoiu, K. J. Malloy, R. M. Osgood and S. R. J. Brueck, *Demonstration of Near-Infrared Negative-Index Metamaterials*, Phys. Rev. Lett. **95**, 137404 (2005) (284 citations).

S. R. J. Brueck and D. J. Ehrlich, *Stimulated Surface Plasma Wave Scattering and Growth of a Periodic Structure in Laser Photodeposited Metal Films*, Phys. Rev. Lett. **48**, 1678 (1982) (145 citations)

S. R. J. Brueck and R. M. Osgood, *Vibrational Energy Relaxation in Liquid N_2-CO Mixtures*, Chem. Phys. Lett. **39**, 568 (1976) (105 citations).

T. G. Alley, S. R. J. Brueck and R. A. Myers, *Space Charge Dynamics in Thermally Poled Fused Silica*, Jour. Noncrystalline Sol. **242**, 165-176 (1998). (104 citations)

S. Zhang, W. Fan, K.J. Malloy, S. R. J. Brueck, N.C. Panoiu and R. M. Osgood, *Near-Infrared Double Negative Metamaterials*, Optics Express **13**, 4922-4931 (2005) (99 citations).

N. Mukherjee, R. A. Myers, and S. R. J. Brueck, *Dynamics of Second-Harmonic Generation in Fused Silica*, Jour. Opt. Soc. Amer. **B11**, 665-669 (1994) (90 citations).

S. R. J. Brueck, *Vibrational Two-Photon Resonance Linewidths in Liquid Media*, Chem. Phys. Lett. **50**, 516 (1977) (83 citations).

A. Mooradian, S. R. J. Brueck and F. A. Blum, *Continuously Stimulated Spin-Flip Raman Scattering in InSb*, Appl. Phys. Lett. **17**, 481 (1970) (78 citations).

Saleem H. Zaidi and S. R. J. Brueck, *Multiple-Exposure Interferometric Lithography*, Jour. Vac. Sci. Technol. **B11**, 658-666 (1993) (67 citations).

Representative Patents:

6,042,998 - S. R. J. Brueck, Saleem H. Zaidi, Stephen D. Hersee and Kevin J. Malloy, Method and Apparatus for Extending Spatial Frequencies in Photolithography

6,097,867 - S. R. J. Brueck and Xiang-Cun Long, Technique for Fabrication of a Poled Electro-Optic Fiber Segment

6,685,841 G. P. Lopez, S. R. J. Brueck, L. Ista, Michael O'Brien, and, Stephen D. Hersee, Nanostructured Devices for Separation and Analysis: Application to Biological Membranes

7,327,924 B2 D. B. Burckel and S. R. J. Brueck, Generalized Bragg Waveguides

7,329,871 B2 W. Fan, S. Zhang, K. J. Malloy and S. R. J. Brueck, Plasmonic Enhanced Infrared Detector Element

7,432,161 S.-C. Lee and S. R. J. Brueck, Fabrication of Optical-Quality Facets on a (001) Orientation Substrate by Selective Epitaxial Growth

7,465,381 G. P. Lopez, S. R. J. Brueck, L. K. Ista, A. L. Garcia, D. N. Petsev, P. Bisong and M. J. O'Brien, Electrokinetic molecular separation in nanoscale fluidic channels

S. R. J. Brueck, Liang Xue and R. Kaspi, *Optically-Pumped, Continuously-Tunable Infrared Laser with a Chirped Distributed Feedback Structure*. (patent allowed, not yet issued).

Grants (past five years)

Agency	Title	Amount	Duration
DARPA	Nanophotonics	$4,000,000	2003-2008
NSF	Tunable IR Lasers for Gas Phase Spectroscopy		
NSF	Chip-Scale Nanofluidics		
Sandia National Labs	Nanoscale Growth		
Sandia National Labs	EFRC in Solid-State Lighting		
Gratings, Inc (SBIR)	Solar Cell Research		
Cornell University	NNIN		
Rensselaer Poly. Inst.	NSF ERC in Smart Lighting		
AFOSR	Optoelectronics Research Center		
AFOSR	Tunable IR Lasers		
Sandia National Labs.	(NINE)		
Sandia National Labs.	IR Metamaterials		
AFRL	High Power Lasers		

BIOGRAPHICAL SKETCH

Carlton M. Caves
Department of Physics and Astronomy (P&A), University of New Mexico (UNM)
caves@info.phys.unm.edu
http://info.phys.unm.edu/~caves

(a) Professional preparation

Rice University, B.A. in Physics and Mathematics, summa cum laude, 1972
California Institute of Technology, Ph.D. in Physics, 1979
Research Fellow, California Institute of Technology, 1979–1981

(b) Professional appointments

Distinguished Professor, University of New Mexico, 2006–present (and Director, Center for Quantum Information and Control, 2009–present)
Professor of Physics and Astronomy, University of New Mexico, 1992–2006
Associate Professor of Electrical Engineering/Electrophysics and Physics, University of Southern California, 1987–1992
Senior Research Fellow in Theoretical Physics, California Institute of Technology, 1982–1987

(c) Lecture courses taught since fall semester 2004

Analytical Mechanics, two-semester upper-division course, 2004–05, and 2006–07
Electricity and Magnetism, two-semester upper-division course, fall semester 2008
Quantum Information Theory, one-semester graduate-level course, fall semester 2005 and spring semester 2009
Quantum Computation, one-semester graduate-level course, spring semester 2006 and fall semester 2009
Sabbatical, University of Queensland, 2007–08

(d) Departmental, university, and external service since fall semester 2004

Graduate Committee (and graduate advisor), P&A, Chair, 2004–05, 2005–06, and fall 2006
Experimental AMO/Quantum Optics Search Committee, P&A, 2004–05
Long-Range Planning/Academic Program Review Committee, P&A, Chair, 2008–2009 and 2009–2010
Senior Tenure and Promotion Committee, A&S: member, 2004–05, Chair, 2005–06
Dean Search Committee, A&S, 2006–07
Research Study Group, Chair, spring-summer 2007. Provost-commissioned study of of UNM research administration produced an influential report in 2007 August.
Program Committee for Annual Meeting of Division of Atomic, Molecular, and Optical Physics, American Physical Society, 2003–2006
Physics Division Review Committee, Los Alamos National Laboratory, 2005
Chair-Elect, 2006, Chair, 2007, and Past Chair, 2008, Topical Group on Quantum Information, American Physical Society
National Science Foundation Physics Division Committee of Visitors, 2006 January 25–27
Friend of the American Physical Society, University of New Mexico, 2006–present

(e) Honors and awards

Fellow, American Physical Society
Fellow, American Association for the Advancement of Science
Einstein Prize for Laser Science, Society for Optical and Quantum Electronics, 1990
Excellence in Teaching Award, UNM Department of Physics and Astronomy, 1998–99, 1999–2000, and 2004–05

(f) Selected recent publications

1. A. Datta, S. T. Flammia, and C. M. Caves, "Entanglement and the power of one qubit," *Physical Review A* **72**, 042316 (2005).

2. A. J. Scott, T. A. Brun, C. M. Caves, and R. Schack, "Hypersensitivity and chaos signatures in the quantum baker's maps," *Journal of Physics A* **39**, 13405–13433 (2006).
3. S. Boixo, S. T. Flammia, C. M. Caves, and JM Geremia, "Generalized limits for single-parameter quantum estimation," *Physical Review Letters* **98**, 090401 (2007).
4. A. Shaji and C. M. Caves, "Qubit metrology and decoherence," *Physical Review A* **76**, 032111 (2007).
5. A. Datta, A. Shaji, and C. M. Caves, "Quantum discord and the power of one qubit," *Physical Review Letters* 100, 050502 (2008).
6. S. Boixo, A. Datta, M. J. Davis, S. T. Flammia, A. Shaji, and C. M. Caves, "Quantum metrology: Dynamics vs. entanglement," *Physical Review Letters* **101**, 040403 (2008).
7. M. J. Woolley, G. J. Milburn, and C. M. Caves, "Nonlinear quantum metrology using coupled nanomechanical resonators," *New Journal of Physics* **10**, 125018 (2008).
8. S. Boixo, A. Datta, M. J. Davis, A. Shaji, A. B. Tacla, and C. M. Caves, "Quantum-limited metrology and Bose-Einstein condensates," *Physical Review A* **80**, 032103 (2009).

(g) PhD supervision

B. L. Schumaker, Caltech PhD 1985, now at JPL
S. L. Braunstein, Caltech PhD 1988, now at York University
D. D. Crouch, Caltech PhD 1988, no longer in physics
C. Zhu, USC PhD 1992, no longer in physics
S. Song, USC PhD 1994, no longer in physics
C. A. Fuchs, UNM PhD 1996, now at Perimeter Institute
H. N. Barnum III, UNM PhD 1999, now at Perimeter Institute
M. A. Nielsen, UNM PhD 1999, now doing work on methods for enhancing scientific communication and collaboration
P. Rungta, UNM PhD 2003, now at Indian Institute of Science Education and Research, Mohali
M. M. Tracy, UNM PhD 2003, now at Central New Mexico Community College
J. M. Renes, UNM PhD 2005, now at Technical University of Darmstadt
B. Eastin, UNM PhD 2008, now a postdoc at NIST Boulder
S. Flammia, UNM PhD 2008, now a postdoc at Perimeter Institute
M. B. Elliott, UNM PhD 2009, no longer in physics
A. Datta, UNM PhD 2009, now a postdoc at Imperial College
S. Boixo, UNM PhD 2009, now a postdoc at Caltech
P. Rice, UNM PhD 2010, continuing as graduate student through spring semester 2010
A. B. Tacla, current UNM PhD student
Z. Jiang, current UNM PhD student

17 PhDs supervised, 2 PhD students currently under supervision

(h) Grants last five years

Quantum entanglement and high-precision measurements, Office of Naval Research, $510,000 for 3 years beginning 2003 March

Southwest Quantum Information and Technology (SQuInT) workshops, Army Research Office, $50,000 for 3 years beginning 2004 February (Co-PI: I. H. Deutsch)

Entanglement and the power of quantum computation, Army Research Office, $370,828 for 3 years beginning 2004 June (Co-PI: I. H. Deutsch)

Partnership in quantum information science, UNM-LANL Joint Science and Technology Laboratory, $139,861 for 2.5 years beginning 2005 January (CO-PIs: B. Bassalleck, I. H. Deutsch, and C. Moore)

Quantum entanglement and high-precision measurements, Office of Naval Research, $515,894 for 4 years beginning 2006 November

Quantum-classical tradeoffs for information-processing tasks, National Science Foundation (PIF), $300,000 for 3 years beginning 2007 July (Co-PI: A. J. Landahl)

Center for Quantum Information and Control, National Science Foundation (PIF), $1,259,811 for 3 years beginning 2009 August (Co-PIs: I. H. Deutsch and P. S. Jessen)

Christos G. Christodoulou

Professor, Department of Electrical and Computer Engineering
University of New Mexico (UNM)
Albuquerque, NM 87131
Tel: 505-277-6580 ; Fax: 505-277-1439; Email:christos@ece.unm.edu

EDUCATION:

American University in Cairo, Physics and Math , B.S., 1979
North Carolina State University, Electrical Engineering, M.S.,1981
North Carolina State University, Electrical Engineering, Ph.D., 1985

APPOINTMENTS:

July 05-present	Professor, University of New Mexico
Jan 99-July2005	Professor and Chair of EECE Department, University of New Mexico
Fall 96 - Fall 98	Professor , University of Central Florida
Fall 93- Fall 95	Associate Chair, ECE Department, University of Central Florida
Summer 1994	Acting Chair, ECE Department , University of Central Florida
Summer 1993	Acting Chair, ECE Department, University of Central Florida
1993-1996	Director of Honors Program, College of Engineering
1990-May 96	Associate Professor at the University of Central Florida
Summer 90	Research Fellow, NASA Langley Research Center
1985- 1990	Assistant Professor at the University of Central Florida

CLASSES TAUGHT LAST 5 YEARS

Electrodynamics
Computational Electromagnetics
Microwave Engineering
Antennas
RF Electronics
Reconfigurable Systems

MOST SIGNIFICANT SERVICE Last 5 Years (dept/university/profession)

Department Chair, Electrical and Computer Engineering 2005-2009
IEEE Distinguished Lecturer, 2007-2009
Board of Directors for GWEC (Global Wireless Education Consortium) 2002-2006
Associate Editor, for IEEE Transactions on Antennas and Propagation, 2001-2007
Associate Editor for the Antennas and Propagation Magazine 2000-now
Associate Editor for the Antennas and Wireless Propagation Letters 2007-now

BOOKS AUTHORED

1) ***"Neural network applications in electromagnetics"***, Christodoulou and Georgiopoulos, Artech House, Jan. 2001
2) ***"Antennas: Fundamentals and Concepts"***, Christodoulou and Wahid, SPIE, August 2001

3) ***"Support Vector Machines for Adaptive Antenna Array Processing and Electromagnetics"***, Martinez-Ramon and Christodoulou, Morgan & Claypool, October 2006.
4) ***"Radio Wave Propagation and Adaptive Antennas for Wireless Communication Links: Terrestial, Atmospheric and Ionospheric"***, Blaunstein and Christodoulou, John Wiley, October *2006.*

AWARDS/HONORS
IEEE Fellow, 2002
IEEE Distinguished Lecturer 2007-now
Gardner-Zemke Professor (Teaching award) 2008-2010
Outstanding Senior Teacher 2009 (UNM- School of Engineering)
Lawton-Ellis Service award- 2007
Outstanding Senior Researcher 2006 (UNM- School of Engineering)

STUDENTS PHD (17) and MS (55)
PHD students: Cam Nguyen, Timothy Durham, Youcheng , Gregory Turner , Ahmed El Zooghby, T. Gomez, Madjid Khodier , George Tzeremes, Dimitrios Anagnostou , Miroslav, Luke Feldner, Matthew Higgins, Mehmet Su, Hesse Lai, Naga Devarapalli, Tom Atwood, and Joseph Costantine
MS Theses: 55.

GRANTS (last 5 years)
Over 11 M from NSF, ONR, AFOSR, AFRL, Sandia National Labs, LANL, and several companies.

PATENTS
G.D. Boreman, I. Codreanu, C. Fumeaux, M. Gritz, C. Christodoulou, *" Wavelength-tunable coupled antenna uncooled infrared (IR) sensor"*, US Patent 6,310,346 (2001)

G.D. Boreman, A. Dogariu, C. Christodoulou, C. Fumeaux, *" Polarization-tunable antenna-coupled infrared detector"*, US Patent 6,037,590 (2000)

Anagnostou, and C. Christodoulou (at UNM) , *"Reconfigurable Multifrequency Antennas with RF MEMS Switch"*- a provisional patent.

L. Ralph Dawson

Education: Ph. D., Electrical Engineering, *Univ. of Southern California*, 1968; M. S., Electrical Engineering, *Univ. of Southern California*, 1965 B. S., Electrical Engineering, *California Inst. of Technology*, 1962. Dissertation title: Growth of Thin Epitaxial GaAs Films from Gallium Solution.

Professional Experience: Research Professor, ECE Dept., Center for High Technology Materials, *University of New Mexico*, 1997- present. Distinguished Member of Technical Staff, Sandia National Laboratories, Albuquerque, NM, 1976-1997. Member of Technical Staff, Bell Laboratories, Murray Hill, NJ. 1969-1976.

Current Research Interests: MBE growth of III-V arsenides and antimonides for IR emitters and detectors; monolithic integration of Silicon and III-V device structures; MBE growth of highly mismatched materials.

Honors and Society Offices: 1985 DOE Basic Energy Sciences Award for Sustained Outstanding Research (Strained-layer Superlattices); 1993 DOE Basic Energy Sciences Award for Sustained Outstanding Research (Artificially Structured Materials); 1990-1996 Distinguished UNM-Sandia Labs Professor; Electronic Materials Committee (TMS), member for 29 years, EMC Committee Chairman for two years, Electronic Materials Conference Chair for two years; International Symposium on Compound Semiconductors, member, International Advisory Committee, Conference Chair in 1991; Narrow Gap Semiconductor Conference, member, International Advisory Committee, Conference Chair in 1995; Materials Research Society, organizer of 4 symposia, former chair of education and short course committee, instructor of 14 short courses; Co-chair, 2007 North American Molecular Beam Epitaxy Conference.

Principal Accomplishments: First MBE growth of strained layer superlattices (SLSs); MBE growth of first pseudomorphic HEMT devices, first strained quantum well lasers; MBE growth of InAsSb/InSb SLSs for 8-12 μm detectors; MBE growth of InAs/InAsSb SLS for mid IR lasers; MBE growth of AlAsSb/GaAsSb Bragg reflectors; LPE growth of high efficiency AlGaAs light emitting diodes, laser diodes, and GaP light emitting diodes.

Publications and Patents: 240 journal publications, 200 conference presentations, editor of 6 proceedings volumes, 19 patents.

Most Relevant Publications:

1. H. S. Kim, E. Plis, J. B. Rodriguez, G. D. Bishop, Y. D. Sharma, L. R. Dawson, S. Krishna, J. Bundas, R. Cook, D. Burrows, R. Dennis, K. Patnaude, A. Reisinger, and M. Sundaram, "Mid-IR focal plane array based on type-II InAs/GaSb strain layer superlattice detector with nBn design" Appl. Phys. Lett. 92, 183502 (2008)
2. Balakrishnan, G.; Mehta, M.; Kutty, M.N.; Patel, P.; Albrecht, A.R.; Rotella, P.; Krishna, S.; Dawson, L.R.; Huffaker, D.L., "Monolithically integrated III-Sb CW super-luminal light emitting diodes on non-miscut Si (100) substrates", Electronics Letters, v 43, n 4, 15 Feb. 2007, p 244-5
3. Tatebayashi, J. (Center for High Technology Materials, University of New Mexico); Khoshakhlagh, A.; Huang, S.H.; Dawson, L.R.; Balakrishnan, G.; Huffaker, D.L., "Formation and optical characteristics of strain-relieved and densely stacked GaSb/GaAs quantum dots", Applied Physics Letters, v 89, n 20, 2006, p 203116
4. Balakrishnan, G. (Center for High Technol. Mater., Univ. of New Mexico, Albuquerque, NM, USA); Huang, S.H.; Khoshakhlagh, A.; Jallipalli, A.; Rotella, P.; Amtout, A.; Krishna, S.; Haines, C.P.; Dawson, L.R.; Huffaker, D.L., "Room-temperature optically-pumped GaSb quantum well based VCSEL monolithically grown on Si (100) substrate", Electronics Letters, v 42, n 6, 16 March 2006, p 350-2

5. Mehta, M. (Center for High Technology Materials, University of New Mexico); Balakrishnan, G.; Huang, S.; Khoshakhlagh, A.; Jallipalli, A.; Patel, P.; Kutty, M.N.; Dawson, L.R.; Huffaker, D.L., "GaSb quantum-well-based "buffer-free" vertical light emitting diode monolithically embedded within a GaAs cavity incorporating interfacial misfit arrays", Applied Physics Letters, v 89, n 21, 2006, p 211110
6. G. Balakrishnan, S. Huang, L. R. Dawson, and D. Huffaker, "Analysis of atomic structure in InAs quantum dashes grown on AlGaAsSb metamorphic buffers", J. Vac. Sci. Tech. B, **22(3)**, 1529 (2004).
7. Balakrishnan, G. (Center for High Technology Materials, University of New Mexico); Huang, S.; Khoshakhlagh, A.; Dawson, L.R.; Xin, Y.-C.; Conlin, P.; Huffaker, D.L., "High quality AlSb bulk material on Si substrates using a monolithic self-assembled quantum dot nucleation layer", Journal of Vacuum Science and Technology B: Microelectronics and Nanometer Structures, v 23, n 3, 2005, p 1010-1012
8. Balakrishnan, G. (Center for High Technol. Mater., Univ. of New Mexico, Albuquerque, NM, USA); Huang, S.H.; Khoshakhlagh, A.; Hill, P.; Amtout, A.; Krishna, S.; Donati, G.P.; Dawson, L.R.; Huffaker, D.L., "Room-temperature optically-pumped InGaSb quantum well lasers monolithically grown on Si(100) substrate", Electronics Letters, v 41, n 9, 28 April 2005, p 531-2
9. Balakrishnan, Ganesh (Center for High Technology Materials, University of New Mexico); Huang, Shenghong; Rotter, Thomas J.; Stintz, Andreas; Dawson, L.R.; Malloy, Kevin J.; Xu, H.; Huffaker, D.L., "2.0 μm wavelength InAs quantum dashes grown on a GaAs substrate using a metamorphic buffer layer", Applied Physics Letters, v 84, n 12, Mar 22, 2004, p 2058-2060

Other Relevant Publications:

10. S. C. Lee, L. R. Dawson, K. J. Malloy, and S. R. J. Brueck, "Molecular Beam Epitaxial Growth of One-dimensional Rows of InAs Quantum Dots on Nanoscale-patterned GaAs", Appl. Phys. Letters, **79**, 2630 (2001).
11. S. R. Kurtz, L. R. Dawson, T. E. Zipperian, and R. D. Whaley, Jr., "High Detectivity InAsSb Strained-Layer Superlattice, Photovoltaic Infrared Detector", IEEE Elect. Dev. Letters, **11**, 54 (1990).
12. L. R. Dawson, "MBE Growth of Thermopbotovoltaic Materials", 1st NREL Conference on Future Generation Photovoltaic Technologies, March 1997.
13. L. R. Dawson, T. E. Zipperian, C. E. Barnes, J. J. Wiczer, and G. C. Osbourn, "Strained-layer superlattice emitter and detector structures using modulation-doped active regions", Proceedings Int. Symposium on GaAs and Related Compounds, Biarritz, 1984, IOP Conf. Series 74, pg 415.
14. A.L. Gray, L. R. Dawson, Y. Lin, A. Stintz, Y.-C. Xin, A.A. Garza[1], and L. F. Lester, " InAs Quantum Dots Grown on an AlGaAsSb Metamorphic Buffer", Proc. MRS Symposium, December 2000.

Ivan H. Deutsch, Professor, Regents Lecturer

Biographical

Educational History:

- S. B., Massachusetts Institute of Technology, Physics (June, 1987)
- Ph. D., University of California, Berkeley CA, Physics (December, 1992)

Employment History:

Present Position: Professor, Regents Lecturer, Dept. of Physics and Astronomy, University of New Mexico

Previous Positions:

8/05 - 8/09	Director of the Center for Advanced Studies, University of New Mexico
6/01 - 6/05	Associate Professor of Physics and Astronomy, University of New Mexico
8/95 - 5/01	Assistant Professor of Physics and Astronomy, University of New Mexico
9/93 - 7/95	National Research Council Postdoctoral Fellow, NIST, Gaithersburg MD
1/93 - 8/93	Postdoctoral Research, France Telecom,

Honors and Awards:

• Fulbright Scholar	2010
• Fellow, American Physical Society	2006
• Regents Lecturer, University of New Mexico	2003
• Excellence in Teaching Award, 4 time recipient, P&A UNM.	1997, 2001, 03, 04
• Sigma Xi Young Investigator Award.	2000
• Miller Research Professor Award, Berkeley California	1999
• National Research Council Fellow.	1993
• Fellowship for Cooperation in Science and Education,	1992
• Department of Education Fellowship.	1990
• Phi Beta Kappa Scholarship for Academic Distinction.	1990
• Outstanding Graduate Instructor Award.	1989
• Phi Beta Kappa.	1987

Research

5 most significant publications:

1. P.S. Jessen and I. H. Deutsch,"Optical Lattices", *Advances in Atomic, Molecular, and Optical Physics* **37**, p. 95-136, B. Bederson and H. Walther eds., (Academic Press, San Diego, 1996). (198 citations, 15.23/year).
2. I. H. Deutsch and P. S. Jessen; "Quantum state control in optical lattices", *Physical Review A* **57**, 1972 (1998). (98 citations, 6.53/year).
3. G. K. Brennen, C. M. Caves, P. S. Jessen, and I. H. Deutsch, "Quantum logic gates in optical lattices", *Physical Review Letters* **82**, 1060 (1999). (356 citations, 32.36/year).
4. D. Hayes, I. H. Deutsch, and P. S. Julienne, "Quantum logic via the exchange blockade in ultracold collisions", *Physical Review Letters* **98**, 070501 (2007). (24 citations, 8/year).
5. I. H. Deutsch and P. S. Jessen, "Quantum control and measurement of atomic spins in polarization spectroscopy", to appear in Optics Communications (2009); arXiv:0909.4506, (review article which establishes a new foundation for quantum control and measurement).

Grants received (2005-2009)

Title: Center for Quantum Information and Control (CQuIC)
PI: Carlton Caves; co-PIs: Ivan Deutsch and Poul Jessen
Funding agency: National Science Foundation
Performance period: 3 years starting August 1, 2009. Amount: $1,259,811.00

Title: Quantum Control of Qudits and Quantum Transport in Optical Lattices
PI: Ivan Deutsch
Funding agency: National Science Foundation
Performance period: 3 years starting August 1, 2009. Amount: $193,726

Title: Elements of Neutral Atom Quantum Computing with Optical Control
PI: Ivan Deutsch
Funding Agency: National Institute of Standards & Technology
Performance period: 3 years starting January 1, 2009. Amount: $390,014

Title: *Quantum Control of Atomic Spins*
PI: Ivan H. Deutsch
Funding agency: National Science Foundation
Performance period: 3 years starting May 1, 2007. Amount: $225,000

Title: *Quantum Control of Trapped Atoms for Improved Stability of Optical Clocks*
PI: Ivan H. Deutsch
Funding agency: Office of Navy Research
Performance period: 3 years starting February 1, 2007. Amount: $366,700

Title: *High Fidelity Gates and Qubit Addressing in an Optical Lattice Quantum Processor*
PI: Ivan Deutsch; Co-PI Poul Jessen
Funding agency: National Science Foundation
Performance period: 3 years starting July 15, 2006. Amount: $ 200,000

Teaching

Advisement:

Ph. D. Theses Supervised (Graduated)
John Grondalski (Dec. 2000), Gavin Brennen (Dec. 2001), Shohini Ghose (Dec. 2003), Tracey Tessier (Dec. 2004), René Stock (May 2005), Andrew Silberfarb (May 2006), Seth Merkel (June 2009), Iris Reichenbach (July 2009),.

M.S. Theses Supervised (Graduated)
Iris Rappert (December 2004).

B.S. Honors Theses Supervised (Graduated)
David Hayes (May 2005), Richard Hipsh (May 1997), Jason Knight (December 1997).

Current Ph. D. Candidates
Colin Trail (7th year), Douglas Bradshaw (7th year), Brian Mischuck (6th year), Carlos Riofrió (4th year).

Current Ph. D. Students (Precandidacy)
Vaibhav Madhok (5th year), Leigh Norris (3rd year).

Postdoctoral Fellows:
Aldo Delgado (2002-2003), Satyan Bhongale (2005-2007). Krittika Kanjilal (2009-present).

Classroom Teaching (2004-2009):
Upper Division Quantum Mechanics I&II, Upper Division Electricity and Magnetism I&II, Graduate Quantum Mechanics I&II, Graduate Electrodynamics, Quantum Optics, Atomic and Molecular Structure, Laser cooling.

Service

Significant Service (2004-2009):

- Center for Advanced Studies Director, 2005 - 2009.
- Associate Chair for Graduate Affairs, Spring 2009.
- Secretary Treasurer, American Physical Society, Topical Group on Quantum Information, 2008-2011.
- Coordinator of "SQuInT" – Southwest Quantum Information and Technology (SQuInT) 1999-2010.
- Graduate Exam Committee, **Chair**, 2004-2009.
- Ad Hoc Committee: Organization of the "Institute for Advanced Studies", joint with Los Alamos.
- Graduate Admissions and Curriculum Committee **Chair**, Spring 2001, Fall 2002-Spring 2004.

Jean-Claude Diels

1987 — present	Professor of Physics and EE
	Department of Physics and Astronomy
	University of New Mexico,
and staff member of the	Center for High Technology Material, and UNM Cancer Center

Educational Information

- Ph.D. in Physics (Brussels, Berkeley). Advisor: E. L. Hahn (UCB); and Physics Engineer (M.S. Brussels).
- Commercial Instrument (IFR multiengine Pilot certificate (2,600 hrs).

1966	"Assistant Chercheur"	Ecole Royale Militaire, (Brussels, Belgium)
1967-79	"Wetenschappelijke Medewerker"	Philips Research Laboratories, Eindhoven
1971-73	"Research Scientist"	University of California, (Berkeley)
1973-75	"Wissentschaflicher Mitarbeiter"	Max Planck Institute Göttingen
1975-81	Research Associate Professor	Center for Laser Studies, USC Los Angeles
1981-86	Professor of Physics	Univ. of North Texas, Denton
(1984	Invited Professor	Université de Bordeaux I)
(1978	"Collaborateur Scientifique"	CEN Saclay, France.)

Classes taught last five years
Advanced Optics I, Advanced Optics II, Laser Physics I, undergraduate Optics, Optics Lab, Seminar 500, Topics in Modern Optics.

Most significant service

Department Optics graduate Committee
University Research Policy Committee / Export Control Committee
Profession Program committee Nonlinear Optics of CLEO, and on Ultrafast Phenomena of CLEO.

Publications: Approx. 90 invited, 260 refereed, 14 patents, 5 book chapters, one book
Selected publications

1. Ladan Arissian and Jean-Claude Diels, "Investigation of Carrier to Envelope Phase and repetition rate — fingerprints of mode-locked cavities", *Journal of Physics B: At. Mol. Opt. Phys*, 42:183001 (2009).

2. Olivier Chalus, Alexey Sukhinin, Alejandro Aceves and Jean-Claude Diels, "Propagation of non-diffracting intense ultraviolet beams", *Opt. Comm*, 281:3356–3360, 2008.

3. R. J. Jones and J. C. Diels. Stabilization of femtosecond lasers for optical frequency metrology and direct optical to radio frequency synthesis. *Phys. Rev. Lett.*, 86:3288–3291, 2001.

4. Scott Diddams, Jean-Claude Diels, and Briggs Atherton. Differential intracavity phase spectroscopy of a three-level system in samarium. *Phys. Rev. A*, 58:2252–2263, 1998.

5. Jean-Claude Diels, Ralph Bernstein, Karl Stahlkopf, and Xin Miao Zhao, "Lightning control with lasers", Scientific American 277: 50-55 (1997).

Course Textbook

- Ultrashort Laser Pulse Phenomena: Fundamentals, techniques and applications on a femtosecond time scale (with W. Rudolph), Elsevier/Academic Press, Series "Optics and Photonics", Boston (1996 – 2006).

Awards

- Recipient of the 51st Annual Research Lecture Award of the University of New Mexico, the highest honor for research and creativity that the University of New Mexico can bestow on a faculty member,
- Recipient of the 2006 Excellence in Engineering Award of the Optical Society of America.
- Fellow of the Optical Society of America.

Students graduated

During Career, 40 PhD, 13 MS. The last 5 years are listed.

Olivier Chalus, ICFO Barcelona	Ladan Arissian, NRC, Canada
Xianmei Meng, Holographics, Hudson	Ye Liu, Quantronix Boston
Aaron Bernstein, UT Texas, Austin	Martha Navarro, Boeing, Albuquerque
Mark Ackerman, Sandia Labs, Albuquerque	James Gruetzner, Sandia Labs, Albuquerque
Daniel Mirell, UC Irvine	Michael Zmuda

Post-doctorates and guests: 21

Sampling: Prem Kumar, Herman Vanherzeele, Laurent Sarger, Wolfgang Rudolph, Paul French, Algis Piskarskas, Paolo di Trapani, Matthias Lenzner, Vaclav Kubecek.

Grants last five years

TITLE	SOURCE	AMOUNT	From ... to
Scanning Intracavity Phase Nanoscope	W. M. Keck Foundation	1,100,000	07/01/08 — 06/30/11
Interfering Pulse train Magnetometer	NSF	350,000	9/15/09 — 8/31/12
Remote detection of explosives	Southwest Institute	60,000	08/01/06 — 03/01/07
Bit-error rate for light comm.	AFOSR DURIP	120,000	04/01/08 — 11/15/09
Bit-error rate for light comm.	AFOSR	230,000	03/01/07 — 11/30/09
Intracavity sensors	NSF	240,000	06/01/06 — 05/31/09
Laser Induced Discharges	ARO DURIP	150,000	04/01/08 — 12/14/09
Laser Induced discharges	ARO	500,000	11/15/05 — 11/14/08
UV Filaments	Ionatron	250,000	08/01/03 — 08/31/05
Stabilized lasers as sensors and frequency standards	NSF	270,000	08/01/02 — 07/31/05

Recent Patents Awarded

- "Sensors of rotation, displacement, index of refraction, magnetic field, electric field and magnetic susceptibility"; bidirectional short pulse ring laser (6,650,682)
- "Automatic Optical Fourier Mouré Wavefront Sensor" (6717661)
- "Gregorian Optical System with Nonlinear Optical Technology for protection against Intense Optical Transients" (7,236,297)
- "Ring laser scatterometer" (6,912,051).
- "Auto-Stabilization of Lasers By Means of Resonant Structures", Provisional filed March 2006. – awarded
- "Method and apparatus for femtosecond communication", (7,593,643)

Richard I. Epstein
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richard.epstein@gmail.com
December 2009

Education

B.S. Engineering Physics, Cornell University 1965
Ph.D., Applied Physics, Stanford University, 1972

Research and Professional Experience

2007-Present	Chief Technical Officer	ThermoDynamic Films
2004-Present	Laboratory Fellow	Los Alamos National Laboratory
1995-Present	Adjunct Professor	University of New Mexico
1983-2004	Staff Scientist	Los Alamos National Laboratory
1976-1983	Assistant Professor	NORDITA, Copenhagen
1974-1976	Postdoctoral Fellow	Harvard University
1972--1974	Postdoctoral Fellow	University of Texas at Austin

Recent research accomplishments:

Developed Optical Refrigerators: This is now a multi-million dollar, world-wide effort to use luminescence cooling of semiconductors and rare-earth-doped crystals and glasses to develop compact, vibration-free cryogenic refrigerators.

Developed a new approach to Gamma Ray Optics: Gamma-ray focusing based on waveguide optics can image radiation in the 100 to 500 keV range. This work has the promise to drastically improving gamma-ray astronomy, medical imaging and weapons detection in this energy range.

Awards:

Los Alamos National Laboratory Fellows Prize, 2000
Laboratory Fellow, Los Alamos National Laboratory, 2004
Fellow of Optical Society of America, 2007

Patents

1. "Fluorescent Refrigeration" Epstein, R. I., Edwards, B. C., Buchwald, M. I. & Gosnell, T. R., 1995, U.S. Patent #5,447,032.
2. "Optical Refrigerator Using Reflectivity Tuned Dielectric Mirrors" Edwards, B. C., Buchwald, M. I. & Epstein, R. I., 2000, U.S. Patent #6,041,610.
3. "Semiconductor-Based Optical Refrigerator" Epstein, R. I. Edwards, B. C., & Sheik-Bahae, M., 2002, U.S. Patent #6,378,321.
4. "High-Frequency, Thin-Film Liquid Crystal Thermal Switches" Kevin J. Malloy, Epstein, R. I. & Sheik-Bahae, M., 2008, U.S. Patent filed.
5. "Multilayer Electrocaloric Refrigerator and Pyroelectric Energy Generator" Kevin J. Malloy & Epstein, R. I., 2008, U.S. Patent filed.

Prof. ELISEEV, Peter G., received Master Deg. from Moscow State University (MSU), Physics Dept. (Moscow, Russia), in 1959. He received PhD (1965) and DrSci (1974) degrees from P. N. Lebedev Physics Institute, Russian Academy of Sciences, Moscow, Russia, where he had been affiliated since 1963 to 2008 after post-graduated staying at MSU (1959-1963). He joined the High Technology Materials Center, University of New Mexico in 1994 as a visiting professor, and he is retired since 2007. At present he is volunteering professor at CHTM. Fields of his scientific interests are physics and technology of semiconductor lasers and related photonics devices: semiconductor optical amplifiers, laser gyros, light-emitting diodes, being author or co-author of more than 500 publications including books "Semiconductor Lasers" (1976), "Introduction into physics of injection lasers" (1983), and "Reliability problems of semiconductor lasers" (1991). He has 10 patents and Inventor Certificates (2 of them – US Patents). His most important papers are

1) **P. G. Eliseev,** Optical strength of semiconductor laser materials (*review*), *Progress in Quant. Electronics*, 20 (1), 1-82 (1996).

2) **P. G. Eliseev,** H. Li, A. Stintz, G. T. Liu, T. C. Newell, K. J. Malloy, and L. Lester, Transition dipole moment of InAs/InGaAs quantum dots from experiments on ultralow-threshold laser diodes,
Appl. Phys. Lett., 77 (2), 262-264 (2000).

3) **P. G. Eliseev,** H. Li, G. T. Liu, A. Stintz, T. C. Newell, L. F. Lester, K. J. Malloy, Ground-state emission and gain in ultra-low-threshold InAs/InGaAs quantum dot lasers, *IEEE J. Select. Topics Quant. Electron.*, 7 (2), 135-146 (2001, Mar./Apr.).

4). **P. G. Eliseev,** P. Adamiec, A. Bercha, F. Dybała, R. Bohdan and W. Trzeciakowski, Anomalous differential resistance change at the oscillation threshold in quantum-well laser diodes,
IEEE J. Quant. Electron., 41 (1) 9-14 (2005, Jan.).

5) **P. G. Eliseev,** Theory of nonlinear Sagnac effect,
Opto-Electronics Rev., 16 (1), 38–43 (2008).

He has been awarded by the Russian Academy Prize (1979), the State Prize of the USSR in science and technology (1984), and N. Holonyak Optical Society of America Prize (2004).

Dr. Nasir Ghani
ECE Department, University of New Mexico
Albuquerque, NM, 87131-0001, USA
Tel: (505) 277-1475, Fax: (505) 277-1439
Email: nghani@ece.unm.edu, URL: http://ece.unm.edu/~nghani

EDUCATION AND TRAINING

- **Bachelors:** University of Waterloo, Canada, Computer Engineering, May 1991
- **Masters:** McMaster University, Canada, Electrical Engineering, October 1992
- **PhD:** University of Waterloo, Canada, Electrical & Computer Engineering, October 1997

RESEARCH AND PROFESSIONAL EXPERIENCE

- *August 2007-Present:* Associate Professor, ECE Department, University of New Mexico
- *August 2006-July 2007:* Associate Professor, ECE Department, Tennessee Tech University
- *August 2003-July 2006:* Assistant Professor, ECE Department, Tennessee Tech University
- *March 2000-January 2003:* Senior Technical Architect, Sorrento Networks Inc., San Diego, CA
- *August 1997-March 2000:* Senior Research Engineer, Nokia Research, Boston, MA
- *June 1993-September 1994:* Design Engineer, Motorola Canada Ltd, Toronto, Canada
- *November 1992-May 1993:* Systems Analyst, IBM Canada Ltd, Toronto, Canada

RESEARCH INTERESTS

- **Cyber-infrastructures**: High-speed networks, communications protocols and architectures (MPLS/GMPLS), IP routing and QoS, access networks, traffic engineering/grooming, network virtualization, Ethernet passive optical networks (EPON), Ethernet packet rings, satellite communications
- **Multi-layer performance**: Application design, grid-computing, TCP/IP enhancements, performance enhancing proxies (window control, shaping), SAN/storage extension
- **General computer/systems related**: Performance evaluation, distributed systems, parallel systems, fault tolerance, survivability, network simulation, software tools, middleware, resource management, scheduling, flow control, buffer management, feedback systems, storage networks

PROFESSIONAL ACTIVITIES

Chairperson Roles

- Chair of *IEEE Technical Committee on High Speed Networks* (IEEE TCHSN) since April 2008
- Co-Chair of Next-Generation Internet Symposium (*IEEE GLOBECOM 2009, 2010*)
- Co-Chair and lead organizer of *IEEE INFOCOM High Speed Networks* (HSN) workshop series (2006-2009)
- Invited member of *IEEE/OSA Optical Fiber Conference* (OFC) TPC (Networks 2007-8, Access 2008-9)
- TPC Co-Chair of *IEEE ANTS 2007* and *HONET 2007/2008*
- Co-Chair of Optical Networking Symposiums (*IEEE ICC 2006, IEEE GLOBECOM 2007*)
- General Conference Co-Chair, *SPIE OptiComm 2003* (Dallas, TX)
- Technical Program Co-Chair, *SPIE OptiComm 2002* (Boston, MA)

Journal Associate Editor

- *IEEE Communications Letters* journal (since May 2002)
- *SPIE Optical Networks* (January 2000-December 2003)

Technical Program Committee

IEEE/OSA OFC 2007-9, IEEE ICC 2006/2005/2003/2002, IEEE Sarnoff Symposium 2007, COIN 2004, SPIE OptiComm 2002-2004, SPIE ITCOM 2001-2003, IEEE ICCCN'99

HONORS AND AWARDS

- NSF CAREER Award (2005)
- Promoted to IEEE Senior Member (2001)
- Canadian Council of Professional Engineers (CCPE) Manulife Financial Award, 1996-1997
- National Sciences & Eng. Research Council of Canada (NSERC) Postgraduate Scholarship, 1995-1997
- National Sciences & Eng. Research Council of Canada (NSERC) Postgraduate Scholarship, 1991-1992

Books Edited

1. *Magnetospheric Phenomena in Astrophysics* 1986, Proceedings of the Los Alamos workshop held in Taos, NM 1984 (AIP, New York), editors: R. I. Epstein & W. C. Feldman.
2. *Gamma-Ray Bursts: Observations, Analyses and Theories*, 1992, Proceedings of the Los Alamos workshop held in Taos, NM, August 1991(Cambridge Univ. Press, Cambridge), editors: C. Ho, R. I. Epstein & E. E. Fenimore.
3. *Isolated Pulsars,* 1993, Proceedings of the Los Alamos workshop held in Taos, NM, February 1992(Cambridge Univ. Press, Cambridge), editors K. A. Van Riper, R. I. Epstein & C. Ho.
4. *Laser Cooling of Solids,* 2007, Proceedings of the SPIE, **6461**, (SPIE, Bellingham) editors R. I. Epstein & M. Sheik-Bahae.
5. *Laser Refrigeration of Solids,* 2008, Proceedings of the SPIE, **6907**, (SPIE, Bellingham) editors R. I. Epstein & M. Sheik-Bahae.
6. *Laser Refrigeration of Solids II,* 2009, Proceedings of the SPIE, **7228** (SPIE, Bellingham) editors R. I. Epstein & M. Sheik-Bahae.
7. *Optical Refrigeration: Science and Applications of Laser Cooling of Solids,* 2009, (Wiley-VCH, Weinheim) editors R. I. Epstein & M. Sheik-Bahae.

Selected Publications (from over 160 published papers):

- "Observations of Laser-induced Fluorescent Cooling of a Solid", Epstein, R. I., Buchwald, M. I., Edwards, B. C., Gosnell, T. R.& Mungan, C. E. 1995, *Nature*, **377**, 500-503.
- "Laser Cooling of a Solid by 16K Starting from Room-Temperature", Mungan, C. E., Buchwald, M. I, Edwards, B. C., Epstein, R. I. & Gosnell, T. R. 1997 *Phys. Rev. Letters*, **78**, 1030-1033.
- "Observation of Anti-Stokes Fluorescent Cooling in Thulium-doped Glass" Hoyt, C. W., Sheik-Bahae, M., Epstein,, R. I., Edwards, B. C., & Anderson, J. E., 2000, *Phys. Rev. Lett.*, **85**, 3600-3603.
- "Can Laser Light Cool Semiconductors?" Sheik-Bahae, M, Epstein, R. I.2004, *Phys. Rev. Letters*, 92, 247403-1.
- "Optical refrigeration", Sheik-Bahae, M., Epstein, R. I., 2007, *Nature Photonics*, **1**, 693-699.
- "Gamma Ray Waveguides", Tournear, D. M., Hoffbauer, M. A., Akhadov, E. A., Chen, A. T., Pendleton, S. J., Williamson, T. L., Cha, K. C. & Epstein, R. I., *Applied Physics Letters*, 92, 153502-1 - 153502-3(2008)
- "Electrocaloric devices based on thin-film heat switches" Epstein, R. I., Malloy, K. J., *J. Applied Phys.*, **106**, 064509, 2009.

MANI HOSSEIN-ZADEH

Assistant Professor of Electrical and Computer Engineering,
Center for High Technology Materials (CHTM), 1313 Goddard SE, Room 116A, Albuquerque, NM 87106.
Phone: 505-272-7845, URL: www.its.caltech.edu/~mhz, E-mail: mhz@chtm.unm.edu

Professional Experience

2008-Present Assistant Professor, Univeristy of New Mexico,
Electrical and Computer Enigineering department (ECE)
And Center for High Technology Materials (CHTM).

2005-2008 Postdoctoral scholar, California Institute of Technology,
Vahala research group & Center for Physics of Information, T. J. Watson Lab of Applied Physics.

2000-2005 Research assistant, University of Southern California,
Advanced Electronic and Photonic Technology Lab.

1996-1999 Research assistant, Sharif University of Technology,
Medical Physics Lab.

Education

2001-2005 University of Southern California (USC), LosAngeles, California, USA.
Philosophy Doctorate, *Electrical Engineering-Electrophysics*, Dec 2004.

1999-2001 University of Southern California (USC), LosAngeles, California, USA.
Master of Science, *Electrical Engineering-Electrophysics*, Dec 2001.

1995-1997 Sharif University of Technology (SUT), Tehran, IRAN.
Master of Science, *Physics*, Aug 1997.

1990-1995 Sharif University of Technology (SUT), Tehran, IRAN.
Bachelor of Science, *Applied Physics*, June 1995.

Courses thought

- Advanced Optics-II
- Laser Physics
- Microwave photonics

Most Relevant Publications:

1. M. Hossein-Zadeh, and K. J. Vahala, "Photonic RF down-converter based on optomechanical oscillation," *IEEE Photonics Technology Letters*, vol. 20, no. 4, pp. 234-236, Feb. 2008.
2. M. Hossein-Zadeh, and K. J. Vahala, "Free Ultra-high-Q microtoroid: a tool for designing photonic devices", *Optics Express,* vol. 15(1), pp. 166-175, Jan 2007.
3. M. Hossein-Zadeh, H. Rokhsari, A. Hajimiri and K. J. Vahala, "Characterization of a radiation-pressure-driven optomechanical oscillator", *Physical Review A,* vol. 74(2), 023813, Aug 2006. (Also appeared on *Virtual Journal of Nanoscale Science & Technology*, Vol. 14(10), Aug. 2006)
4. M. Hossein-Zadeh, and A. F. J. Levi, "14.6 GHz $LiNbO_3$ microdisk photonic self-homodyne RF receiver", *IEEE Microwave Theory and Techniques - special issue on Microwave Photonics*, vol. 54(2)-part 2, pp. 821-831, Feb 2006.
5. D.A. Cohen, M. Hossein-Zadeh, A. F. J. Levi "Microphotonic modulator for microwave receiver", *Electronics Letters* 37(5), pp. 300-301, March 2001.

BOOKS AND GUEST-EDITORSHIP

- N. Ghani, K. Sivalingam (Editors), *SPIE OptiComm 2002: Optical Networking and Communications*, SPIE Publications, ISBN: 0-8194-4635-X, WA, USA, July 2002.
- Co-guest editor, *Optical Switching and Networking* (OSN) journal, special issue on Selected Papers from ANTS 2007 (Bombay, India), January 2009.
- Co-guest editor, *IEEE Communications Magazine*, special issue on Virtual Private Networks, April 2007.
- Co-guest editor, *IEEE Communications Magazine*, two back-to-back special issues of *Optical Communications Supplement* on Optical Testbeds Parts I & II, August and November 2005.
- Co-guest editor, *Cluster Computing: The Journal of Networks, Software Tools, and Applications* (Kluwer), special issue on Advances in Optical Network Switching and Routing, July 2004.
- Co-guest editor, *IEEE Network*, special issue on IP-Optical Integration, July/August 2001.

SELECTED JOURNAL PUBLICATIONS

- C. Xie, N. Ghani, Q. Liu, R. Kouatang, W. Shu, Y. Qiao, M. Wu, S. Peng, "Traffic Engineering For Ethernet over SONET/SDH (EoS): Advances and Frontiers", *IEEE Network*, 2009.
- N. Ghani, *et al*, "Value-Added Services in Next-Generation SONET/SDH Networks", *IEEE Communications Magazine*, Vol. 46, No. 11, November 2008, pp. 64-73.
- N. Ghani, *et al*, "Control Plane Design in Multidomain/Multilayer Optical Networks," *IEEE Communications Magazine*, Vol. 46, No. 6, June 2008, pp. 78-87.
- N. Ghani, A. Gumaste, "Ethernet over Fiber and WDM," Chapter 8, *Delivering Carrier Ethernet: Extending Ethernet Beyond the LAN*, McGraw Hill Publishers, November 2007, pp. 197-233.

PATENTS AWARDED

- N. Ghani, S. Dixit, "An ECN-Based Approach for Congestion Management in Hybrid IP-ATM Networks," *United States Patent 6.160.793*, Nokia, December 2000.
- N. Ghani, S. Dixit, "Enhanced Acknowledgment Pacing Device and Method for TCP Connections," *United States Patent 6.215.769*, Nokia, April 2001

RESEARCH GRANTS (LAST 5 YEARS)

- N. Ghani, M. Hayat, "Paradigms for Survivability of Cyber-Infrastructure Backbone Networks Against WMD Attacks", Defense Threat Reduction Agency, $460,076, May 2009-May 2012.
- N. Ghani , "Virtualized Network Control (VNC)", Department of Energy Office of Science award (DE-SC0001229), $156,000, August 2009-August 2012.
- N. Ghani, "Hybrid Multi-Layer Networks Control for Emerging Cyber-Infrastructures", Department of Energy Office of Science award (ER25828), $525,000, August 2007-August 2010.
- N. Ghani, "Dynamic Multi-Domain/Multi-Granularity Network Provisioning", NSF CAREER award (CNS-0806637), $409,000, February 2005-May 2010.
- X. He, N. Ghani, "Research Experience for Undergraduates in Network & Communication Systems", NSF REU award (SCI-0453438), $300,000, June 2005-August 2008 (at TTU).
- I. Fidan, N. Ghani, "The Development of a Remotely Accessible Rapid Prototyping Laboratory", NSF Course Curriculum and Lab Improvement award (DUE-0536509), $125,000, June 2006-May 2009.
- D. Benhaddou, N. Ghani, "Value-Added Proposition for Optical Services: A Multi-Domain OSS/Control Plane Perspective", Sprint-Nextel grant, $112,000, May 2004-May 2005 (at TTU).

STUDENTS SUPERVISED

- **PhD:** Qing Gary Liu (2008)
- **Masters:** T. Frangieh (2008), Rolande Kouatang, (2008), Manuel Garcia (2007), Mehmet Ata Kök (2007), Murali Hari Krishna (2006), Matthew Varghese (2005), Karthik Atthuru (2005), Krishna Amimireddygari (2005), Joseph Ayeleso (2005), Lee Carmichael (2004), Monica Limaye (2004).

CLASSES TAUGHT

- **Undergraduate:** Computer Networks (UNM), Software Engineering (UNM), Signals and Systems (TTU), Introduction to Telecommunications (TTU)
- **Graduate:** Advanced Computer Networks (UNM), Optical Networks and Sub-Systems (UNM), Advanced Optical Networks (TTU)

Ravinder K. Jain

Education

Institution	*Major*	*Degree*	*Year*
UC Santa Barbara	Electrical Engineering	B.S.	1970
UC Santa Barbara	Physics	A.B	1970
UC Berkeley	Electrical Engineering and Computer Science	M.S.	1972
UC Berkeley	Electrical Engineering and Computer Science	Ph.D.	1974

Professional Appointments

Dates	*Institution*	*Position Occupied*
1992-present	Electrical & Computer Engineering and Physics, University of New Mexico	Professor, Microelectronics Chair (92-98)
1992-1999	Alliance for Photonic Technology, University of New Mexico	Associate Director
1984-1991	Physical Technology Department, Amoco Technology Company, Naperville, IL	Senior Research Scientist, Manager
1978-1984	Optical Physics Department, Hughes Research Laboratories, Malibu, CA	Member of the Technical Staff
1978-1981	Physics Department, Pepperdine University, Malibu, CA	Adjunct Professor
1975-1978	Coherent Wave Physics Department, Bell Laboratories, Holmdel, NJ	Member of the Technical Staff
1974-1975	Electrical Engineering and Computer Science, UC Berkeley, CA	Lecturer

Classes taught in the last 5 years (w. course titles, not just class numbers)

ECE 203	Circuit Analysis I
ECE 206L	Instrumentation
ECE 475	Introduction to Electro-Optics and Opto- Electronics
ECE 565	Optical Communication Components and Subsystems
ECE 566	Advanced Optical Subsystems and Networks

Most significant service during the last 5 years (dept/university/profession)

Promotions and Tenure Committee, ECE
Undergraduate Committee, ECE
Rankings Committee, ECE
Faculty Search Committee, CHTM
Web Design Committee, CHTM

Most significant refereed publications (in chronological order)

- "Absorption Processes Associated with Anti-Stokes Fluorescence in Rhodamine B Solutions," R.K. Jain, C. Hu, T.K. Gustafson, S.S. Elliott, and M.S. Chang, J. Appl. Phys., **44**, 3157-3161 (1973).
- "Plasma Radiation from Tunnel Junctions," T.L. Hwang, S.E. Schwarz, and R.K. Jain, Phys. Rev. Lett., **36**, 379-381 (1976).

Departmental service

- Member of Optical Science Engineering (OSE) Graduate Committee at UNM.
- Member of OSE PhD qualification exam committee (designing problems, proctoring and evaluation)

Journal Referee

- *Electronic Letters, Optics Express, Physical Review Letters, Physical Review B, Review of Scientific Instruments, Nature Photonics, Optics Letters, Physical Review A, Photonics Technology Letters, Optics Communications.*

Awards and honors

- 2-years postdoctoral fellowship from *Center for Physics of Information* (CPI) at California Institute of Technology. (Sept 2006-Sept 2008)
- *Student leadership award* (from University of Southern California USC 5/2001).

Professional memberships

- Institute of Physics (*IOP*, England), *Associate member.*
- Institute of Electrical and Electronic Engineers (*IEEE*), *member.*
- Optical Society of America (*OSA*), *member.*

Principal research accomplishments

Radiation-pessure-driven optomechanical oscillator: characterization of the optomechanical oscillator (Oscillation linewdith, frequency, noise, stability, optical spring effect, ...), study of injection locking phenomena in these oscillators and demonstration of their first application as all-optical RF down-converters.

Photonic wireless receiver: Demonstration of the First photonic wireless RF/microwave receiver based on active microdisk optical resonator (This technology is transferred to NASA Glenn Research Center for further development.)

Free ultra high-Q (UH-Q) microtoroid resonators: This patented technology enables the usage of UH-Q microtoroid optical resonators in integrated photonic circuits (photonic RF signal processors, multi-pole optical filters and photonic sensors) as well as cavity-QED experiments. The result of the first phase of the project was reported in *News and Views* section of *Nature Photonics* magazine (vol. 1, No. 3, March 2007).

V. M. Kenkre
Distinguished Professor of Physics and
Director of the Consortium of the Americas for Interdisciplinary Science - University of New Mexico
E-mail address: kenkre@unm.edu

Academic Degrees
B. Tech. (Electrical Engineering) I.I.T. Bombay, 1968
M.A. (Physics) SUNY at Stony Brook, 1971
Ph.D. (Physics) SUNY at Stony Brook, 1971

Positions
07/05 - Distinguished Professor of Physics
07/00 - Director, Consortium of the Americas for Interdisciplinary Science
07/96 - 06/00 Director, Center for Advanced Studies
12/84 - 06/05 Professor of Physics
04/99 - Adjunct Professor of Physics (University of Pune, India)
07/80 -12/84 Associate Professor of Physics (University of Rochester)
01/75 - 06/80 Assistant Professor of Physics (University of Rochester)

Recent Honors and Citations
10/05 Fellow of the American Association for Advancement of Science
for fundamental work on quantum transport theory, for applications of statistical mechanics to epidemiology, and for contributions to international science collaborations between the U.S. and Latin America.
07/05 Distinguished Professor of Physics of the University of New Mexico
04/05 International Excellence Award of the University of New Mexico
for outstanding contributions to international education and programs at the University of New Mexico.
07/04 Annual Research Lecturer Award -- 2005 (highest faculty recognition at UNM)
for making seminal contributions to the fields of theoretical condensed matter physics and statistical physics; for both the fundamental and the interdisciplinary nature of his research, as shown by his work on transport coherence of quantum systems, on photosynthesis of lightharvesting complexes of green plants and his most recent applications of mathematical models to the theory of the spread of epidemics.
05/01 Department Award for Outstanding Contributions to International Research Outreach
for outstanding contributions to international research outreach for the department and the university.
11/98 Fellow of the American Physical Society
for fundamental advances in the transport of quasi-particles in materials, ultra-fast phenomena, disordered materials, and light-matter interactions.

Primary Service
Served as Director of the UNM Center for Advanced Studies for 4 years, turned it into an interdepartmental and interdisciplinary center, and launched, on behalf of the Center, a number of collaborations with scientists elsewhere. Founded in 2000 a new UNM Center, Consortium of the Americas for Interdisciplinary Science, strongly supported first by Los Alamos National Laboratory and then by the National Science Foundation. That Center was funded by the NSF at over $1.5 M and used as a pilot project for launching a new program of NSF: the PIRES. The Consortium has a twin mission, interdisciplinary and international, is considered by the NSF to be unique in the USA, and has arranged more than 50 workshops in Latin America and the USA, and has hosted more than 100 visiting Latin American scientists for short and long periods. See http://consortium.unm.edu. Served also as member of the international advisory committee to the Provost at UNM and as member of the advisory committee to the international programs at NSF.

Five Selected Recent Publications from a total of more than 250
• V. M. Kenkre, L. Giuggioli, G. Abramson, and G. Camelo-Neto, *Theory of Hantavirus Infection Spread Incorporating Localized Adult and Itinerant Juvenile Mice*, Eur. Phys. J. B 55, 461-470 (2007).
• M. Aldana, V. Dossetti, C. Huepe, V. M. Kenkre, and H. Larralde, *Phase Transitions in Systems of Self-Propelled Agents and Related Network Models*, Phys. Rev. Letters 98, 095702, 1-4 (2007).
• V. M. Kenkre and F. Sevilla, *Thoughts about Anomalous Diffusion: Time-dependent Coefficients versus Memory Functions*, in "*Contributions to Mathematical Physics: a Tribute to Gerard G. Emch*", ed. T.S. Ali and K.B. Sinha, (Hindustani Book Agency, New Delhi 2007) p. 147-160.
• V. M. Kenkre and Niraj Kumar: *Nonlinearity in bacterial population dynamics: Proposal for experiments for the observation of abrupt transitions in patches*, Proc. Nat. Acad. Sc. 105,18752 (2008).
• V. M. Kenkre, Z. Kalay, and P. E. Parris: *Extensions of effective-medium theory of transport in disordered systems*, Phys. Rev. E 79, 011114 (2009).

Recent Research Support
• Award from the National Science Foundation for $1,406,780 for 5 years. It is a single-P.I. grant and was awarded a 'creativity extension' for exceptional performance.
• Award from the Howard Hughes Medical Institute for $1,000,000 for 3 years for Interdisciplinary Graduate Education. P.I. J. Brown, co-PI's S. Forrest, V. M. Kenkre, F. Smith.
• Award from the NSF-NIH for 5 years for work on Ecological Drivers of Rodent-borne Disease Outbreaks: Trophic Cascades and Dispersal Waves; present PI: V. M. Kenkre; earlier co-PI's T.Yates and R. Parmenter, V. M. Kenkre.
• Award from the Air Force Research Laboratory for $85,000 for 2 years for work on Theoretical Transport Studies of Non-Equilibrium Carriers Driven by High Electric Fields.
• Award from DTRA for $250,457 for 2 years for work on Energetic Systems and Unique Phenomena: Modeling of the Electromagnetic Response of the Shock to Detonation Transition. co-PI D.H. Dunlap.
• Award from DARPA for over $3,000,000 for work on Predictive Modeling, Visualization and Pattern Recognition Utilizing Large and Complex Datasets; with co-PI's Yates, Loring, Scuderi, Helman, Dragoo and Michener.
Additional earlier funding from NSF, Los Alamos National Laboratory, Sandia National Laboratory, Lovelace Research Institutes, Office of Naval Research.

Students (PhD, masters, honors undergraduate) and postdocs supervised during career – names

PhD	Joey Libatique, Balaji Srinivasan, Chi Yan, Justin Darrow, H. W. K. Tom
Masters	Xiushan Zhu, Ning Ma, Yanrui Zhao, Weiliang Chen, Li Wang, Weifeng Zhao
Honors undergraduate	Melissa Aillaud, Zachary Nishino, Robert Bradley, Damian Ancukiewicz, Dmitry Vorobiev
Postdoc	Christopher Scholz, Vikas Sudesh, Chandra Yelleswarapu, Abani Biswas, Orhan Aytur, Xi-Cheng Zhang

Grants (last 5 years)

- Integrated Plasmon-Optic Circuits for Nanometric Sources and Sensors, AFOSR
- Center for Fiber Optic Communications & Ultra-Broadband Systems (FOCUS), NSF
- AFOSR Block Grant: Optoelectronics Research Center

Important patents awarded (out of 40+)

1. # 4,039,851, "Time-dispersion tuned Raman oscillator", **Jain, R.K**, Lin, C, and Stolen, R. Issued 4/2/77
2. # 4,063,106, "Optical fiber Raman oscillator", Ashkin, A, **Jain, R.K.**, Lin, C and Stolen, R. Issued 12/13/77
3. # 4,165,515, "Light emitting tunnel junctions which are stable at room temperature", Bergman Jr., J, **Jain, R.K**, and Wagner, S. Issued 8/21/79
4. # 4,493,086, "Synchronously-pumped phase-conjugate laser", **Jain, R.K** and Guiliano, C. Issued 1/8/85
5. # 4,731,338, "Method for selective intermixing of layered structures composed of thin solid films", Ralston, J, Moretti, A, and **Jain, R.K**. Issued 3/15/88
6. # 4,784,450, "Apparatus for generating and amplifying new wavelengths of optical radiation", **Jain, R.K** and Stenersen, K. Issued 11/15/88
7. # 5,390,202, "Regenerative optical pulse generator", Yan, C, Reddy, K.P.J, **Jain, R.K**, and McInerney, J. Issued 2/14/95
8. # 5,598,425, "High stability ultra-short sources of electromagnetic radiation", **Jain, R.K.**, McInerney, J, Reddy, K.P.J, and Yan, C. Issued 1/28/97
9. # 5,617,499, "Technique for fabrication of a poled electro-optic fiber segment", Brueck, S.R.J, Long, X-C, and **Jain, R.K**. Issued 4/1/97
10. # 6,221,565, "Tunable Bragg gratings and devices employing the same", **Jain, R.K**. and Srinivasan, B. Issued 4/21/01
11. # 6,360,040, "Method for coupling of laser beams into waveguides", Srinivasan, B, **Jain, R.K.**, and Tafoya, J.D. Issued 3/19/02
12. # 6,510,167, "Method for actively modelocking an all-fiber laser", **Jain, R.K**, Srinivasan, B. Issued 1/21/03
13. # 6,510,276, "Highly doped fiber lasers and amplifiers", **Jain, R.K**, Srinivasan, B, Poppe, E. Issued 1/21/03
14. # 6,570,893, "Precisely wavelength-tunable and wavelength-switchable narrow linewidth lasers", Libatique, N.J.C and **Jain, R.K.**. Issued 5/27/03
15. # 6,660,532, "Modular assembly for reagentless affinity separation and detection of analyte", Lopez, G; Sklar, L; Hampton, P; Tender, L; Opperman, K; Rabinovich, E; **Jain, R.K**. and Yan, J. Issued 12/9/03

- "Stimulated Electron Tunneling in Metal-Barrier-Metal Structures due to Surface Plasmons," D.P. Siu, R.K. Jain, and T.K. Gustafson, Appl. Phys. Lett., **28**, 407-409 (1976).
- "A High-Efficiency Tunable cw Raman Oscillator," R.K. Jain, C. Lin, R.H. Stolen, W. Pleibel, and P. Kaiser, Appl. Phys. Lett., **30**, 162-164 (1977).
- "Generation of Synchronized cw Trains of Picosecond Pulses at Two Independently Tunable Wavelengths," R.K. Jain and J.P. Heritage, Appl. Phys. Lett., **32**, 41-43 (1978).
- "Length Detuning Characteristics of the Synchronously Mode-Locked cw Dye Laser," C.P. Ausschnitt, J.P. Heritage, and R.K. Jain, IEEE J. Quantum Electronics, **QE-15**, 912-917 (1979).
- "DFWM in Semiconductors: Application to Phase Conjugation and to Picosecond Resolved Studies of Transient Carrier Dynamics," R.K. Jain, Opt. Engrg., **21**, 199-218 (1982).
- "Degenerate Four-Wave Mixing in Semiconductor-Doped Glasses," R.K. Jain and R.C. Lind, J. Opt. Soc. Amer., **73**, 647-653 (1983).
- "Development of the Stimulated Raman Spectrum in Single-Mode Fused Silica Fibers," R.H. Stolen, C. Lee, and R.K. Jain, J. Opt. Soc. Amer., **B1**, 652-657 (1984).
- "Picosecond Pulse Generation in cw Semiconductor Lasers using a Novel Regenerative Gain-Switching Technique", C. Yan, K.P.J. Reddy, R.K. Jain and J.G. McInerney, IEEE Photon. Tech. Lett. **5**, 494 (1993)
- "High Power Watt-Level CW Operation of Diode-Pumped 2.7 μm Fiber Lasers Using Efficient Cross-Relaxation and Energy Transfer Mechanisms", B. Srinivasan, J. Tafoya, and R.K. Jain, Optics Express, **4**, 490 (1999)
- "A Broadly Tunable Wavelength-Selectable WDM Source Using a Fiber Sagnac Loop Filter", N.J.C. Libatique and R.K. Jain, IEEE Photon. Techn. Lett., **13**, pp. 1283-1285 (2001)
- "10-Watt-level diode-pumped compact 2.78 μm ZBLAN fiber laser", X.S. Zhu and R. Jain, Opt. Lett., **32**, pp 26-28 (2007)
- "Near-IR Emission from Metal-Insulator-Metal Tunnel Junctions Based on Surface Plasmon Interactions," J.Y. Chen, D. Ancukiewicz, L. Wang, and R.K. Jain, in *Conference on Lasers and Electro-Optics (CLEO)* (Baltimore, MD, 2009), p. JTuD90
- "Maximization of nonlinear fluorescence from ultrasmall (< 2 nm) semiconductor quantum dots to be used for deep tissue imaging," L. Wang, and R.K. Jain, J. Opt. Soc. Am. B **26**, 2161-2166 (2009)

Books authored or co-authored or edited or co-edited

- "Degenerate Four-Wave Mixing in Semiconductors," (Book Chapter) R.K. Jain and M.B. Klein, in ***Optical Phase Conjugation***, pp. 307-415, Ed., R.A. Fisher (Academic Press, New York, 1983).
- "Direct Optical Probing of Integrated Circuits and High Speed Devices," (Book Chapter) J. M. Wiesenfeld and R. K. Jain, in ***Probing High-Speed Electrical Signals***, pp. 221-334, Ed., R.B. Marcus (Academic Press, New York, 1990).

Prizes/awards/honors

- Fellow, American Physical Society, 2008
- Fellow, Institute of Electrical & Electronic Engineers, 1990
- Fellow, SPIE/ The International Society for Optical Engineering, 1988
- Fellow, Optical Society of America, 1986
- Harold E. Edgerton Award, SPIE, 1992
- Special Achievement Award, Amoco Technology Company, 1990
- Outstanding Paper of the Year Award, Hughes Research Labs (HRL), 1983
- Recipient of Several Invention & Published Paper Awards at HRL
- Member, Sigma Xi - Scientific Research Society of America, 1974

Name	Department	Date
Steven J. Koch	Physics and Astronomy	November 9, 2009

Educational History:

Ph.D.	2003 May	Cornell University, Ithaca, NY	Physics (Biophysics Minor)
M.S.	2000	Cornell University, Ithaca, NY	Physics (Biophysics Minor)
B.S.	1996	U. Michigan, Ann Arbor, MI	Physics (Honors)

Ph.D. Dissertation: Probing protein-DNA interactions by unzipping single DNA molecules with a laser trapping microscope, Dr. Michelle D. Wang advisor (Cornell Physics)

Employment History

Assistant Professor	2006 Aug.-pres.	University of New Mexico, Albuquerque
Postdoctoral Fellow	2004-2006	Center for Integrated Nanotechnology (CINT) / Sandia National Labs, Albuquerque
Postdoctoral Appointee	2003-2004	Sandia National Labs, Albuquerque
Research Assistant	1997-2003	Cornell University, Ithaca, NY
Teaching Assistant	1996-1997	Cornell University, Ithaca, NY

Classes taught, last five years:

- Introductory Physics, Fall06, Spring 08, Spring 09 (approx 390 undergraduate students)
- Junior Physics Lab, Fall 07-09 (approx 40 undergraduate physics majors)

Most significant service, last five years:

- Biophysical Society Membership committee 2010-
- Referee service for Physical Review Letters, European Biophysical Journal, American Society of Mechanical Engineers, Nucleic Acids Research, Foundation for Fundamental Research on Matter (FOM, Netherlands), US DOE SBIR Program
- Committee work for University of New Mexico, Department of Physics: Regener Hall Committee, Graduate Committee. Committee work outside of department: NSMS Advisement Committee; UNM ECE / CHTM Faculty Search Committee
- Local scientific outreach: judging middle- and high-school science fairs.

Five most significant publications

Koch SJ, Shundrovsky A, Jantzen BC, and Wang MD (2002). "Probing protein-DNA interactions by unzipping a single DNA double helix." Biophys J **83**(2): 1098-105.

Koch SJ, and Wang MD (2003). "Dynamic force spectroscopy of protein-DNA interactions by unzipping DNA." Phys Rev Lett **91**(2): 028103.

Liu Haiqing, Spoerke Erik D., Bachand M, Koch Steven J, Bunker Bruce C., Bachand George D. (2008) "Biomolecular Motor-Powered Self-Assembly of Dissipative Nanocomposite Rings" Advanced Materials **20**(23):4476-4481

Xia Deying, Gamble Thomas C., Mendoza Edgar A., Koch Steven J., He Xiang, Lopez Gabriel P., and Brueck S. R. J. "DNA Transport in Hierarchically-Structured Colloidal-Nanoparticle Porous-Wall Nanochannels." Nano Lett., **8** (6) 1610 - 1618, 2008, http://pubs.acs.org/cgi-bin/abstract.cgi/nalefd/2008/8/i06/abs/nl080190s.html

Koch SJ, Thayer GE, Corwin AD, de Boer MP. 2006. "Micromachined piconewton force sensor for biophysics investigations." Applied Physics Letters **89**, 173901 http://link.aip.org/link/?APPLAB/89/173901/1

Professional Recognition, Honors, etc. (Teaching, research, service)

CINT Postdoctoral Fellowship	2004-2006	Sandia National Labs
Molecular Biophysics Training Grant	200-2003	NIH / Cornell
GAANN TA/RA Award	1996-2000	US Dept. Ed. / Cornell
Honorable Mention NSF Grad.Research Fellowship	1996	NSF
Sigma Pi Sigma, Physics Honor Society	1996	U. Michigan
Phi Beta Kappa	1995	U. Michigan
James B. Angell Scholar, 2 Consec. 4.0 Semesters	1995	U. Michigan
Sharon Naughton-Briggs Memorial Scholarship	1993-1996	U. Michigan

Research Funding:

1. Coupled Atomistic Modeling and Experimental Studies of Energy Transduction and Catalysis in the Molecular Motor Protein Kinesin
Susan Atlas (Lead PI); Steven J. Koch (co-PI); Steven Valone (co-PI)
Defense Threat Reduction Agency (DTRA)
January 2009-December 2011 (3 years), $593,000 direct + $215,000 for Koch component.

2. Single-Molecule Analysis of DSB Repair Events in Vivo
Steven J. Koch PI; Janet Oliver is the PI of the overall ACS IRG grant #IRG-92-024
American Cancer Society
May 2007 – May 2008, $22,500 direct costs only
April 2009- March 2010 $20,000 direct costs only

Ph.D. Student Advising:

Lawrence J. Herskowitz; non-thesis MS 2008; Physics Ph.D. in progress, expected 2010.

Anthony L. Salvagno; non-thesis MS 2008; Physics Ph.D. in progress, expected 2011.

Roger A. Maloney; non-thesis MS 2008; Physics Ph.D. in progress, expected 2010.

BIOGRAPHICAL SKETCH: SANJAY KRISHNA

NAME	POSITION TITLE
Sanjay Krishna	Associate Professor, Electrical and Computer Engg, Associate Director, Center for High Tech Materials

EDUCATION/TRAINING

	DEGREE *(If applicable)*	YEAR(s)	FIELD OF STUDY
Indian Institute of Technology, Madras	M.Sc	1996	Physics
University of Michigan Ann Arbor	M.S.	1999	Electrical Engineering
University of Michigan Ann Arbor	Ph D	2001	Applied Physics

Positions and Employment

1995	Visiting Student Researcher, Tata Inst. Fundamental Research, India
1996-1997	Graduate Student Assistant, Tata Inst. Fundamental Research, India
1997-1998	Graduate Student Instructor, University of Michigan, Ann Arbor
1998-2001	Graduate Student Research Assistant, University of Michigan, Ann Arbor
2001-2006	Assistant Professor, ECE Dept, University of New Mexico, Albuquerque
2006-Present	Associate Professor, ECE Dept, University of New Mexico, Albuquerque
2009-Present	Associate Director, Center for High Technology Materials, University of New Mexico
2009-Present	UNM Regents Lecturer

Honors and Distinctions

1996	Gold Medal from Indian Institute of Technology, Madras
1997	First in Grad School of Physics at Tata Institute of Fundamental Research
1997	Graduate Student Fellowship, Dept. of Physics, University of Michigan
1999	Best student paper award at North American Molecular Beam Epitaxy Conference
2003	Outstanding Young Engineer Award by IEEE Albuquerque Chapter
2004	ECE Outstanding Researcher Award
2004	Oak Ridge Associated Universities Ralph Powe Jr. Faculty Enhancement Award
2005	School of Engineering Junior Faculty Teaching Award
2007	North American Molecular Beam Epitaxy Young Investigator Award
2007	Defense Intelligence Agency Chief Scientist Award for Excellence
2008	IEEE-Nanotechnology Council Early Career Achievement Award
2008	SPIE Early Career Achievement Award
2009	UNM School of Engineering Sr. Research Excellence Award
2009	UNM Regents Lecturer Award

Conference Committees

2007	Conference Co-Chair of the North American Molecular Beam Epitaxy Conference
2006	Publications Chair of IEEE Conference on Nanotechnology
2005-2008	Chair of the program committee on "Optoelectronic Materials and Processing (OMP) for IEEE/LEOS
2005-2009	Chair of the Center for Integrated Nanotechnologies (CINT) Users Executive Committee
2008-2009	Associate Editor for IEEE Transactions in Nanotechnology
2008-2009	Associate Editor for IEEE Photonics Technology Letters
2007	Program Committee of "The International Conference on Electronic Materials"
2007-Present	Program committee of "IEEE LEOS Optical MEMS & NanoPhotonics

B. Selected Publications (> 90 publications, over 1200 citations, H-index=20)

1. K. Banerjee, S. Ghosh,S. Mallick, E. Plis, S. Krishna,and C. Grein, "Midwave infrared InAs/GaSb strained layer superlattice hole avalanche Photodiode", APPLIED PHYSICS LETTERS 94, 201107,(2009)
2. Woo-Yong Jang, Majeed M. Hayat, J. Scott Tyo, Ram S. Attaluri, Thomas E. Vandervelde, Yagya Sharma, Rajeev Shenoi,Andreas Stintz, Elizabeth R. Cantwell, Steven C. Bender, Sang Jun Lee, Sam Kyu Noh, and Sanjay Krishna, "Demonstration of Bias-Controlled Algorithmic Tuning of Quantum Dots in a Well (DWELL) MidIR Detectors", IEEE JOURNAL OF QUANTUM ELECTRONICS, VOL. 45, JUNE 2009
3. H. S. Kim, E. Plis, J. B. Rodriguez, G. D. Bishop, Y. D. Sharma, L. R. Dawson, S. Krishna, J. Bundas, R. Cook, D. Burrows, R. Dennis, K. Patnaude, A. Reisinger, and M. Sundaram, "Mid-IR focal plane array based on type-II InAs/GaSb strain layer superlattice detector with nBn design" Appl. Phys. Lett. 92, 183502 (2008)

Recent Post-doctoral Associates

Dr. Sudheer Phatak, Dr. Lubosh Skala, Dr. Marek Kus', Dr. R. Amritkar, Dr. Gustavo Camelo Neto, Dr. Daniel Escaff, Dr. Claudio Fusco, Dr. Luca Giuggioli, Dr. Jayanthi Santhanam, Dr. Francisco Seville, Dr. Ana Tereza Silva, Dr. Rodrigo Lima, Dr. Victor Doserti, Dr. Julian Candia, Dr. Evgeny Zemskov, Dr. Niraj Kumar. Additionally hosted and collaborated with more than 60 visiting scientists of various levels of seniority.

Supervision of Graduate Students: 19 PhD's and 1 Masters

V. Seshadri (1977), Y. Wong (1979), P.E. Parris (1984), D.W. Brown (1984), J.D. Andersen (1985), G.P. Tsironis (1986), D.H. Dunlap (1987), H. Wu (1989), X. Fan , (1990), V. Kovanis (1991), F. Biscarini (1993), S. Raghavan (1996), M. Endicott , (1996), D. Sheltraw (1996), J. Scott (1998), L.A. Giuggioli (2004), D. McInnis (2007), M. Tiwari (2008), Ziya Kalay (2009), Luis Felipe Gonzales (2009). Current PhD students: Alden Astwood and Kathrin Spendier, the latter co-mentored with J. Thomas.

Dissertations and Present Locations of the 20 Graduate Students

1. V. SESHADRI (Ph.D. in1977) now at the Bell Laboratories. Title of thesis, Master Equation Theory of Simultaneous Vibrational Relaxation and Intramolecular Decay.
2. Y. WONG (Ph.D. in1979) now at the Bell Laboratories. Title of thesis, Theoretical Study of Exciton Transport in Molecular Crystals.
3. P.E. PARRIS (Ph.D. in1984) now Chairman of the Physics Department and Professor at the University of Missouri, Rolla. Title of thesis, Sensitized Luminescence as a Probe of Exciton Transport in Organic Molecular Solids.
4. D.W. BROWN (Ph.D. in1984) now a Research Scientist at the Institute of Nonlinear Science at the University of California, San Diego. Title of thesis, Neutron Scattering and Muon Spin Rotation as Probes of Light Interstitial Transport.
5. J.D. ANDERSEN (Ph.D. in1985) now Professor at the Rochester Institute of Technology. Title of thesis, Transport Theory for Photoinjected Electrons in Naphthalene.
6. G. P. TSIRONIS (Ph.D. in1986) now a Professor of Physics at the University of Crete, Greece. Title of thesis, Transport Studies in Nonlinear Dimers and Molecular Solids.
7. D.H. DUNLAP (Ph.D. in1987) now Associate Professor at the University of New Mexico. Title of thesis, Charge Transport in High Fields and under Strong Carrier-Lattice Interactions.
8. H. WU (Ph.D. in1989) now a Senior Researcher at NASA. Title of thesis, Transport Studies Based on the Discrete Nonlinear Schroedinger Equation.
9. X. FAN (Ph.D. in1990) now at the University of North Texas. Title of thesis, Studies of Unusual Thermal Transport in Solids and of Related Nonlinear Problems.
10. V. KOVANIS (Ph.D. in1991) now Senior Research Scientist at Corning Inc. Title of thesis, Wave Packet Evolution in Restricted Geometries.
11. F. BISCARINI (supervised jointly with C. Bustamante of University of Oregon, Eugene) (Ph.D. in1993) now a Research Scientist at CNR, Bologna. Title of thesis, Theory of Scanning Tunneling Microscopy and Simulations of Images of Metal Surfaces and Absorbed Molecules
12. S. RAGHAVAN (Ph.D. in1996) now a Senior Scientist at Corning. Title of thesis, Strongly Interacting Quasiparticle-Boson Systems: Validity of Approximation Schemes.
13. M. ENDICOTT (Ph.D. in1996) now at the University of Kentucky. Title of thesis, A Study of the Statistical Mechanics of Two Complex Systems.
14. D. SHELTRAW (Ph.D. in1996) now a Research Scientist at the VA/LANL laboratory. Title of thesis, Diffusion of Spins in the Presence of Magnetic Field Gradients and Confinement.
15. J. SCOTT (Ph.D. in1998) Title of Thesis, Nonlocal Effects and Spatial Correlations in the Transmission of Stress in Granular Materials.
16. L. A. GIUGGIOLI (Ph.D. in 2004) now Assistant Professor at University of Bristol, United Kingdom. Title of Thesis, Theory of Transport in Organic Crystals and Biological Systems.
17. DAVID MCINNIS (Ph.D. in 2007) now Research Scientist at All State, Chicago. Title of Thesis, Applications of Nonlinear Science and Kinetic Equations to the Theory of the Spread of Epidemics.
18. MUKESH TIWARI (Ph.D. in 2008) now Assistant Professor at the Dhirubhai Institute, Gandhinagar, India. Title of Thesis, Quasiparticle Motion in some Classical and Quantum Mechanical Systems: Investigations of Nanoscale Friction and Polaron Mobility.
19. ZIYA KALAY (Ph.D. in 2009) now Research Scientist at Kyoto University, Japan. Title of Thesis, Statistical Mechanics of Transport in Disordered Lattices and Reaction-Diffusion Systems.
20. LUIS-FELIPE GONZALES (MS in 2009) now Amgen Fellow at Teach for America, Inc., Houston. Title of Thesis, Applications of Statistical Mechanics and Nonlinear Science to Ecological Phenomena.

Courses Taught Recently at UNM

2004 Spring: Advanced Seminar - Complex Systems Theory PHYS 500-001 ; Statistical Mechanics & Thermodynamics Phys505-001
2004 Fall: Heat & Thermodynamics + P P 301.001; Problems for Physics 301 P 451.060
2005 Fall: Heat & Thermodynamics P 301.001; Problems for Physics 301 P 451.060; Advanced Statistical Mechanics P 576.001
2006 Fall: Heat & Thermodynamics P 301.001; Problems for Physics 301 P 451.060
2007 Spring: Nonlinear Science and Mathematical Biology Phys 452-034 and 581A-001
2007 Fall: P 529.001 Condensed Matter 1; PIBBS Biology 503 Unit 4 Theory of Animal Motion and Spread of Epidemics
2008 Spring: Advanced Seminar: Statistical Physics PHYS 500-03; Statistical Mechanics & Thermodynamics PHYS 505-001
2008 Fall: Classical Mechanics I PHYS 503-001; Advanced Seminar: Statistical Physics PHYS 500-009; PIBBS Biology 503 Unit 2 Theory of the Spread of Epidemics
2009 Spring: Statistical Mechanics & Thermodynamics PHYS 505.001; Advanced Seminar: Statistical Physics PHYS 500.009
2009 Fall: Advanced Seminar: Statistical Physics PHYC 500.009; Classical Mechanics I PHYC 503.001

LUKE F. LESTER

A. PROFESSIONAL PREPARATION

Cornell University, Engineering Physics, B.S., 1984
Cornell University, Electrical Engineering, Ph.D., 1992 (Advisor: Lester F. Eastman)

B. APPOINTMENTS

Professor, Electrical & Computer Engineering, UNM (2007-present)
Microelectronics Endowed Chair Professor, UNM (2008-present)
General Chair, Optical Science and Engineering Graduate Program, UNM (2009-present)
Associate Chair, Graduate Director of ECE, UNM (2009-present)
Associate Director of the Center for High Technology Materials, UNM (2004-2008)
Associate Professor, Electrical & Computer Engineering, UNM (2000-2007)
Assistant Professor, Electrical & Computer Engineering, UNM (1994-2000)
Chief Technology Officer, Zia Laser, Inc., Albuquerque, NM (2001-2003)
Engineer, General Electric Electronics Laboratory, Syracuse, NY (1985-1994)
Senior Member, IEEE (2000)

C. PUBLICATIONS

Over 95 journal articles and 100 conference papers and presentations, 6 patents, 2 patents pending. H-index of 30.

(i) SELECT PUBLICATIONS

1. N. G. Usechak, Y.-C. Xin, C. Y. Lin, L. F. Lester, D. J. Kane, and V. Kovanis, "Modeling and Direct Electric-Field Measurements of Passively Mode-Locked Quantum-Dot Lasers," *J. Special Topics Quantum Electron.*, **15**(3), 653-660 (2009).
2. Y.-C. Xin, D. J. Kane, and L. F. Lester, "Frequency-resolved optical gating characterization of a passively modelocked quantum-dot laser" *Electron. Lett.*, 44, 1255-56 (2008).
3. Y.C. Xin, C.Y. Lin, Y. Li, H.P. Bae, H.B. Yuen, M.A. Wistey, J. S.H. Jun, S.R. Bank, L.F. Lester, "Monolithic 1.55 micron GaInNAsSb quantum well passively mode-locked lasers" *Electron. Lett.* **44**(9), 581-582 (2008).
4. Y. C. Xin, Y. Li, V. Kovanis, A. L. Gray, L. Zhang, and L. F. Lester, "Reconfigurable Quantum Dot Monolithic Multi-Section Passive Mode-Locked Lasers," *Optics Express* **15**(12), 7623-7633 (2007).
5. A. Martinez, Y. Li, L.F. Lester, and A.L. Gray, " Microwave frequency characterization of undoped and p-doped quantum dot lasers" *Appl. Phys. Lett.* **90**(25), 251101 (2007).
6. N. A. Naderi, M. Pochet, F. Grillot, N. B. Terry, V. Kovanis, and L. F. Lester, "Modeling the Injection-Locked Behavior of a Quantum Dash Semiconductor Laser" " *J. Special Topics Quantum Electron.*, **15**(3), 563-571 (2009).
7. F. Grillot, C. Y. Lin, N. A. Naderi, M. Pochet, and L. F. Lester, "Optical feedback instabilities in a monolithic InAs/GaAs quantum dot passively mode-locked laser," *Appl. Phys. Lett.*, **94**(15), 153503 (2009).
8. X. D. Huang, A. Stintz, H. Li, L. F. Lester, J. Cheng, and K. J. Malloy, "Passive mode-locking in 1.3 μm two-section InAs quantum dot lasers," *Appl. Phys. Lett.*, **78**, 2825-2827 (2001).
9. H. Su and L. F. Lester, "Dynamic properties of quantum dot distributed feedback lasers: high speed, linewidth and chirp" *J. Phys D: Appl. Phys.* **38** (2005) 2112-2118.
10. L. Zhang, et al. "Low timing jitter, 5 GHz optical pulses from monolithic two-section passively mode-locked 1250/1310 nm quantum dot lasers for high speed optical interconnects," Paper OWM4, OFC 2005.

D. SYNERGISTIC ACTIVITIES

UNM Science and Technology Corporation Speaker Series, gave talk on "Faculty Entrepreneurship: A First Hand Account"
Guest on local KAGM radio on Start-up Companies from UNM
Member, UNM Conflict of Interest Task Force 2005
Program and Awards Committee, SSDM 2005
IEEE LEOS Annual Meeting Committee Member 2005-2008
Air Force Faculty Fellow, Summer 2006 and Summer 2007

E COLLABORATORS AND OTHER AFFILIATIONS

- Collaborators
  - Peter Smowton and Peter Blood, Cardiff University
  - Jim Harris, Stanford University
  - Seth Bank, University of Texas, Austin
  - Dan Kane, Southwest Sciences
  - Tom Koch, Lehigh University
  - Serge Oktyabrsky, UAlbany
  - Ryne Raffaelle, RIT
  - Vassilios Kovanis, AFRL-Sensors Directorate
  - Alfred Forchel, Univ. of Wuerzburg
  - Kevin Malloy, Univ. of New Mexico
  - Bjorn-Ove Fimland, Norwegian University of Science and Technology
  - Andrew Sarangan, Univ. of Dayton
  - Dennis Derickson, Cal-Poly, San Luis Obispo
  - Michael Hayduk, AFRL-IF Directorate
- Co-Editors
  - None
- Graduate Advisor
  - Lester F. Eastman, Cornell University
- Postdoctoral Advisor
  - None
- Thesis and Postdoc Advisees
  - Yan Li, PhD, Emcore, Inc.
  - Yongchun Xin, PhD and Postdoc, IBM
  - Petros Varangis, PhD, Nanocrystal, Inc.
  - Lei Zhang, PhD, Nanocrystal, Inc.
  - Allen Gray, PhD, Semprius, Inc.
  - Ronghua Wang, PhD, Intel, Inc.
  - Edwin Pease, PhD, Tau Technologies, Inc.
  - Guangtian Liu, PhD, Coherent, Inc.
  - Sylvia Dorato, PhD, AFRL-Kirtland
  - Hui Su, PhD, Emcore, Inc.
  - Leslie Vaugh, PhD, AFRL-Kirtland
  - Tim Newell, Research Professor, AFRL-Kirtland

Kevin J. Malloy

PhD students supervised	***DISSERTATION***
Gaciela Rosas-de Guel (PhD EE 1992)	"Deep Level Traps in Te-Doped Psuedomorphic HEMTs"
Donald L. McDaniel, Jr. (PhD EE 1992)	"Threshold reduction by Wavelength-Resonant Spacing of Quantum Well Absorbers in an Optical Bistable Etalon"
James A. Lott (PhD EE 1993)	"Visible Vertical Cavity Surface Emitting Lasers"
Liancheng Zou (PhD Physics 1994)	"Second Harmonic Generation from $Al_xGa_{1-x}As$ Thin Films and Multilayers"
Saket Chadda (PhD ChE 1994)	"Structural Evaluation of Novel Semiconductor Radiation Detectors"
Dong S. Lee (PhD Physics 1995)	"Reduced Absorption and Gain Without Inversion in Semiconductor Quantum Wells"
Kamil Agi (PhD EE 1997)	"Evolution of the Dispersive Properties of Photonic Crystals"
Audra Rice (PhD EE, 1999)	"Influence of the Microstructure on Transport Properties of P-type GaN:Mg"
Mohammad Mojahedi (PhD EE 1999)	"Superluminal Group Velocities and Structural Dispersion"
Guangtian Liu (PhD EE 2000)	"Quantum Dot Laser Diodes Using the Dot-in-a-Well" Structure"
Carole Mourad (PhD EE 2000)	"Quaternary GaInAsSb Heterostructures Grown by MBE"
Fred Gelbard (PhD EE 2001)	"Modeling the Electronic States of Quantum Structures"
Xiaodong Huang (PhD EE 2001)	"The Steady State and Transient Behavior of InAs Quantum Dot Laser Diodes"
Babar Minhas (PhD EE 2003)	"Numerical Modeling of Periodic Structures: Metallic Grids and Metamaterials"
P. Dan Popescu (PhD Optical Sciences, 2003)	"Spatial and Spectral Investigations of Transport in Quantum Dots"
Giovanni Donati (PhD Optical Sciences 2004	"Band Gap and Band Offsets of Quaternary GaInAsSb Alloys"
Alexander Uhkanov (PhD Optical Sciences 2004)	"Carrier-Induced Optical Properties of InAs Quantum Nanostructure Semiconductor Laser Active Regions"
Thomas Rotter (PhD Optical Sciences 2007)	"Growth and Properties of Self Assembled InAs Quantum Dash Laser Active Regions"
Alexander Albrecht (PhD Physics, 2009)	"InAs Quantum Dot Vertical Cavity Lasers"
Jing Chen (Ph.D. EE, 2009)	"Metal-Insulator-Metal Plasmonic Waveguides and Devices"
Chi Yang (PhD Electrical Engineering, 2009)	"1.55 μm AlGaInAs Multiple Quantum Well Semiconductor Diode Lasers"

Grants in the last 5 years

Co-Principal investigator on a DARPA grant on "The integration of Quantum Dot Lasers for Chip-Scale Interconnects," on an AFOSR grant on "Plasmonic Nanophotonics," and on a AFOSR MURI "Laser Cooling of Solids," and on an ARL Research Grant "MAST CTA.

Important Patents:

I am **co-inventor on five issued patents** (the first three are related to quantum dot laser diodes that were licensed by Zia Laser, Inc., now Innolume GmbH, from STC.UNM):

- 6,600,169 (issued Jul 29, 2003), "Quantum dash device."
- 6,782,021 (issued Aug 24, 2004) "Quantum dot vertical cavity laser."
- 6,816,525 (issued Nov 9, 2004), "Quantum dot lasers."
- 7,282,732 (issued Oct 16, 2007) "Quantum dot structures."
- 7,329,871 (issued Feb 12, 2008), "Plasmonic enhanced infrared detector element."

I am **co-inventor on two other patent applications**:

- "High-Frequency, Thin-Film Liquid Crystal Thermal Switches," 2008, U.S. Patent filed.
- "Multilayer Electrocaloric Refrigerator and Pyroelectric Energy Generator" Kevin J. Malloy & Epstein, R. I., 2008, U.S. Patent filed.

Kevin J. Malloy

Educational History

B.S., Electrical Engineering, University of Notre Dame, 1978

M.S., Electrical Engineering, Stanford University, 1980

Ph.D., Electrical Engineering, Stanford University, 1984

Professional Appointments

Dates	Institution	Position
August, 2009 to present	University of New Mexico	Professor of Physics and Astronomy
December, 2003 to July, 2009	University of New Mexico	Associate Dean for Research, School of Engineering
January 2000 to December, 2003	University of New Mexico	Associate Director, Center for High Technology Materials
January 1990 to July 2009	University of New Mexico	Assistant, Associate and then full Professor of Electrical and Computer Engineering
October 1988 to January 1990	The University of California - Berkeley	Visiting Associate Research Engineer
October 1983 to October 1988	Air Force Office of Scientific Research	Program Manager for Electronic Materials

Classes taught last 5 years

EECE 475	Introduction to Optoelectronics	Developed this course as an under/grad.
ChNE 575	Introduction to Nanotechnology	Co-developed and team taught the first offering.
EECE 578	Advanced Semiconductor Optoelectronics	Updated to include nanophotonics

Service (last 5 years)

Department/University: served as Associate Dean for Research

Profession:

Member of the Program Committee, CLEO, 1999-2004

Conference Co-Chair, SPIE Photonics West, 2002

Vice-Chair OSA Technical Group on Optical Devices and Nanostructures, 2002-2003

Publications (5)

h-factor of 30:

	Times Cited
S. Zhang*, W. J. Fan*, N. C. Panoiu, K. J. Malloy, R. M. Osgood, and S. R. J. Brueck, "Experimental demonstration of near-infrared negative-index metamaterials," *Phys. Rev. Lett.*, vol. 95, pp. 137404, 2005.	261
G. T. Liu*, A. Stintz, H. Li, K. J. Malloy, and L. F. Lester, "Extremely low room-temperature threshold current density diode lasers using InAs dots in $In_{0.15}Ga_{0.85}As$ quantum well," *Electron. Lett.*, vol. 35, pp. 1163-1165, 1999.	259
H. Y. Fan, K. Yang*, D. M. Boye, T. Sigmon, K. J. Malloy, H. F. Xu, G. P. Lopez, and C. J. Brinker, "Self-assembly of ordered, robust, three-dimensional gold nanocrystal/silica arrays," *Science*, vol. 304, pp. 567-571, 2004.	169
T. C. Newell, D. J. Bossert, A. Stintz, B. Fuchs, K. J. Malloy, and L. F. Lester, "Gain and linewidth enhancement factor in InAs quantum-dot laser diodes," *IEEE Photon. Tech. Lett.*, vol. 11, pp. 1527-1529, 1999.	150
L. F. Lester, A. Stintz, H. Li, T. C. Newell, E. A. Pease*, B. A. Fuchs, and K. J. Malloy, "Optical characteristics of 1.24-μm InAs quantum-dot laser diodes," *IEEE Photon. Tech. Lett.*, vol. 11, pp. 931-933, 1999.	139

Books

K. J. Malloy and K. Khachaturyan, "DX and Related Defects in Semiconductors," *Semiconductors and Semimetals*, vol. 38, pp. 235-291, 1993.

D. L. Kendall, C. B. Fleddermann, and K. J. Malloy, "Critical Technologies for the Micromachining of Silicon," *Semiconductors and Semimetals*, vol. 37, pp. 293-337, 1992.

K. Faber and K. J. Malloy, eds., "Mechanical Properties of Semiconductors," *Semiconductors and Semimetals*, vol. 37, 1992.

Marek Osinski
Address: Center for High Technology Materials, University of New Mexico
1313 Goddard SE, Albuquerque, New Mexico 87106-4343
Tel. (505) 272-7812; Fax (505) 272-7801; Email: osinski@chtm.unm.edu

Professional Preparation:

• University of Warsaw, Poland	Physics	M.Sc., 1971
• Institute of Physics, Polish Academy of Sciences	Physical Sciences	Ph.D., 1979
• University of Southampton, UK (postdoctoral)	Semiconductor Lasers	1980-1984

Appointments:

- July 1999 - present, Professor of Electrical & Computer Engineering, Professor of Physics & Astronomy, and Professor of Computer Science, Center for High Technology Materials, Univ. of New Mexico
- Jan. 1997 – Jan. 1998: Visiting Professor, Department of Electrical and Electronic Engineering and Satellite Venture Business Laboratory, University of Tokushima, Japan
- 1988-1989: NTT Visiting Professor in Telecommunications, University of Tokyo, Japan
- 1987-1999: Associate Professor, University of New Mexico
- 1985 - 1987: Visiting Associate Professor, University of New Mexico
- 1984-1985: British Telecom Senior Associate of Research in Coherent Optical Communication at Cambridge University, England
- 1980-1984: Visiting Research Fellow at Southampton University, England
- 1971-1980: Research Assistant and Senior Research Associate, Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

Selected Professional Activities:

- Fellow of SPIE, OSA; Senior Member of IEEE; Senior Member of IEEE Photonics Society (former LEOS); Senior Member of IEEE Engineering in Medicine and Biology Society (EMBS); Member of MRS, ECS
- Optoelectronics Technical Committee Member, *IEEE International Reliability Physics Symposium*, 1995-1998
- Program Committee Member, *Photonics for Space Environments IV-VII*, SPIE Annual Meeting, 1996-2000
- Program Committee Member, *2nd International Symp. on Blue Laser and Light Emitting Diodes (2nd ISBLLED)*, Chiba, Japan, 29 Sept. - 2 Oct., 1998
- Steering Committee Member, *SPIE/Laser Society of Japan International Forum on High Power Lasers and Applications AHPLA '99*, Osaka, Japan, 1-5 Nov. 1999
- Conference Chairman, *Advanced High-Power Lasers*, Osaka, Japan, 1-5 Nov. 1999
- Symposium Chairman, *Symposium on Integrated Optoelectronic Devices*, SPIE Photonics West, San Jose, CA, Jan. 1998-2001
- Conference Chairman, *Design, Fabrication, and Characterization of Photonic Devices I-II, SPIE International Symposium on Photonics and Applications ISPA*, Singapore, 1999-2001
- Conference Co-Chairman, *Nano/Biophotonics and Biomedical Applications*, SPIE Photonics West, San Jose, CA, 24-27 Jan. 2005
- Chairman, *Technical Program Subcommittee 15 on LEDs, Organic LEDs, and Solid State Lighting*, CLEO Conference on Lasers and Electro-Optics, 2005-2007
- Member, Optoelectronics Symposium Advisory Committee, *SPIE Photonics West Symposium*, San Jose, CA, 2002-2008.
- Conference Co-Chairman, *Physics and Simulation of Optoelectronic Devices II-XVIII*, SPIE Photonics West 1994-2010
- Conference Chairman, *Colloidal Quantum Dots for Biomedical Applications I-V*, SPIE Photonics West, San Jose, CA, 2006-2010

Honors, Awards, and Society Offices:

- Editor, *Progress in Quantum Electronics* (1991-2003)
- Member, *Optoelectronics Best Paper Award Committee*, SPIE Photonics West 1998-2001
- EECE Distinguished Researcher Award, EECE Department, University of New Mexico (2001, 2007)
- Member, SPIE Symposia Committee, 2002-2003
- Fellow of SPIE, The International Society for Optical Engineering (2002)

4. Fan, W; Zhang, S; Panoiu, NC; Abdenour, A; Krishna, S; Osgood, RM; Malloy, KJ; Brueck, SRJ "Second harmonic generation from a nanopatterned isotropic nonlinear material" NANO LETTERS; MAY 2006; v.6, no.5, p.1027-1030
5. Sarath D. Gunapala, Sumith V. Bandara, Cory J. Hill, David Z. Ting, John K. Liu, Sir B. Rafol, Edward R. Blazejewski, Jason M. Mumolo, Sam A. Keo, Sanjay Krishna, Y.-C. Chang, and Craig A. Shott, "640 512 Pixels Long-Wavelength Infrared (LWIR) Quantum-Dot Infrared Photodetector (QDIP) Imaging Focal Plane Array" IEEE JOURNAL OF QUANTUM ELECTRONICS, VOL. 43, NO. 3, MARCH 2007

Issued and Pending Patents

1. S. Krishna, M. Hayat, J. S. Tyo, U. Sakoglu and S. Raghavan Detector with tunable spectral response. United States Patent No. 7,217,951 (2007)
2. S. Krishna, M. Hayat, J.P.R. David, "Intersubband detector with avalanche multiplier region", United States Patent Number 7,271,405 (2007).
3. P. Dowd, P. Hill, L.R. Dawson and S. Krishna, "Semiconductor Conductive Layers", US Patent 7, 583, 715 B2, (2009).
4. G.von Winckel, E.A. Coutsias and S. Krishna" Spectral Element Eigensolver for Inhomogenous Media", Provisional Patent Filed, June 2004.
5. S. Krishna and O. J. Painter, "High Performance Hyperspectral Detectors Using Photon Controlling Cavities" Provisional Patent Filed,
6. S. Krishna, M.M. Hayat and J.S. Tyo, " The infrared retina", Provisional Patent filed, May 2007.

Graduated Group Members:

- ***Postdoctoral Fellows:*** Dr. Tom Vandervelde, Dr. Jean Baptiste Rodriguez, Dr. Jay Brown, Dr. Abdenour Amtout, Dr. Phil Dowd
- ***PhD Students:*** Dr. Greg von Winckel, Dr. Zhimei Zhu, Dr. Elena Plis, Dr. Ram Attaluri, Dr. Fred Newmann, Dr. Jonathan Andrews, Dr. Christopher Wilcox
- ***M.S. Students:*** Greg Bishop, Jason Shelton, Michael Lenz, Eric Varley, Kalyan Teja Posani, Senthil Annamalai, Diana Jepson, Chris Wilcox, Mario Serna, Sunil Raghavan, Andrea Scott, Nina Weisse Bernstein

Current Research Support

- Co-PI: Collaborative Research: Impact Ionization Engineered and Nanoscale Quantum-dot Based Avalanche Photodiodes", NSF, May 2006-Nov 2009) $150K
- PI: "Development of Very Long Wave Infrared Detectors Based on Type II Strain Layer Superlattices" MDA-STTR Phase II, Nov 2008-Nov 2010 $300K
- PI: "Hyperspectral Sensors with Nanoscale Quantum Dots and Plasmon Assisted Photonic Crystal Cavities", AFOSR/Caltech, May 2006-Jan 2010 $361K
- Co-PI: " Intelligent and Adaptable Spectral Sensing Systems Based on Tunable Infrared Quantum-Dot Focal Plane Arrays" DIA, July 2007-Jan 2010 $411K
- PI: "Nanoscale Based Far Infrared and THz Detectors" Global Research Laboratory Program, 2007-2013 $750K
- PI: " Mid infrared sensors with Photon Controlling Cavities", Air Force Research Laboratory, Jan 2007-Jan 2010: Award: $350K
- PI: " Demonstration of Polarimeter in a Pixel", Air Force Office of Scientific Research 2006-2009: Award: $550K
- Co-PI: "A Reconfigurable Readout Circuit for Integrated Infrared Spectral Sensing", NSF, Aug 2009-July 2012, $450K (3 PIs)
- PI: "Plasmon Assisted Nanoscale Sensor Arrays", IC Postdoc, July 2009-July 2011, $240K
- PI: " Growth of InAs/GaSb Based Type II Strain Layer Superlattice" IR Nova, Sweden, June 2008-Nov 2009 $55K
- PI: "Novel Heteroengineered Detectors for Multi-Color Infrared Detection" AFOSR, March 2009-March 2012 $300K
- PI: "Adaptive Integrated Multi-Modal Sensing Array" Polaris Sensors, STTR AFOSR, July 2009-July 2010, Phase I $36K
- PI: " Molecular Beam Epitaxy System For Electronic and Optoelectronic Devices" AFOSR, May 2009-May 2010 $926,800K

ABRIDGED CV

Sudhakar Prasad
Dept of Physics and Astronomy
University of New Mexico
December 3, 2009

Educational history

Ph.D. (Physics)	Harvard University	Cambridge, Mass.	1983
A.M. (Physics)	Harvard University	Cambridge, Mass.	1979
M.S. (Physics)	Indian Inst. of Technology	New Delhi, India	1978

Thesis/dissertation titles

Ph.D.: "Topics in Coherent Atom-Field Interactions"
[Advisor: Prof. Roy J. Glauber (2005 Physics Nobel Prize)]
M.S.: "Design and Fabrication of a Digital Autocorrelater"
[Advisor: Prof. S. Chopra]

Professional appointments

Professor, Physics and Astronomy, UNM	1997-present
Director, Center for Advanced Studies, UNM	2000-2005
Regents' Lecturer, UNM	1994-1997
Associate Professor, Physics and Astronomy, UNM	1991-1997
Assistant Professor, Physics and Astronomy, UNM	1985-1991
Research Associate, Center for Advanced Studies, UNM	1984-1985
Post-doctoral Fellow, Institute for Modern Optics, UNM	1983-1984

Classes taught last 5 years

Methods of Theoretical Physics I and II (senior-graduate-level)
Classical Electrodynamics (graduate-level)
Electricity and Magnetism II (senior-level)
Intermediate Quantum Mechanics I and II (senior-level)
General Physics III (sophomore level)
Optical Coherence and Imaging (graduate seminar)

Most significant service last 5 years

Provost's Task Force on identifying areas of marked distinction at UNM (2003-5)
Chair, Experimental Optics Faculty Search Committee (2005)
Dept's Undergraduate Committee (since 2003)
DARPA's DSRC Panel on Information in Photonics (2004)
Program Committee Member
* Computational Optical Imaging and Sensing (Opt. Soc. of America, 2009)
* Image Reconstruction from Incomplete Data (SPIE, 2009)
Numerous dissertation and thesis committees

- Fellow of OSA, The Optical Society of America (2003)
- Guest Editor, Special Section on Colloidal Quantum Dots for Biomedical Applications, IEEE Transactions on NanoBioscience, 2006, 2009
- Guest Editor, *Special Issue on Biomedical Applications of Colloidal Nanocrystals*, Journal of Biomedicine and Biotechnology, Nov. 2007
- Gardner-Zemke Professorship at UNM Dept. of Electrical & Computer Engineering, Dec. 2008-2011

Areas of Current Research Interest:

Integrated optoelectronics; Optoelectronic materials and devices; Injection-locked ring lasers; Semiconductor ring laser gyros; Colloidal nanocrystals for biomedical applications; Nuclear radiation detectors; Nanoscintillators; Effects of radiation on optoelectronic devices; Nanophosphors; VCSELs and 2D arrays; Comprehensive semiconductor laser simulation; Thermal effects in semiconductor lasers; Life testing, reliability and failure analysis of optoelectronic devices; Unipolar optoelectronic devices.

Principal Accomplishments:

- Co-inventor of resonant-periodic-gain (RPG) surface-emitting lasers
- Demonstration of optical chaos in multiterminal semiconductor lasers
- Invention and first demonstration of distributed-feedback RPG surface-emitting lasers
- First self-consistent comprehensive studies of thermal properties of VCSELs and 2D arrays
- Determination of defect-related degradation mechanism in AlGaN/InGaN/GaN optoelectronic devices driven at high current densities
- Formulation of criterion for estimating the strength of current self-distribution effect in diode lasers
- First thermal-electrical simulation study of cryogenic VCSELs and intracavity-contacted VCSELs
- Co-inventor of integrated semiconductor ring laser gyro
- Co-inventor of high-brightness broad-area semiconductor lasers with tilted-gratings
- Co-inventor of unipolar group-III-nitride semiconductor structures

Publications and Patents:

Over 430 publications, 26 edited books of proceedings, 5 book chapters, 5 granted and 5 pending patents.

Representative Publications:

1. W. Streifer, M. Osiński, and A. Hardy, "Reformulation of the coupled mode theory of multiwaveguide systems", *Journal of Lightwave Technology* **LT-5** (#1), pp. 1-4, Jan. 1987.
2. M. Osiński and J. Buus, "Linewidth broadening factor in semiconductor lasers - An overview", Invited Paper, *IEEE Journal of Quantum Electronics* **QE-23** (#1), pp. 9-29, Jan. 1987.
3. H.-J. Cao, C.-Y. Liu, H. Ling, H. Deng, M. Benavidez, V. A. Smagley, R. B. Caldwell, G. M. Peake, G. A. Smolyakov, P. G. Eliseev, and M. Osiński, "Frequency beating between monolithically integrated semiconductor ring lasers", *Appl. Phys. Lett.* **86**, no. 4, Article 041101 (2005).
4. G. A. Smolyakov and M. Osiński, "Analysis of lateral-mode confinement in VCSELs with ring metal apertures", Journal of Lightwave Technology **23** (#12), pp. 4278-4286, Dec. 2005.
4. M. Osiński, H.-J. Cao, C.-Y Liu, and P. G. Eliseev, "Monolithically integrated twin ring diode lasers for rotation sensing applications", *J. Crystal Growth* **288**, pp. 144-147 (2006).
5. H.-J. Cao, N. J. Withers, G. A. Smolyakov, and M. Osiński, "Microwave frequency beating between monolithically integrated quantum-dot ring lasers", *Electron. Lett.* **43**, pp. 1456-1458 (2007).

Synergistic Activities:

- ECE co-chair of Optical Science and Engineering Graduate Committee, UNM, 2000 - 2004
- Faculty Advisory Committee Member, Diversity Programs, School of Engineering, UNM, 2002-2008
- PI on the NSF Bridges for Engineering Education planning grant on *Curriculum, Program, and Infrastructure Development for Bachelor of Science in Optical Science and Engineering*, 2002-2005
- Member, Photonics Technology Program Advisory Committee, Central New Mexico Community College (former Albuquerque Technical-Vocational Institute), 2002-2008
- PI on the NSF IGERT grant on *Integrating Nanotechnology with Cell Biology and Neuroscience*, 2006-present
- Advisory Board Member, National Security Studies Program, UNM, 2009–present
- **Over the last 3 years, supervised 7 Ph.D. students, 11 M.S. students, 17 undergraduate students, 17 high school interns, and 2 postdoctoral scholars**

CV Wolfgang Rudolph

Educational Background:

- Diploma (Master) in Physics, Friedrich-Schiller-University (FSU) Jena, Germany 1982
- Ph.D. in Physics, FSU Jena, 1985
- Dr. of Science (Habilitation), FSU Jena, 1989

Professional Appointments:

- Regents' Professor, 2006 -
- Professor of Physics and Electrical Engineering, Department of Physics and Astronomy and ECE Department (joint appointment), UNM, 1997 - present
- Associate Professor, University of New Mexico, 1991 – 1997
- Senior Research Associate, FSU Jena, 1987 – 1991
- Visiting scientist, Center for Applied Quantum Electronics, North-Texas-State University, Denton TX, 1985 – 1986
- Invited Professor at the Department of Electrical Engineering at the University of Pavia, Italy, 1992
- Invited Professor at the Institute of Metrology, Tsukuba, Japan, Spring 1997

Field of Interest:

Quantum Electronics, Nonlinear Optics, Laser Physics, Optical Spectroscopy, Ultrashort Light Pulses, Ultrafast Phenomena in Matter, Optical Imaging

Publications:

more than 120 refereed and invited articles incl. proceedings, more than 160 refereed and invited talks, co-authored two books, second edition of one published in 2006, seven book chapters

Recent Publications:

1. M. Mero, J. Liu, W. Rudolph: *Scaling laws of fs laser pulse induced breakdown in oxide films:* Phys. Rev. B 71 (2005) 115109
2. X. Liu, R. Stock, W. Rudolph: *Ballistic electron transport in Au films*, Phys. Rev. B72 (2005) 195431
3. A. Schwarz, W. Rudolph: *Dispersion-compensating beam shaper for femtosecond optical vortex beams*, Opt. Lett. 33 (2008) 2970
4. X. Liu, J. Thomas, W. Rudolph: *Photobleaching resistance of stimulated parametric emission in microscopy*, Opt. Lett. 34 (2009) 304
5. D. Nguyen and L. A. Emmert and I. V. Cravetchi and M. Mero and W. Rudolph and M. Jupe and D. Ristau: *TixSi1-xO2 optical coatings with tunable index and their response to intense subpicosecond laser pulse irradiation*, Appl.Phys.Lett.93(2008) 261903

Books and book chapters (recent):

1. M. Mero, J. Zeller, W. Rudolph: *Ultrafast processes in highly excited dielectric thin films*, in Femtosecond Laser Spectroscopy (Ed. P. Hannaford), Springer 2005
2. J.-C. Diels and W. Rudolph: *Ultrashort Laser Pulse Phenomena – Fundamentals, Techniques and Applications on a Femtosecond Time Scale*, Academic Press 1996, second edition September 2006
3. M. Lenzner, W. Rudolph: *Laser induced optical breakdown in solids*, in Strong-Field Laser Physics (Eds. T.Brabec, F.Krausz) Springer 2008

5 most significant refereed publications

1. S. Prasad and S. R. Kulkarni, ``Noise in Optical Synthesis Images 1: Ideal Michelson Interferometers," J. Opt. Soc. Am. A **6**, pp.1702-1714 (1989)
2. S. Prasad, "Information Optimized Phase Diversity Speckle Imaging," Opt. Lett. **29**, pp. 563-565 (2004)
3. S. Prasad, T. Torgersen, V. P. Pauca, R. Plemmons, and J. van der Gracht, "High-Resolution Imaging Using Integrated Optical Systems," Int. J. Imaging Syst. Technolog. **14**, pp. 67-74 (2004)
4. S. Prasad, "Digital Superresolution and the Generalized Sampling Theorem," J. Opt. Soc. Am. A **24**, pp. 311-325 (2007)
5. S. Prasad and X. Luo, "Support-Assisted Optical Superresolution of Low-Resolution Image Sequences: The One-Dimensional Problem," Opt. Express **17**, pp. 23213–23233 (2009)

Prizes/awards/honors

2009 UNM's Outstanding Teacher of the Year Award
2009 UNM Presidential Teaching Fellow (nominee)
2008 UNM's Presidential Teaching Fellow (nominee)
2004 Fellow of the Optical Society of America
1997 Excellence in Teaching Award, Physics and Astronomy, UNM
1994 UNM Regents' Lecturer
1994 AFOSR Summer Faculty Research Fellow
1982 Harvard's Russell Fellowship

Students (PhD, masters, honors undergraduate) and postdocs supervised

Ph.D.

Bart Abbott (1991); Lee-Zhung Wang (1992); Victor Gamiz (1995); Lilly Bakalis (1996); David Tyler (2000); Carl Tuttle (2000); Wei Guo (2000); Douglas Hope (2004); S. Narravula (in progress)

M.S.

Pablo Reyes (2007-2009, not completed)

Post-doctoral

Gianfranco Gentile (2005-7), Joseph Helmboldt (2005-6), Douglas Hope (2008-present)

Research Grants

1. "Information Theoretic Studies and Assessments of Space Object Identification (ITS-A-SOI)," AFOSR's PROTEA program; $1M from July 1, 2009 to June 30, 2014.
2. "Combining Imaging and Non-imaging Observations for Improved SOI," AFOSR Discovery Challenge Thrusts (DCT) program; $600K from Feb 1, 2008 to Jan 31, 2011.
3. "A Practical Enhanced Resolution Integrated Optical Digital Imaging Camera System (PERIODIC)," funded by DTO; $1M from Mar 1, 2005 to Jan 15, 2008.
4. "EVITA: Enhancements via Information Theoretic Analysis," funded by Boeing LTS, Maui, $200K from Aug 2004 to Sep 2009.
5. "Sparse Representation and Compressed Sensing of Image Data," funded by the Army Research Laboratory under their AS-CTA program for $150K from Oct 2005 to May 2007.

Mansoor Sheik-Bahae

Professor

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University of New Mexico, MSC07-4220
Albuquerque, NM, 87131

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Web: www.optics.unm.edu/sbahae/

Education:

Ph.D. Electrical Engineering (Electro-Physics), 1987
State University of New York (SUNY) at Buffalo
B.S. Electrical Engineering, 1980, *Summa Cum Laude*
Catholic University of America, Washington D.C.

Employment History:

5/05-now	Professor, Department of Physics and Astronomy, and Department of Electrical and Computer Engineering, University of New Mexico, Albuquerque, NM
8/94-5/05	Assistant and Associate Professor, Department of Physics and Astronomy University of New Mexico, Albuquerque, NM
5/87 - 8/94	Research Scientist and Associate Research Professor, CREOL, University of Central Florida, Orlando, Florida

Concurrent Appointments & Positions:

- Director of Consortium for Laser Cooling in Solids (*CLCS*) 2004-present
- General Chair of Optical Science and Engineering (OSE) program at UNM. 2001-2009

Awards and Recognitions:

- First author on the most cited paper in the IEEE-JQE history (LEOS 2007)
- *OSA Fellow* (2000)
- 1996 *NSF-CAREER award*
- 1990 *Engineer of the Year Award,* IEEE/LEOS (Orlando, Florida)

Professional Services and Positions:

UNM: Director of Consortium for Laser Cooling in Solids (*CLCS*) 2004-present (UNM), General Chair of Optical Science and Engineering (OSE) program at UNM. 2001-2009, Co-Chair 2009-present. Member of Graduate Committee, Long Range Planning Committee, Optics Exam Committee, Colloquium Committee at the Department of Physics and Astronomy.

National and International: Chair of SPIE Photonics West conference on Laser Cooling on Solids (2007-2010), Member of program subcommittee *Nonlinear Optics* for QELS 2006, Chair of CLEO subcommittee on *Application of Nonlinear Optics* 2002 and 2003. Member of IEEE-LEOS Program Committee on *Nonlinear Optics, 2003,* Member of OSA's Book Publishing Committee, 2003, Member of OSA's Web Committee, 2003, Member of OSA's Holonyak Award Committee, 2004-2006,

Former Graduate Students and Postdocs: Dr. Chad Hoyt (Bethel Univ., PhD student), Dr. Babak Imangholi (Univ. Ariz., PhD student and postdoc), Dr. Joachim Zeller (Univ. Kaiserslauthern, PhD student), Dr. Wendy Patterson (UNM, PhD Student), Dr. Daniel Bender (Sandia Nat. Lab., PhD student), Dr. Wendy Patterson (UNM, Chem. Eng., PhD Student), MS Student: Toshi Hyrayama, Brook Jilek, Venkat Venkupuram. Dr. Michael Hasselbeck (Research Scientist, current), Dr. Mahenra Shakya (Postdoc- current), Dr. Anca Mocofanescu (Univ. of Boston, former Postdoc). **Currently supervising 6 graduate students.**

4. J. Thomas, W. Rudolph: *Biological Microscopy with Ultrashort Laser Pulses* in Tunable Laser Sources (Ed. F. Duarte), Taylor & Francis, 2008

Awards:

- Gustav Hertz Prize of the National Physical Society (1988)
- Prize of the Faculty of Natural Science (1989)
- Fellow of the Optical Society of America
- Regents' Professor, 2006

Students and postdocs:

PhD: V. Petrov, P. Heist, D. van Lap, M. Kempe, J. Nicholson, J. Jasapara, R. Teehan, J. Glassman, J. Bienfang, M. Mero, X. Liu,
current: A. Ratanavis (Dec.09), Z. Sun, D. Nguyen, C. Rodriguez, N. Zameroski, S. Kasarla, R. Weber
MS thesis: J. Krueger, J. Deitche, A. Thon, M. Magnor, R. Stock, T. Rau, C. Kletecka, M. Schormeyer, S. Green, C. Wolpert, A. Schwarz, R. Weber
Postdocs: J. Zeller, J. Nicholson, M. Mero, I. Cravetchi, N. Campbell, P. Straka, Juanlin Liu, V. Nampoothri, A. Sabbah, Z. Liu, Z. Wang, L. Emmert,

Grants (active during past five years):

- 2001-2005: PI (DoD) *Femtosecond Laser Pulse – Material Interactions*, $560K,
- 2001-2007: PI (NSF) *Cross-disciplinary Optics Research and Education* (IGERT-grant), $2.8 Mio
- 2006 -2007: PI (DTRA/ARA): *Laser induced breakdown spectroscopy*, $190K
- 2005-2010: PI MURI (DoD) *Optically pumped Atomic and Molecular Lasers*, $2.5Mio
- 2007-2010: PI (ONR) *Dielectric breakdown in thin films*, $650K
- 2007-2012: CoPI MURI (ONR, JTO) *Dielectric breakdown in optical coatings*, $2.5 Mio
- 2008-2009: PI (ARO) *Development of IR spectrometer*, $95K
- 2008-2011: PI (ONR) *Stand-off spectroscopy using fs filaments*, $750K
- 2007-2010: PI (NSF) *Multi-wavelengh fs laser pulse source*, $280K
- 2008-2009: PI (ARO) *CW UV from diode lasers*, $50K

Courses Taught at UNM (past five years):

Optical Spectroscopy (569), Laser Physics I (464), Optics Laboratory (476L and 477L), Laser Physics II (564), Advanced Optics I (471), Advanced Optics II (554), Solid State Physics (430), Optics (302)

Service (recent):

- Assoc. Dept. Chair for graduate Studies (2002 – present)
- Dept Chair, Fall 2007
- Chair, Mini-Symposium (Femtosecond Laser Damage) at the Boulder Damage Conference 2009
- Member Faculty Senate Graduate Committee
- Member (long-range plan committee, graduate committee, various adhoc committees)

James Louis Thomas

Education

Stanford University, Stanford, CA	B.S., Honors		Physics
Cornell University, Ithaca, NY	M.S.		Physics
Cornell University, Ithaca, NY	Ph. D.		Physics

Professional appointments

Associate Professor, Physics and Astronomy, University of New Mexico 7/2007 – present.
Assistant Professor, Physics and Astronomy, UNM, 8/2003 – 7/2007.
Assistant Professor, Chemical Engineering, Columbia University, 8/1996 – 7/2003
Postdoctoral Researcher; Polymer Science and Engineering, UMASS Amherst, 9/1991-7/1995

Classes taught last 5 years

Graduate/Undergraduate Optics Laboratory
Advanced Optics II
Biophysics Seminar, Optics Seminar
Complete Freshman / Sophomore Physics Series and associated problems courses:
I. Mechanics, II. E&M+Thermodynamics, III. Optics, Special Relativity, and Quantum Mechanics.

Service

Chair, Optical Science and Engineering Qualifying Examination Committee
Optical Sciences Graduate Committee
Co-organizer (with John McGraw) of P&A Departmental Research Retreat, 2006
Reviewer for *Langmuir, J. Controlled Release, Adv. Functional Materials, Biomaterials, Biomacromolecules, Biophys. J., J. Phys.D, ChemPhysChem, J. Phys. Cond. Matter.*

5 Most Significant Publications

1. "Photobleaching resistance of stimulated parametric emission in microscopy," Optics Letters 34, 304-306. X. Liu, W. Rudolph, J.L. Thomas. 2009.
2. "ERK nuclear translocation is dimerization-independent but controlled by the rate of phosphorylation," Journal of Biological Chemistry, *in press* 2010. D.S. Lidke, F. Huang, J.N. Post, B. Rieger, J.L. Thomas, J. Pouysségur, T.M. Jovin, P. Lenormand.
3. "Receptor aggregation by intermembrane interactions: A Monte Carlo study." G.M. Fricke, J.L Thomas. Biophysical Chemistry 119(2): 205-211. 2006.
4. "Factors affecting responsivity of liposomes to 20 kHz ultrasounnd." H-Y. Lin, J.L. Thomas. Langmuir, 20 (15): 6100-6106. 2004.
5. "Large-scale co-aggregation of fluorescent lipid probes with cell surface proteins." James Thomas, David Holowka, Barbara Baird, and Watt Webb. J. Cell Biol. 125, 795-802. 1994.

Students

Stavroula Sofou, currently assistant professor of Chemical and Biological Engineering, Polytechnic University of New York.

Hung-Yin Lin, currently assistant professor of Chemical and Materials Engineering, National University of Kaohsiung, Kaohsiung Taiwan.

Kathrin Spendier (honors undergraduate, UNM; current PhD candidate, Thesis "Exptl and Theoretical Investigation of Receptor Aggregation on Cell Surfaces.")

Classes Taught (last 5 Years): Optics (undergraduate), Laser Physics(I&II), Advance Optics (I &II), Nonlinear Optics, Seminar Courses.

SIGNIFICANT TECHNICAL AND SCIENTIFIC CONTRIBUTIONS:

- Invented and named the Z-scan technique (with Van Stryland and other co-workers at UCF). Z-scan is a sensitive and powerful experimental method for absolute measurement of optical nonlinearities of materials.
- Developed a simple, comprehensive quantum mechanical theory for predicting the ultrafast electronic optical nonlinear coefficients of semiconductors. This work required a better understanding and formulation of the Kramers-Kronig transformation as applied to nonlinear optics (with Van Stryland and other co-workers at UCF).
- Performed pioneering work on the physics, measurement, and applications of the cascaded second-order nonlinearities (with co-workers at UCF).
- Developed the MOSAIC technique (and algorithm) together with the Kerr-Lens-Autocorrelation method for ultrashort laser pulse characterization. This resulted in the issuance of a U.S. Patent (6,108,085). This has been extended to real-time E-field reconstruction.
- Have made key theoretical and experimental contributions toward the goal of laser cooling in semiconductors. Demonstrated the first optical cryocooler (Nature Photonics, 2010). Co-inventor of the "nano gap thermal barrier" for solving the luminescence trapping problem. (U.S. Patent # 6,378,321).

Publication Summary: 3 *edited books, 8 book chapters, 100 journal publications (12 invited), >130 presentations at the meetings (37 invited), 3 US patents,* **Number of Citations > 4500 , H-index=28**

1. R. I. Epstein and M. Sheik-Bahae, Optical Refrigeration: Science and Applications of Laser Cooling of Solids, Wiley-VCH, ISBN-10: 3527408762 (2009)
2. M. Sheik-Bahae and R.I. Epstein, "Optical Refrigeration: Advancing toward an all-solid-state cryocooler", Invited Progress Article, Nature Photonics, Vol. 1, 693-699 (2007).
3. D. Seletiskiy, M. Sheik-Bahae, et al. "Laser Cooling to Cryogenic Temperatures", Nature Photonics, to be published (March 2010)
4. D. Bender, M.P. Hasselbeck, and M. Sheik-Bahae, "Sensitive ultrashort pulse chirp measurement," Opt. Lett. Vol. **31**, 122-124 (2006).
5. M.P. Hasselbeck, D. Seletskiy, L. R. Dawson, and M. Sheik-Bahae, "Direct observation of Landau damping in a solid state plasma", Phys. Stat. Solidi (c), Vol. 5, 253-256 (2008).
6. M. Sheik-Bahae and R. I. Epstein, "Can Laser Light Cool Semiconductors?, Phys. Review Lett. . **92**, 247403 (2004

Grants Summary: Total ≈ $ 11,000,000 (since 1995)

- NSF: $3.6M (CAREER, IGERT, MRI, and regular grants)
- AFOSR $5.2M (MURI, DURIP, HSI, and regular grants)
- NASA $ 0.9 M
- DTRA $0.92 M
- LANL/ Univ. of California: $ 0.3M
- NATO

Personal: US Citizen, Married, DOB: 1956