

## Mansoor Sheik-Bahae

### Professor

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### Educational History:

Ph.D. Electrical Engineering (Electro-Physics), 1987  
*State University of New York (SUNY) at Buffalo*

M.S. Electrical Engineering, 1982  
*Catholic University of America, Washington D.C.*

B.S. Electrical Engineering, 1980, *Summa Cum Laude*  
*Catholic University of America, Washington D.C.*

### Employment History :

6/05- now Professor, Department of Physics and Astronomy,  
and Department of Electrical and Computer Engineering  
University of New Mexico, Albuquerque, NM

3/99- 5/05 Associate Professor, Department of Physics and Astronomy,  
University of New Mexico, Albuquerque, NM

8/94- 3/99 Assistant Professor, Department of Physics and Astronomy,  
University of New Mexico, Albuquerque, NM

9/90 - 8/94 Associate Research Professor, Center for Research and Education in Optics  
and Lasers (CREOL), University of Central Florida, Orlando, Florida

### Awards:

- ◆ *OSA Fellow* (2000)
- ◆ 1996 *NSF-CAREER award*
- ◆ 1990 *Engineer of the Year Award*, IEEE/LEOS (Orlando, Florida)

### Professional Service:

- Chair of *Optical Science and Engineering Program* University of New Mexico (03-now)
- Member of the Executive Organizing Committee (SPIE- Photonics West- LASE), 07,08
- Conference co-chair (Laser Cooling in Solids, SPIE- Photonics West) 07,08
- Chair and member of program subcommittee *Applications of Nonlinear Optics* for CLEO 99-04
- Member of the OSA's *New Focus Student Award* Committee, 1998 and 1999.
- Member of OSA's Book Publishing and OSA's Web Committees, 2003
- Member of OSA's Holonyak Award Committee, 2004, 2005.
- Member of IEEE-LEOS Program Committee on *Nonlinear Optics*, 2003
- Referee for *Applied Physics Letters*, *Optics Letters*, *IEEE Journal of Quantum Electronics*, *Journal of Optical Society of America (B)*, *Optics Communications*, *Applied Optics*, *Optical and Quantum Electronics*. Referee for *NSF, Research Cooperation*.

**Personal:** US Citizen, Married, DOB: 1956

## **SIGNIFICANT TECHNICAL AND SCIENTIFIC CONTRIBUTIONS:**

- Invented and named the Z-scan technique. Z-scan is a sensitive and powerful experimental method for absolute measurement of optical nonlinearities of materials. This technique and its mathematical analysis were published in a series of nine original papers by myself and co-workers. Z-scan is now being used extensively in many universities and research institutes around the world. It is also described and analyzed in most text books in nonlinear optics. According to the August 2006 SciSearch citation index, the collection of papers I authored on Z-scan have been cited more than 2000 times. One of these papers (IEEE/JQE/1990) has been named the most cited paper of JQE history (2007). It was reprinted in an SPIE's Milestone Series of Selected Reprints on *Ultrashort Laser Pulse Bioeffects*, edited by William P. Roach, Thomas E. Johnson (2003)
- 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. The theory gives a universal and consistent relationship between absorptive and refractive components of the nonlinear coefficients in optical solids. This has proven to be of great importance in device applications such as ultrafast all-optical switching and sensor protection. There are seven papers authored by myself and co-authors on this subject, which have been cited 800 times as of August 2006 (SciSearch).
- Performed pioneering work on the physics, measurement, and applications of the cascaded second-order nonlinearities. The definitive papers on this topic were authored by myself and co-workers and have been cited 900 times (SciSearch, Aug. 2003).
- Developed the MOSAIC algorithm together with the Kerr-Lens-Autocorrelation experimental technique for ultrashort laser pulse characterization. This resulted in the issuance of a U.S. Patent (6,108,085). This technique has recently been adapted to perform femtosecond electric-field reconstruction from a single autocorrelator. A domestic company (Femtochrome, Berkeley, CA) and a German company (APE) are exploring commercial development of this algorithm in their autocorrelators.
- Have made key theoretical and experimental contributions toward the goal of laser cooling in semiconductors. I have developed a theory of laser-cooling in semiconductors for arbitrary external efficiency (PRL, 2004) and am a co-inventor of the "nano gap thermal barrier" for solving the luminescence trapping problem. (U.S. Patent # 6,378,321).

## **Recent Research RECOGNITIONS:**

- Elected Fellow of the Optical Society of America (OSA) in 2000 for "Invention of Z-Scan" and for "Insight into the Application of Causality in Nonlinear Optics".
- Results of research on laser cooling of solids published in the journal *Physical Review Letters* (17, 3600, 2000) was highlighted in the renowned science magazine *Nature* (News and Views, May 2000).
- PhD student Chad Hoyt won a prestigious *New Focus Student Award* at the annual meeting of the Optical Society of America in 2000. His work on optical refrigeration earned the top prize of \$10,000. Nearly 100 students from top institutions in the US and abroad compete in this program each year. *For more current information on our research efforts, see [www.optics.unm.edu/sbahae/](http://www.optics.unm.edu/sbahae/)*

**Past Graduate Students, Research Staff and Postdocs:**

<b>Name</b>	<b>Degree (Year)</b>	<b>Current Status</b>	<b>Contact</b>
Chad W. Hoyt	Ph.D. (2003)	Bethel College, Tenured Track Faculty	<a href="mailto:hoycha@bethel.edu">hoycha@bethel.edu</a>
Joachim Zeller	Ph.D. (2004)	Staff Scientist, Faro Technologies, GmbH (Germany)	<a href="mailto:Joachim.Zeller@physik.uni-karlsruhe.de">Joachim.Zeller@physik.uni-karlsruhe.de</a>
Babak Imangholi	Ph.D. (2006)	Postdoctoral Position, University of New Mexico	<a href="mailto:babak@unm.edu">babak@unm.edu</a>
Venkat Vankipuram	M.S. (2005)	Technical Staff, Industry (Atlanta)	
Toshi Hirayama	M.S. (2004)	Ph.D. Student, Holland	
Michael P. Hasselbeck	Res. Scientist 2001-current		<a href="mailto:mph@unm.edu">mph@unm.edu</a>
Babak Imangholi	Postdoc 2006-current		<a href="mailto:babak@unm.edu">babak@unm.edu</a>
Anca Mocofanescu	Postdoc 2004-2005	BWH, Harvard University, Boston MA	<a href="mailto:amocofanescu@rics.bwh.harvard.edu">amocofanescu@rics.bwh.harvard.edu</a>

## Research Funding (at UNM)

**Total > \$ 10,000,000 since 1995**

Project Title: "Cascading Nonlinear Effects in Synchronously-Pumped Optical Oscillators"

Principal Investigators: M. Ebrahimzadeh, M. Sheik-Bahae

Funding Organization: North Atlantic Treaty Organization (NATO)

Duration: 1995-1996

Amount: \$10,000

Project Title: "Investigation of femtosecond dynamics and optical switching in active semiconductors"

Principal Investigators: M. Sheik-Bahae

Funding Organization: National Science Foundation (CAREER Award Program)

Duration: 1996-2000

Amount: \$210,000

Project Title: "Development of Ultrafast High Power IR-UV Laser Source"

Principal Investigators: W. Rudolph, J.C. Diels, and M. Sheik-Bahae

Funding Organization: National Science Foundation (ARI Instrumentation Program)

Duration: 1996-1999

Amount: \$270,000

Project Title: "Optical Refrigeration in Semiconductors"

Principal Investigators: M. Sheik-Bahae

Funding Organization: University of California/Los Alamos National Laboratory

(NUCOR- program)

Duration: 1997-2000

Amount: \$165,000

Project Title: "Acquisition and Upgrading of Equipment: Supplement to CAREER Grant"

Principal Investigators: M. Sheik-Bahae

Funding Organization: National Science Foundation

Duration: 1999-2000

Amount: \$60,000

Project Title: "Optical Refrigeration Research"

Principal Investigators: M. Sheik-Bahae

Funding Organization: Los Alamos National Lab.

Duration: 2000-2003

Amount: \$150,000

Project Title: " Instrument Acquisition for Ultrafast Spectroscopy and Imaging"

Principal Investigators: M. Sheik-Bahae

Funding Organization: National Science Foundation

Duration: 1999-2003

Amount: \$144,578

Project Title: "Investigation of Ultrafast Coherent Current Control in Large and Small Gap Semiconductors: Theory and Experiments"

Principal Investigators: M. Sheik-Bahae

Funding Organization: National Science Foundation

Duration: 2001-2004

Amount: \$240,000

Project Title: " Solid-State Optical Refrigerators for Space Missions"

Principal Investigators: R. I. Epstein, M. Sheik-Bahae

Funding Organization: NASA  
Duration: 2000-2003  
Amount: \$900,000

Project Title: "IGERT: Cross-disciplinary Optics Research and Education (CORE)"  
Principal Investigators: W. Rudolph, M. Sheik-Bahae, S. Stricker, J. Brozik, G. Lopez  
Funding Organization: National Science Foundation  
Duration: 2001-2007  
Amount: \$2,435,000

current

Project Title: " All Solid-State Optical Cryocoolers ”  
Principal Investigators: M. Sheik-Bahae and R. I. Epstein  
Funding Organization: AFOSR (HSI program)  
Duration: 2001-2004  
Amount: \$500,000

Project Title: "Laser Cooling of Optical Solids and Semiconductors”  
Principal Investigators: M. Sheik-Bahae  
Funding Organization: AFOSR  
Duration: 2001-2004  
Amount: \$344,000

Project Title: " Instrumentation for All-Solid-State Optical Cryocooler Project”  
Principal Investigators: M. Sheik-Bahae  
Funding Organization: AFOSR  
Duration: 2003-2005  
Amount: \$145,000

Project Title: " Consortium for Laser Induced Cooling in Solids (CLICS)”  
Principal Investigators: M. Sheik-Bahae  
Funding Organization: MURI Program /AFOSR  
Duration: 2004-2009  
Amount: \$4,000,000

current

Project Title: "Investigation of Novel Glass Scintillators for Gamma-ray Detection”  
Principal Investigators: M. Sheik-Bahae  
Funding Organization: DTRA  
Duration: 2006-2009  
Amount: \$460,000

current

Project Title: "Instrumentation for All-Solid-State Optical Cryocooler Project ”  
Principal Investigators: M. Sheik-Bahae  
Funding Organization: DURIP Program /AFOSR  
Duration: 2006-2007  
Amount: \$161,000

current

## • PUBLICATIONS

Summary: Total: >240  
8 book chapters  
100 journal publications (12 invited),  
130 presentations at the meetings (37 invited)  
3 US patents

### **Number of Citations > 4000**

Compiled from LANL's SciSearch as of Dec. 2006

#### **Invited Book Chapters:**

1. Characterization and Modeling of Nonlinear Optical Absorption and Refraction, E.W. Van Stryland, M. Sheik-Bahae and D.J. Hagan, in *Nonlinear and Quantum Optics*, ed. N. Bloembergen, pp. 527-578, Research Trends in Physics Series, Institute for Advanced Studies Press, 1997.
2. Z-scan Technique for Materials Characterization, Eric Van Stryland and M. Sheik-Bahae, in *Materials Characterization and Optical Probe Techniques, Critical Reviews of Optical Science and Technology*, Vol. CR69, 501-524, SPIE 1997.
3. Nonlinear Optics of Bound-Electrons in Solids, M. Sheik-Bahae, in *IMA Volumes in Mathematics and Applications*, ed. J.V. Moloney, Volume 101, page 205-220, Springer-Verlag, 1998
4. Z-Scan, E. W. Van Stryland and M. Sheik-Bahae, , in *Characterization Techniques and Tabulations for Organic Nonlinear Materials*, M. G. Kuzyk and C. W. Dirk, Eds., page 655-692, Marcel Dekker, Inc., 1998
5. Optical Nonlinearities in the Transparency Region of Bulk Semiconductors, M. Sheik-Bahae and E.W. Van Stryland, in *Nonlinear Optics of Semiconductors*, E. Garmire and A. Kost, Eds., Volume 58 of Semiconductor and Semimetals, pp. 257-318, Academic Press (1998)
6. Third Order Optical Nonlinearities, M. Sheik-Bahae and M. P. Hasselbeck, in *OSA Handbook of Optics*, Vol. IV, pp 17.3-17.38, McGraw-Hill, 2001
7. Nonlinear Refraction, M. Sheik-Bahae, in *Encyclopedia of Optical Engineering*, Dekker, (2003) ISBN: 0-8247-4258-3
8. Nonlinear Optics Basics: Kramers-Krönig Relations in Nonlinear Optics, M. Sheik-Bahae, in *Encyclopedia of Modern Optics*, edited by Robert D. Guenther, Duncan G. Steel and Leopold Bayvel, Elsevier, Oxford, 2004, ISBN 0-12-227600-0.

## Patents:

1. *Interferometric Auto-Correlator Using Third-Order Nonlinearity*  
U.S. Patent #6,108,085; 2000; M. Sheik-Bahae
2. *Semiconductor-Based Optical Refrigerator*  
U.S. Patent #6,378,321; 2002; R. I. Epstein, B. C. Edwards, and M. Sheik-Bahae
3. *Evanescent-Wave Subcavity Active Mirrors*, Patent Pending

## Refereed Journal Publications:

1. M. Sheik-Bahae, H.S. Kwok, "Characterization of a picosecond CO<sub>2</sub> laser system", Appl. Opt. 24, 666 (1985).
2. M. Sheik-Bahae, P. Mukherjee, and H.S. Kwok, "Two-photon and three-photon absorption coefficients in InSb," J. Opt. Soc. Am. B, 3, 379 (1986).
3. M. Sheik-Bahae, H.S. Kwok, "The frequency spectrum of Optical Free Induction Decay ultrashort CO<sub>2</sub> laser pulses," Appl. Opt. 25, 3333 (1986).
4. P. Mukherjee, M. Sheik-Bahae, H.S. Kwok, "New method of measuring relaxation times in semiconductors and metals," Appl. Phys. Lett. 46, 770(1985).
5. M. Sheik-Bahae, M.P. Hasselbeck, H.S. Kwok, "High intensity CO<sub>2</sub> laser interaction with InSb," J. Opt. Soc. Am. B 3, 1082(1986).
6. M. Sheik-Bahae, H.S. Kwok, "Picosecond CO<sub>2</sub> laser induced self-defocusing in InSb," IEEE J. Quantum Electron. QE-23, 1974 (1987).
7. M. Sheik-Bahae, T. Rossi, H.S. Kwok, "Frequency dependence of the two-photon absorption coefficient in InSb: tunneling effects," J. Opt. Soc. Am. B 4, 1964 (1987).
8. M. Sheik-Bahae, H.S. Kwok, "Controlled CO<sub>2</sub> laser melting of Silicon," J. Appl. Phys. 63, 518 (1987).
9. M. Sheik-Bahae, H.S. Kwok, "Dynamic reflectivity switching of infrared lasers by an inhomogeneous plasma," Opt. Lett. 12, 702 (1987).
10. H.S. Kwok, P. Mukherjee, and M. Sheik-Bahae, "Ultrashort Laser Pulse Duration Dependent Free Carrier Absorption in Thin Gold Films," Phys. Lett. A, 122, 191(1987).
11. M. Sheik-Bahae, A.A. Said, and E.W. Van Stryland, "High Sensitivity, Single Beam n<sub>2</sub> Measurements," Opt. Lett. 14, 955-957 (1989).
12. M. Sheik-Bahae, A.A. Said, T.H. Wei, D.J. Hagan, and E.W. Van Stryland, "Sensitive Measurement of Optical Nonlinearities Using a Single Beam," IEEE Journal of Quantum Electronics, QE-26, 760-769 (1989).

13. M. Sheik-Bahae, D.J. Hagan, and E.W. Van Stryland, "Dispersion and Band-Gap Scaling of the Electronic Kerr Effect in Solids Associated with Two-Photon Absorption", *Phys. Rev. Lett.* 65, 96(1990).
14. (Invited) M.J. Soileau, T.H. Wei, M. Sheik-Bahae, D.J. Hagan, Martine Sence, and E.W. Van Stryland, "Nonlinear Optical Characterization of Organic Materials", *Mol. Cryst. Liq. Cryst.* 207, 97-101(1991).
15. M. Sheik-Bahae, A.A. Said, D.J. Hagan, and E.W. Van Stryland, "Nonlinear Refraction and Optical Limiting in Thick Media," *Opt. Eng.* 30, 1228(1991).
16. (Invited) P. Palffy-Mulhoray, H.J. Yuan, L. Li, M.A. Lee, J.R. DeSalvo, T.H. Wei, M. Sheik-Bahae, D.J. Hagan, and E.W. Van Stryland, "Measurements of Third Order Nonlinearities of Nematic Liquid Crystals", *Mol. Cryst. Liq. Cryst.* 207, (1991).
17. M. Sheik-Bahae, D.C. Hutchings, D.J. Hagan, and E.W. Van Stryland, "Dispersion of Bound Electronic Nonlinear Refraction in Solids," *IEEE J. Quantum Electron.* QE-27, 1296(1991).
18. (Invited) D.C. Hutchings, M. Sheik-Bahae, D.J. Hagan, and E.W. Van Stryland, "Kramers-Kronig Relations in Nonlinear Optics", *Optical and Quantum Electronics, Tutorial Review* 24, 1-30 (1992).
19. A. A. Said, M. Sheik-Bahae, D.J. Hagan, T.H. Wei, J. Wang, J. Young, E.W. Van Stryland, "Determination of Bound and Free-Carrier Nonlinearities in ZnSe, GaAs, CdTe, and ZnTe," *J. Opt. Soc. Am. B.* 9, 409 (1992).
20. R. DeSalvo, D.J. Hagan, M. Sheik-Bahae, G. Stegeman, H. Vanherzeele, E.W. Van Stryland, "Self-focusing and Defocusing by Cascaded Second Order Effects in KTP," *Opt. Lett.* 17, 28 (1992).
21. M. Sheik-Bahae, J. Wang, J.R. DeSalvo, D.J. Hagan, E.W. Van Stryland, "Measurement of Nondegenerate Nonlinearities Using a Two-Color Z-scan," *Opt. Lett.* 29, 258(1992).
22. M. Sheik-Bahae, D.C. Hutchings, D.J. Hagan, E.W. Van Stryland, "Universal Dispersion and Band-Gap Scaling of  $n_2$  in Solids," *Optics and Photonics News*, vol. 2, pp. 22, December 1991.
23. M. Sheik-Bahae, R. DeSalvo, D.J. Hagan, G. Assanto, G.I. Stegeman, E.W. Van Stryland, "Nonlinear Phase Shifts Using Second Order Nonlinearities," *Optics and Photonics News*, Vol.3, pp. 11, Dec. 1992.
24. E.W. Van Stryland, M. Sheik-Bahae, A.A. Said, D.J. Hagan, "Characterization of Nonlinear Optical Absorption and Refraction," *Prog. Crystal Growth and Charact.* 27, 279-311 (1993).
25. R. DeSalvo, M. Sheik-Bahae, A.A. Said, D.J. Hagan, E.W. Van Stryland, "Z-scan Measurement of the Anisotropy of Nonlinear Refraction and Absorption in Crystals," *Opt. Lett.* 18, 194-197 (1993).
26. G.I. Stegeman, M. Sheik-Bahae, E.W. Van Stryland, "Large Nonlinear Phase Shifts in Second Order Nonlinear Optical Processes," *Opt. Lett.* 18, 13-15(1993).



27. G. Assanto, G.I. Stegeman, M. Sheik-Bahae, E.W. Van Stryland, "All Optical Switching Devices Based on Large Nonlinear Phase Shifts from Second Harmonic Generation," *Appl. Phys. Lett.*, **62**, 1323-1325 (1993)
28. M. Sheik-Bahae, J. Wang, E.W. Van Stryland, "Nondegenerate Optical Kerr Effect in Semiconductors," *IEEE J. Quantum Electron.* **QE-29**, 30, 249-255 (1994).
29. T. Xia, D.J. Hagan, M. Sheik-Bahae, and E.W. Van Stryland, "Eclipsing Z-scan Measurements of  $\lambda/10^4$  Wavefront Distortion," *Opt. Lett.* **19**, 317-319 (1994).
30. J. Wang, M. Sheik-Bahae, A.A. Said, D.J. Hagan, E.W. Van Stryland, "Time-Resolved Z-scan Measurements of Optical Nonlinearities," *J. Opt. Soc. Am. B.* **11**, 1009-1017(1994).
31. J.U. Kang, A. Villeneuve, M. Sheik-Bahae, G.I. Stegeman, K. Al-hemyari, J.S. Aitchison, C.N. Ironside, "Limitation Due to Three Photon Absorption on Useful Spectral Range for Nonlinear Optics in AlGaAs Below Half Bandgap," *Appl. Phys. Lett.* **65**, 147-149 (1994).
32. T. Xia, M. Sheik-Bahae, A.A. Said, D. J. Hagan, E.W. Van Stryland, "Z-scan and EZ-scan measurements of optical nonlinearities," *International J. Nonlinear Opt. Phys.* **3**, 489-500 (1994).
33. D.J. Hagan, Z. Wang, G. I. Stegeman, E.W. Van Stryland, "Phase-controlled transistor action by cascading of second-order nonlinearities in KTP," M. Sheik-Bahae, G. Assanto, *Opt. Lett.* **19**, 1305-1307 (1994)
34. M. Sheik-Bahae, E.W. Van Stryland, "Ultrafast nonlinearities in semiconductor laser amplifiers," *Phys. Rev. B*, **50**, 14171-14178 (1994).
35. C.A. Aversa, J.E. Sipe, M. Sheik-Bahae, E.W. Van Stryland, "Third-order optical nonlinearities in semiconductors: The two-band model," *Phys. Rev. B*, **50**, 18073-18082 (1994).
36. G. Assanto, G.I. Stegeman, M. Sheik-Bahae, E.W. Van Stryland, "Coherent Interactions for All-Optical Signal Processing via Quadratic Nonlinearities," *IEEE J. Quantum Electron.* **QE-31**, 673-681 (1995).
37. M. Sheik-Bahae, J. Wang, E.J. Canto-Said, R. DeSalvo, D.J. Hagan, and E.W. Van Stryland, "Polarization-dependent four-wave-mixing and two-photon coherence in solids," *IEEE J. Quantum Electron.* **QE-31**, 1270-1273 (1995).
38. R. DeSalvo, A.A. Said, D.J. Hagan, E.W. Van Stryland and M. Sheik-Bahae, "Infrared to Ultraviolet Measurements of Two-Photon Absorption and  $n_2$  in Wide Bandgap Materials," *IEEE J. Quantum Electron.* **QE-32**, 1324-1333 (1996).
39. M. Sheik-Bahae, "Femtosecond Kerr-lens Autocorrelation," *Opt. Lett.*, **22**, 399 (1997).
40. A. A. Said, T. Xia, D.J. Hagan, E.W. Van Stryland and M. Sheik-Bahae, "Nonlinear refraction and absorption in CuCl at 532 nm", *J. Opt. Soc. Am. B-14*, 410 (1997).
41. M. P. Hasselbeck, E.W. Van Stryland, and M. Sheik-Bahae, "Scaling of four-photon absorption in InAs," *J. Opt. Soc. Am. B-14*, 1616 (1997).

42. W. Rudolph, M. Sheik-Bahae, A. Bernstein, L. F. Lester, "Femtosecond autocorrelation measurements based on two-photon photoconductivity in ZnSe," *Opt. Lett.* **22**, 313 (1997).
43. M. P. Hasselbeck, E.W. Van Stryland, and M. Sheik-Bahae, "Dynamic band unblocking and leakage two-photon absorption in InSb", *Phys. Rev.* **B15**, 7395-7403 (1997).
44. M. Sheik-Bahae and M. Ebrahimzadeh, "Measurements of nonlinear refraction in the second-order  $\chi^{(2)}$  materials  $\text{KTiOPO}_4$ ,  $\text{KNbO}_3$ ,  $\beta\text{-BaB}_2\text{O}_4$ , and  $\text{LiB}_3\text{O}_5$ ", *Opt. Comm.* **142**, 294-298 (1997).
45. J. Zeller, W. Rudolph, and M. Sheik-Bahae, "Theoretical and Experimental Investigation of a Quenched Cavity Laser with Saturable Absorber", *Applied Physics B*, **66**, 295-303 (1998).
46. M.P. Hasselbeck, A.A. Said, E.W. Van Stryland, and M. Sheik-Bahae, "Three-photon absorption in InAs", *Optical and Quantum Electronics*, **30**, 193 (1998).
47. Gutierrez, P. Dorn, J. Zeller, D. King, L. F. Lester, W. Rudolph, and M. Sheik-Bahae, "Autocorrelation measurement of femtosecond laser pulses by use of a ZnSe two-photon detector array," *Opt. Lett.*, vol. 24, pp. 1175-1177, 1999.
48. M. Sheik-Bahae, "Quantum Interference Control of Current in Semiconductors: Universal Scaling and Polarization Effects.," *Phys. Rev. B, Rapid Communications*, vol. 60, pp. 11258-11260, 1999.
49. C. W. Hoyt, M. Sheik-Bahae, R. I. Epstein, B. Edwards, J. Anderson "Observation of anti-Stokes fluorescence cooling in Tm-dopes glass", *Phys. Rev. Lett.* Vol. 17, 3600 (2000)
50. J. Zeller, J. Jasapara, W. Rudolph, M. Sheik-Bahae, Spectro-temporal characterization of a femtosecond white-light continuum by transient-grating diffraction, *Opt. Comm.*, **185**, 133-137 (2000).
51. M.P. Hasselbeck, D. Stalnaker, L.A. Schlie, T.J. Rotter, A. Stintz, M. Sheik-Bahae, "Emission of terahertz radiation from coupled plasmon-phonon modes in InAs," *Phys. Rev. B* **65**, 233203 (2002)
52. T. Hirayama, and M. Sheik-Bahae, "Real-time chirp diagnostic in ultrashort laser pulses," *Opt. Lett.* Vol. 27, 860-862 (2002).
53. C. W. Hoyt, M. Sheik-Bahae, M. Ebrahimzadeh, "High-power picosecond optical parametric oscillator based on periodically poled lithium niobate", *Opt. Lett.* **27**, 1543-1546 (2002).
54. Hoyt, C., M. Sheik-Bahae, et al., Advances in laser cooling of thulium-doped glass. *J. Opt. Soc. Am. B* ,. **20**, 1066-1074(2003).
55. B. Imangholi, M. P. Hasselbeck, and M. Sheik-Bahae, "Absorption Spectra of Wide Gap Semiconductors in the Transparency Region" *Opt. Comm.* **227**, 337-341 (2003).
56. Joachim Zeller, Wolfgang Rudolph and Mansoor Sheik-Bahae "Anomalous nonlinear photoresponse in a InGaN/GaN heterostructure" *J. Appl. Phys.*, **95**, 6152 (2004).

57. M. Sheik-Bahae and R. I. Epstein, "Can Laser Light Cool Semiconductors?", *Phys. Review Lett.* . **92**, 247403 (2004).
58. B. Imangholi, M.P. Hasselbeck, and M. Sheik-Bahae. R. I Epstein, S. Kurtz, "Effects of epitaxial lift-off on interface recombination and laser cooling in GaInP/GaAs heterostructures," *Appl. Phys. Lett.* **86**, 81104 (2005)
59. D. Bender, M.P. Hasselbeck, and M. Sheik-Bahae, "Sensitive ultrashort pulse chirp measurement," *Opt. Lett.* Vol. **31**, 122-124 (2006).

**Other Writings (Proceedings):**

1. M. Sheik-Bahae, P. Mukherjee, M.P. Hasselbeck, H.S. Kwok, "High Density Carrier Generation in Indium Antimonide," in *Ultrashort Phenomena IV*, Ed. by D.H. Auston, K.B. Eisenthal (Springer-Verlag, Berlin, 1984), pp.201.
2. P. Mukherjee, M. Sheik-Bahae, and H.S. Kwok, "Pulse Duration Dependence of Free Carrier Absorption in Semiconductors," in "Energy Beam-Solid Interaction and Transient Thermal Processing", D.K. Biegelsen, G.A. Rosgonyi and C.V. Shank, Eds. (North-Holland, Amsterdam, 1985) pp. 97-100.
3. D.J. Hagan, E.W. Van Stryland, Y.Y. Wu, T.H. Wei, M. Sheik-Bahae , A.A. Said, K. Mansour, J. Young, and M.J. Soileau, "Passive Broadband High-Dynamic-Range Semiconductor Limiters", *Proceedings of SPIE volume 1105, Materials for Optical Switches, Isolators, and Limiters*, pp.103-113, Orlando, Florida 1989.
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29. Bender, D. A., Hasselbeck, M. P. and M. Sheik-Bahae. "Measuring the chirp of an ultrashort laser pulse at the noise floor", in Laser Beam Control and Applications. Edited by Kudryashov, Alexis V.; Paxton, Alan H.; Ilchenko, Vladimir S.; Giesen, Adolf; Nickel, Detlef; Davis, Steven J.; Heaven, Michael C.; Schriempf, J. Thomas. Proceedings of the SPIE, Volume 6101, pp. 253-260 (2006)
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34. (Invited) M. P. Hasselbeck, D. V. Seletskiy, M. Sheik-Bahae, and R. Dawson. "Coherent plasmons in InSb", *Proc. of SPIE* Vol. 6118, 61180W (2006).
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38. B. Imangholi, C. Wang, E. Soto, M. Sheik-Bahae, A. Stintz, N. Nuntawong, K. Malloy and R.I. Epstein "Heterostructure Design Optimization for Laser Cooling of GaAs" SPIE Proceedings: Laser Cooling of Solids, San Jose, CA vol. 6461 (2007).
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### **Presentations at Scholarly Meetings:**

#### **A: Invited:**

1. M. Sheik-Bahae, D.J. Hagan and E.W. Van Stryland, "Dispersion of the Electronic  $n_2$  originating from two-photon absorption in semiconductors", OSA Annual Meeting, Orlando FL, 1989.
2. E.W. Van Stryland, M. Sheik-Bahae, D.J. Hagan, T.H. Wei, A.A. Said, J. Young, E. Canto and A. Miller, "Measurement of the Fast Electronic  $n_2$  Associated with Two-Photon Absorption in Semiconductors", Lasers 89, New Orleans, Dec. 1989.
3. E.W. Van Stryland, M. Sheik-Bahae, A.A. Said, T.H. Wei, D.J. Hagan, Y.Y. Wu, and M.J. Soileau, "Sensitive, Single Beam  $n_2$  Measurements", Interdisciplinary Laser Science Conference ILS-V, Stanford, California, Aug. 28-31, 1989.
4. E.W. Van Stryland, D.J. Hagan, M. Sheik-Bahae and M.J. Soileau, "Semiconductor Nonlinearities for Optical Limiting", conference on Nonlinear Optics: Materials, Phenomena and Devices, Kauai, Hawaii, July 16-20, 1990.
5. M.J. Soileau, T.H. Wei, M. Sheik-Bahae, D.J. Hagan, Martine Sence, and E.W. Van Stryland, "Nonlinear Optical Characterization of Organic Materials", III International Topical Meeting on Optics of Liquid Crystals, Optical Properties and Applications of Liquid Crystals and Organic Materials, Cetraro, Italy, Oct. 1-5, 1990.
6. P. Palffy-Mulhoray, H.J. Yuan, L. Li, M.A. Lee, J.R. DeSalvo, T.H. Wei, M. Sheik-Bahae, D.J. Hagan, and E.W. Van Stryland, "Measurements of Third Order Nonlinearities of Nematic Liquid Crystals", III International Topical Meeting on Optics of Liquid Crystals, Optical Properties and Applications of Liquid Crystals and Organic Materials, Cetraro, Italy, Oct. 1-5, 1990.

7. D.J. Hagan, M. Sheik-Bahae, D.C. Hutchings, A.A. Said, T.H. Wei, and E.W. Van Stryland, "Kramers-Kronig Relations for Bound-Carrier (fast) Nonlinearities", Lasers 90, San Diego, Ca., Nov. 1990.
8. M. Sheik-Bahae, "Z-scan", NLO 91, Adelaide, Australia, March 1991.
9. M.J. Soileau, M. Sheik-Bahae, D.C. Hutchings, D.J. Hagan, E.W. Van Stryland, "Wavelength Dependence of Nonlinear Absorption and Refraction in Solids," XIV International Conference on Coherence and Nonlinear Optics, Leningrad, USSR 1991.
10. D.J. Hagan, M. Sheik-Bahae, A.A. Said and E.W. Van Stryland, "Nonlinear Absorption and Refraction Measurements by the Z-scan," Electronic and Glass and Optical Materials Joint Meeting, American Ceramic Society, Crystal City, VA, Oct. 20-23, 1991.
11. E.W. Van Stryland, M. Sheik-Bahae, G. Stegeman, "Characterization of Nonlinear Optical Materials," American Association for Crystal Growth, 4-th Conference, Atlantic City, NJ, Oct. 2-4, 1991.
12. E.W. Van Stryland, M. Sheik-Bahae "Measurement and Theory of Dispersion on  $n_2$  in Solids," 22nd Winter Colloquium on Quantum Electronics, Snowbird, Utah Jan. 5-8, 1992.
13. E.W. Van Stryland, M. Sheik-Bahae, D.C. Hutchings and D.J. Hagan, "Z-scans and Nonlinear Kramers-Kronig Relation," Invited lecture at the International School on Nonlinear Photonics and Optical Physics, Capri, Italy, June 1-5, 1992.
14. G.I. Stegeman, M. Sheik-Bahae, E.W. Van Stryland, "Very Large Third Order Nonlinearities via Cascading of Second Order Effects," IQEC, Vienna, 1992.
15. M. Sheik-Bahae "Ultrafast Nonlinearities in Semiconductor Lasers", , US-Australian Bilateral Workshop on Nonlinear Optics, Cocoa Beach, FL, Aug. 1992.
16. E.W. Van Stryland, G.I. Stegeman, R. DeSalvo, D.J. Hagan, and M. Sheik-Bahae, "Cascading of  $\chi^{(2)}$  for  $\chi^{(3)}$  Nonlinearities," Nonlinear Optics 2nd Topical Meeting, Maui, Hawaii, 1992.
17. E.W. Van Stryland, A.A. Said, and M. Sheik-Bahae, "Z-scan Characterization of Nonlinear Optical Materials," QELS 1993, Baltimore, MD.
18. D.J. Hagan, M. Sheik-Bahae, A.A. Said, and E.W. Van Stryland, "Nonlinear Refraction and Absorption Measurements by the Z-Scan", joint meeting of the Glass and Optical Materials Division and Electronics Division of the American Ceramic Society, Crystal City, VA, Oct. 20-23, 1991.
19. M.J. Soileau, M. Sheik-Bahae, D.C. Hutchings, D.J. Hagan and E.W. Van Stryland, "Wavelength Dependence of Nonlinear Absorption and Refraction in Solids", XIV International Conference on Coherent and Nonlinear Optics, Leningrad, 1991.
20. D.J. Hagan, M. Sheik-Bahae, A.A. Said and E.W. Van Stryland, "Nonlinear Refraction and Absorption Measurements by the Z-Scan", Electronics and Glass and Optical Materials Joint Meeting, American Ceramic Society, Crystal City, Oct. 20-23, 1991.

21. M. Sheik-Bahae, M.J. Soileau and E.W. Van Stryland, "Measurement of Nonlinear Absorption and Refraction of Light by Matter", AAPT Winter Meeting Orlando, FL, 1992.
22. E.W. Van Stryland, M. Sheik-Bahae, D.J. Hagan, "Characterization of Nonlinear Absorption and Nonlinear Refraction in Advanced Optical Materials", OE-LASE '93, Los Angeles, CA, Jan. 18-22, 1993.
23. E. W. Van Stryland, G. Stegeman, M. Sheik-Bahae, J. D. DeSalvo, and D.J. Hagan, "Phase Shifting and Switching Via Cascaded Nonlinearities", 23rd Winter Colloquium on Quantum Electronics, Snowbird, Utah Jan. 5-8, 1993.
24. Eric W. Van Stryland, M. Sheik-Bahae, and D. J. Hagan, "Scaling Laws for Nonlinear Absorption and Refraction in Bulk Semiconductors", Second Workshop on Optical Properties of Mesoscopic Semiconductor Structures, Snowbird, Utah, April 20-23, 1993.
25. E.W. Van Stryland, M. Sheik-Bahae, T. Xia, C. Wamsley, Z. Wang, A.A. Said, and D.J. Hagan, "Ultra-Sensitive Measurement Technique for Thin-Film Nonlinearities", POLYMEX-93, International Symposium on Polymers, Cancun, Mexico, Nov. 1-5, 1993.
26. T. Xia, D.J. Hagan, M. Sheik-Bahae, M.J. Soileau, and E.W. Van Stryland, "Modeling of Z-Scans in the Internal Self-Action Regime", The Volga Laser Tour conference, Saratov to Moscow, Russia, June 25-July 4, 1993.
27. E.W. Van Stryland, M. Sheik-Bahae, A.A. Said, and D.J. Hagan, "Characterization of Nonlinear Optical Materials", 1993 Boulder Damage Conference, 25th anniversary, Boulder, CO, Nov. 1993.
28. P. Li-Kam-Wa, M. Sheik-Bahae, A. Miller, B. Chai, "Self-Modelocked Cr<sup>+4</sup> doped Colquirite Lasers", IEEE Lasers and Electro-Optics Society 1993 Annual Meeting, paper UOE/SSL1.3, San Jose, CA, Nov. 15-18 1993.
29. M. Sheik-Bahae, "Nonlinear Optics of Bound-Electrons in Solids," Plenary Talk at IMA Workshop on Nonlinear Optical Materials, Institute of Mathematics and its Applications, University of Minnesota, March 4-8, 1996.
30. M. P. Hasselbeck, E.W. Van Stryland, and M. Sheik-Bahae, "Dynamic band unblocking and leakage 2PA in InSb", QELS conference, Anaheim, CA 1996.
31. E. W. Van Stryland, R. Negres, E. Miesak, D.J. Hagan, and M. Sheik-Bahae, " $\chi^{(3)}$ 's: Their Characterization and Understanding," Nonlinear Optics '98, Kauai, Hawaii, August 1998.
32. Michael Hasselbeck, Daniel Bender, Stefano Bigotta, James Distel, Richard Epstein, Scott Greenfield, Babak Imangholi, Wendy Patterson, Denis Seletskiy, Mansoor Sheik-Bahae, Jared Thiede, Nima Vadiie, Venkatesh Vankipuram, "Laser Cooling of Infrared Sensors" SPIE, 2004
33. M. Sheik-Bahae "Advances in Laser Cooling of Semiconductors", SPIE Photonics West, San Jose, CA (2006).



34. M. P. Hasselbeck, D. V. Seletskiy, M. Sheik-Bahae, and R. Dawson. "Coherent plasmons in InSb", *SPIE - Photonics West* (San Jose, CA, 21-26 Jan. 2006) paper 6118-33, (2006).
35. M. Sheik-Bahae "Advances in Laser Cooling of Solids", Photonics 2006, Hyderabad, India, (2006)
36. M. Sheik-Bahae "Laser Cooling of Solids", QELS, 2007, Baltimore, MD
37. M. Sheik-Bahae "Laser Cooling of Semiconductors", Fundamental Optical Processes in Semiconductors, Big Sky, MO 2007.

**B: Contributed Conference Papers:**

1. M. Sheik-Bahae, P. Mukherjee, and H.S. Kwok, "Picosecond CO<sub>2</sub> Laser Induced Self-Defocusing in InSb," IQEC, San Francisco, California 1986.
2. M. Sheik-Bahae, A. Tavano, P. Mukherjee, H.S. Kwok, "New Method of Measuring Relaxation Times in Semiconductors," CLEO, Baltimore, Maryland 1985.
3. M. Sheik-Bahae, T. Rossi, and H.S. Kwok, "Tunneling Induced Two-Photon Absorption in InSb" OSA Annual Meeting, Rochester, New York, 1987.
4. D.J. Hagan, E.W. Van Stryland, Jim Young, T.H. Wei, M. Sheik-Bahae, A.A. Said, K. Mansour, and M.J. Soileau, "Passive Broadband High-Dynamic-Range Semiconductor Limits", SPIE's conference 1105 Technical Symposium, Orlando, Florida 1989.
5. M. Sheik-Bahae, A. Said, E.W. Van Stryland, and M.J. Soileau, "Thermal Lensing in CS<sub>2</sub> at 10  $\mu\text{m}$ ," Annual Meeting of the Optical Society of America, Santa Clara, Ca., 1988.
6. E.W. Van Stryland, M. Sheik-Bahae, D.J. Hagan, "Sensitive n<sub>2</sub> Measurement and Relation of n<sub>2</sub> to Two-Photon-Absorption", Gordon Conference on Nonlinear Optics and Lasers, July, 1989.
7. A.A. Said, M. Sheik-Bahae, T.H. Wei, J. Young, D.J. Hagan, M.J. Soileau and E.W. Van Stryland, "Z-scan: A simple Sensitive Technique for Measuring Refractive Nonlinearities", OSA Annual Meeting, Orlando FL, 1989.
8. M. Sheik-Bahae, A.A. Said, T.H. Wei, Y.Y. Wu, D.J. Hagan, M.J. Soileau and E.W. Van Stryland, "Z-Scan: A Simple and Sensitive Technique for Nonlinear Refraction Measurements", SPIE-OELASE, San Diego, Aug., 1989.
9. J.R. DeSalvo, D.J. Hagan, M. Sheik-Bahae, and E.W. Van Stryland, "Sensitive Measurement of Anisotropy of Third Order Nonlinearities", OSA Annual meeting, Boston, Mass., 1990.
10. A.A. Said, M. Sheik-Bahae, D.J. Hagan, and E.W. Van Stryland, "Alternative Z-scan Geometries", OSA Annual Meeting, Boston, Mass., 1990.

11. J.R. DeSalvo, M. Sheik-Bahae, D.J. Hagan, E.W. Van Stryland, "Cascaded Second Order Nonlinear Refraction in KTP," International Laser Science Conference of the American Physical Society, Monterey, CA, Sept. 22-26, 1991.
12. M. Sheik-Bahae, J. Wang, D.C. Hutchings, J.R. DeSalvo, A.A. Said, D.J. Hagan, E.W. Van Stryland, "Measurement and Theory of Nondegenerate Bound Electronic Nonlinearities in Semiconductors," OSA Annual Meeting, Nov. 3-8, San Jose, CA, 1991.
13. R. DeSalvo, M. Sheik-Bahae, D.J. Hagan, E.W. Van Stryland, G.I. Stegeman, "Nonlinear Refraction from  $\chi(2):\chi(2)$  in KTP," OSA Annual Meeting, Nov. 3-8, San Jose, CA 1991.
14. D.J. Hagan, J. Young, M. Sheik-Bahae, M.J. Soileau, and E.W. Van Stryland, "Nonlinear Optical Characterization of CdTe as Applied to Limiting at 1.06 Microns", Conference on Lasers and Electro-Optics (CLEO), Baltimore, Md., 1989.
15. M. Sheik-Bahae, A.A. Said, Y.Y. Wu, T.H. Wei, D.J. Hagan, and E.W. Van Stryland, "A Simple and Sensitive Technique for Determining Refractive Nonlinearities", Conference on Lasers and Electro-Optics (CLEO), Baltimore, Md., 1989.
16. M. Sheik-Bahae, Ali A. Said, T.H. Wei, D.J. Hagan, E.W. Van Stryland, and M.J. Soileau, "Sensitive n, Measurements Using a Single Beam", 1989 Boulder Damage Conference, Boulder, Co., 1989.
17. Ali A. Said, M. Sheik-Bahae, M.J. Soileau, and E.W. Van Stryland, "LID to TAS", 1989 Boulder Damage Conference, Boulder, Co., 1989.
18. M. Sheik-Bahae, D.J. Hagan, A. Miller, and E.W. Van Stryland, "Relation Between  $n_2$  and Two-Photon Absorption", 1989 Boulder Damage Conference, Boulder, Co., 1989.
19. M. Sheik-Bahae, A.A. Said, and E.W. Van Stryland, "Simple Analysis and Geometrical Optimization of a Passive Optical Limiter Based on Internal Self-action", SPIE's 1089 Technical Symposium, Orlando, Florida 1989.
20. M. Sheik-Bahae, D.J. Hagan, A.A. Said, James Young, T.H. Wei, and E.W. Van Stryland, "Kramers-Kronig Relation Between  $n_2$  and Two-Photon Absorption", SPIE meeting on Materials for Optical Switches, and Limiters II, Orlando, Fl., 1990.
21. A.A. Said, M. Sheik-Bahae, D.J. Hagan, E. Canto, Y.Y. Wu, James Young, T.H. Wei, and E.W. Van Stryland, "Nonlinearities in Semiconductors for Optical Limiting", SPIE meeting on Materials for Optical Switches, and Limiters II, Orlando, Fl., 1990.
22. D.J. Hagan, Y.Y. Wu, E. Canto, M. Sheik-Bahae, A.A. Said, J. Young, T.H. Wei, M. Junnarkar, and E.W. Van Stryland, "Anomalous Dispersion of the Electronic Kerr Effect", Seventh Topical Meeting on Ultrafast Phenomena, Monterey, Ca., May 14-17, 1990.
23. A.A. Said, M. Sheik-Bahae, T.H. Wei, J. Young, M Junnarkar, D.J. Hagan and E.W. Van Stryland, "Z-scan measurements of high-order optical nonlinearities in semiconductors", CLEO, Anaheim CA, (1990)
24. M. Sheik-Bahae, D.C. Hutchings, D.J. Hagan, M.J. Soileau, and E.W. Van Stryland, "Dispersion of  $n_2$  in Solids", 1990 Boulder Damage Conference, Boulder, Co., 1990.

25. D.J. Hagan, M. Sheik-Bahae, D.C. Hutchings, and E.W. Van Stryland, "Scaling Laws for Ultrafast All Optical Switching", Annual Meeting of LEOS '90, Boston, Mass., 1990.
26. M. Sheik-Bahae, D.J. Hagan, D.C. Hutchings, A.A. Said, E. Canto-Said, T.H. Wei, and E.W. Van Stryland, "Anomalous Dispersion of the Nonresonant Electronic Kerr Effect", EQEC UK 1991.
27. M. Sheik-Bahae, J.R. DeSalvo, J.W. Wang, D.J. Hagan, E.W. Van Stryland, "Dual-wavelength Z-scan", CLEO, Baltimore, Maryland 1991.
28. M. Sheik-Bahae, D.C. Hutchings, D.J. Hagan, E.W. Van Stryland, "Nondegenerate Bound Electronic Kerr Effect  $n_2$  in Semiconductors," QELS, Baltimore, Maryland 1991.
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91. B. Imangholi, C. Wang, E. Soto, M. Sheik-Bahae, A. Stintz, N. Nuntawong, K. Malloy and R.I. Epstein "Heterostructure Design Optimization for Laser Cooling of GaAs" *SPIE -Photonics West* (San Jose, CA, 20-25 Jan. 2007).

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### **Seminars and Colloquia:**

1. "*Picosecond CO<sub>2</sub> Laser Interaction with Semiconductors*", Center for Applied Quantum Electronics, North Texas State University, Denton, Texas, Feb. 1987.
2. "*Kerr Lensing in Optical Resonators*", CREOL, University of Central Florida, Orlando, FL, Aug. 1991.
3. "*Ultrafast Optical Nonlinearities in Diode Lasers*," CREOL, University of Central Florida, Orlando, FL, Oct. 1991.
4. "*Kramers-Kronig Dispersion Relations in Nonlinear Optics*," AT&T Bell Laboratories, Holmdel, NJ, Feb. 1992.
5. "*Bound-Electronic Nonlinear Refraction in Semiconductors*," AT&T Bell Laboratories, Murray Hill, NJ, Feb. 1992.
6. "*Theory and Measurements of Optical Nonlinearities in Solids*," Colloquium: Department of Physics, University of South Florida, Tampa FL, April 1992.
7. "*Ultrafast Optical Nonlinearities in Solids*", Department of Physics and Astronomy, University of New Mexico, Albuquerque, NM, April 1994.
8. "*Development and Applications of Z-Scan*," Wright Laboratories, Wright-Patterson AFB, Dayton, OH, April 1994.
9. "*Nonlinear Optical Measurement Techniques*," Los Alamos National Laboratories, New Mexico, January 1998.
10. "*Measurement, Theory and Application of Bound-Electronic Nonlinearities in Solids*," Colloquium: Department of Physics and Astronomy, New Mexico State University (NMSU), Las Cruces, NM, April 1998.
11. "All –Solid-State Optical Cryocoolers" Wright Laboratories, Wright-Patterson AFB, Dayton, OH, May 2000.
12. "Chilling with Light" CREOL/School of Optics, Univ. of Central Florida, May 2003

## Teaching

### Graduate Courses:

- **Laser Physics I:** *Fundamental of Lasers, Resonators*,  
Text: Laser Electronics, Verdeyen, See <http://www.phys.unm.edu/~opsci/sbahae/>
- **Laser Physics II:** *Semiconductor Lasers, Optical Detection, Quantum Optics and Noise, Waveguides, ultrafast phenomena.* <http://www.optics.unm.edu/sbahae/courses/>  
Text: Instructor's Lecture Notes
- **Nonlinear Optics**  
Text: Nonlinear Optics, Boyd <http://www.optics.unm.edu/sbahae/courses/>
- **Advanced Optics I & II:** *Ray Optics, Diffraction, Polarization, Coherence, Holography*  
Text: Optics, Klein & Furtak <http://www.optics.unm.edu/sbahae/courses/>
- **Graduate Seminars**

### Undergraduate Courses:

- **Light & Color:** *first-year, non-math based course on optics in nature, photography, color and vision*  
Text: Seeing the Light, by Falk, Brill & Stork  
Developed a course webpage with downloadable PowerPoint lectures including useful links, applets, pictures, and animations: <http://www.phys.unm.edu/~opsci/sbahae/>
- **Introduction to Optics**  
Text: Optics, by Hecht See: <http://www.phys.unm.edu/~opsci/sbahae/>
- **Undergraduate Seminars**

## Mentoring

My group has actively participated in undergraduate mentorship programs at UNM. In particular, in the last 4 years, we successfully involved 6 undergraduate students (mostly from underrepresented groups of Hispanics and Native Americans) in our research program under UNM's PURSUE program funded by NASA. Currently, my group is also involved with a mentoring program for gifted students from local Albuquerque high schools.