

GREG GBUR
Curriculum Vitae
Assistant Professor
UNC Charlotte
Department of Physics and Optical Science
and
Center for Optoelectronics and Optical Communications
9201 University City Blvd
Work phone: (704) 687-8137
gjgbur@uncc.edu
<http://www.physics.uncc.edu/PhysStaff/gjgbur/>

CAREER OBJECTIVES

I intend to extend the understanding and use of classical coherence theory in optical physics, with an eye towards useful applications of coherence phenomena. In particular, I am studying the properties of partially coherent wave propagation in random media such as atmospheric turbulence.

I plan to investigate, through exact numerical simulations, light interactions at subwavelength scales, with the goal of developing novel nano-scale optical devices.

I plan to develop new methods of doing imaging of three-dimensional objects (tomography), with the ultimate goal of developing viable techniques for performing medical diagnostics.

I would like to generate a better understanding of optics, and physics in general, within the nonscientific community, through teaching, lectures, and publications.

EDUCATION

Degrees:

Ph.D., University of Rochester, 2001, theoretical physics
M.A., University of Rochester, 1996, physics
B.A., University of Chicago, 1993, physics (with honors)

PH.D. DISSERTATION

title: *Nonradiating sources and the inverse source problem*,
advisor: Professor Emil Wolf

POSTDOCTORAL RESEARCH

University of Rochester, under Professor Emil Wolf, April 2001- April 2002
Vrije Universiteit, Amsterdam, under Professor Taco Visser, April 2002-August 2004

HONORS, AWARDS, AND ACHIEVEMENTS

GAANN (Department of Education) fellowship, 1994 - 1997
 University of Rochester Department of Physics Susumu Okubo Prize, 1996
 Air Force Office of Scientific Research AASERT fellowship, 1997-2000
 University of Chicago Student Marshal, 1993
 Member of University of Rochester Physics and Astronomy graduate admissions committee, 1997
 Co-organizer of *The Natural World as Art and Science* 2006, UNC Charlotte

TEACHING EXPERIENCE

UNC Charlotte:

Instructor, OPTI 6101/8101, *Math Methods for Physics*, Fall 2004, Fall 2005, Fall 2006

Instructor, OPTI 6271, *Advanced Physical Optics*, Spring 2005

Instructor, PHYS 3141, *Modern Physics*, Fall 2005, Spring 2006, Fall 2006, Spring 2007

Instructor, PHYS 3101, *Math Methods*, Spring 2006

University of Rochester:

Co-instructor with Professor Adrian Melissinos, *graduate mathematical methods for physicists 401- 403*, autumn 1999.

Grader, *graduate quantum optics II*, spring 2002.

Grader, *graduate classical coherence theory 534*, spring 2000.

Grader, *graduate classical coherence theory 534*, spring 1999.

Teaching assistant, *college physics 113 - 114*, autumn 1994 - spring 1995.

Guest lecturer, *graduate E&M II 416*, 4/24/2000 & 4/26/2000.

University of Chicago:

undergraduate physics tutor, 1992 - 1993 academic year.

AREAS OF RESEARCH

- Propagation of beams through turbulence. It has been suggested that partially coherent beams propagate better in atmospheric turbulence. I coauthored a paper on the spreading of such beams in turbulence, and confirmed that indeed they have certain advantages over their fully coherent counterparts. Further studies involve investigations of scintillation properties of various classes of partially coherent beams, for possible application in optical communication systems.
- Nano-scale electromagnetics. The discovery of enhanced light transmission through subwavelength holes and the role of surface plasmons in the enhancement has created new possibilities for subwavelength optical devices. I am undertaking exact numerical simulations of Maxwell's equations near subwavelength features in metal plates in order to obtain a deeper understanding of such phenomena, with an eye towards developing novel optical devices.
- Singular optics. The phase of an optical field can exhibit unusual behavior in the neighborhood of zeros of intensity, including optical vortices and saddles. My

collaborators and I demonstrated that drastic spectral changes occur in the vicinity of such phase singularities for polychromatic fields. We are now currently investigating the properties of phase singularities of coherence functions.

- Inverse scattering problems. Methods such as computed tomography which can be used to create images of three-dimensional objects are of great importance in a variety of applications, including medical imaging, geophysics, materials testing, even archaeology. I have been involved in the development of a new method of diffraction tomography which requires only intensity measurements of the scattered field.
- Nonradiating sources. It has been shown that there exist solutions to inhomogeneous wave equations which do not produce any radiation outside the domain of the source. My thesis work investigated the properties of such nonradiating sources and determined some new properties of them, particularly for partially coherent sources.
- Beam quality and characterization. There is a great interest in determining quantitative measures of laser beam quality. I have been involved in a variety of research projects regarding such beam quality factors, including determining conditions for which the transverse moments of the beam exist and finding methods of minimizing such moments.

OTHER EXPERIENCE

- Assisted in updating of seventh edition of *Principles of Optics* by Max Born and Emil Wolf (Cambridge University Press, 1999).
- Performed typesetting of front matter and several new articles for the collected papers of Emil Wolf (World Scientific Publishing, 2001).
- Developed algorithm in FORTRAN for stacking of CsI crystals for detector for Fermilab's KTeV research group, summer 1992.
- Wrote software in C and tested hardware for a readout system for the light output of a CsI crystal as part of bachelor's thesis, "*A readout system for the CsI test array*".
- Supervised the workers of a CsI crystal processing lab devoted to the testing and optimization of the light output of crystals for the KTeV detector, 1993-1994.
- Wrote FORTRAN code for analysis of data from the CLEO detector at Cornell in search of the rare B decay $B \rightarrow K\nu\nu$, summer 1995.
- Performed various measurements of the shape, durability, and porosity of a tube designed to be the inner wall of the drift chamber for the CLEO detector, 1995-1996.
- Generated figures for upcoming book by Emil Wolf on *Introduction to the Theory of Coherence and Polarization*.

PUBLICATIONS

1. G. Gbur and E. Wolf, "Sources of arbitrary states of coherence that generate completely coherent fields outside the source", *Opt. Lett.* 22 (1997), 943.
2. G. Gbur and P.S. Carney, "Convergence criteria and optimization techniques for beam moments", *Pure Appl. Opt.* 7 (1998), 1221.
3. M. Berry, J.T. Foley, G. Gbur and E. Wolf, "Nonpropagating string excitations", *Am. J. Phys.* 66(2) (1998), 121.
4. G. Gbur and E. Wolf, "Phase conjugation with random fields and with deterministic and random scatterers", *Opt. Lett.* 24 (1999), 10.
5. G. Gbur, D.F.V. James, and E. Wolf, "Energy conservation law for randomly fluctuating electromagnetic fields", *Phys. Rev. E* 59 (1999), 4594.
6. G. Gbur and K. Kim, "The quasi-homogeneous approximation for a class of three-dimensional primary sources", *Opt. Commun.* 163 (1999), 20; erratum in *Opt. Commun.* 167 (1999), 311.
7. P.S. Carney and G. Gbur, "Optimal apodizations for finite apertures", *J. Opt. Soc. Am. A* 16 (1999), 1638.
8. G. Gbur and E. Wolf, "Determination of density correlation functions from scattering of polychromatic light", *Opt. Commun.* 168 (1999), 39.
9. G. Gbur, J.T. Foley and E. Wolf, "Nonpropagating string excitations – finite length and damped strings", *Wave Motion* 30 (1999), 125.
10. G. Gbur and D.F.V. James, "Unpolarized sources that generate highly polarized fields outside the source", *J. Mod. Opt.* 47 (2000), 1171.
11. G. Gbur, "Uniqueness of the solution to the inverse source problem for quasi-homogeneous sources", *Opt. Commun.* 187 (2001), 301.
12. G. Gbur and E. Wolf, "The Rayleigh range of Gaussian Schell-model beams", *J. Mod. Opt.* 48 (2001), 1735.
13. G. Gbur and E. Wolf, "Relation between computed tomography and diffraction tomography", *J. Opt. Soc. Am. A* 18 (2001), 2132.
14. G. Gbur and E. Wolf, "The Rayleigh range of partially coherent beams", *Opt. Commun.* 199 (2001), 295.
15. G. Gbur, T.D. Visser and E. Wolf, "Anomalous behavior of spectra near phase singularities of focused waves", *Phys. Rev. Lett.* 88 (2002), 013901.

16. G. Gbur and E. Wolf, "Spreading of partially coherent beams in random media", *J. Opt. Soc. Am. A* 19 (2002), 1592.
17. G. Gbur, T.D. Visser and E. Wolf, "Singular behavior of the spectrum in the neighborhood of focus", *J. Opt. Soc. Am. A* 19 (2002), 1694.
18. E. Wolf and G. Gbur, "Determination of the scattering amplitude and of the extinction cross-section from measurements at arbitrary distances from the scatterer", *Phys. Lett. A* 302 (2002), 225.
19. T.D. Visser, G. Gbur and E. Wolf, "Effect of the state of coherence on the three-dimensional spectral intensity distribution near focus", *Opt. Commun.* 213 (2002), 13.
20. G. Gbur and E. Wolf, "Diffraction tomography without phase information", *Opt. Lett.* 27 (2002), 1890.
21. G. Gbur and E. Wolf, "Hybrid diffraction tomography without phase information", *J. Opt. Soc. Am. A* 19 (2002), 2194.
22. G. Gbur, T.D. Visser and E. Wolf, "Singular optics with polychromatic light", *Optics & Photonics News*, December 2002, p. 55.
23. G. Gbur, "Performing diffraction tomography without phase information", *Proceedings Symposium IEEE/LEOS Benelux Chapter, 2002, Amsterdam*, 151.
24. H.F. Schouten, T.D. Visser, G. Gbur, D. Lenstra, and H. Blok, "Creation and annihilation of phase singularities near a sub-wavelength slit", *Optics Express* 11 (2003), 371.
25. H.F. Schouten, G. Gbur, T.D. Visser and E. Wolf, "Phase singularities of the coherence functions in Young's interference experiment", *Opt. Lett.* 28 (2003), 968.
26. G. Gbur and T.D. Visser, "Coherence vortices in partially coherent beams", *Opt. Commun.* 222 (2003), 117.
27. G. Gbur, "Nonradiating sources and other 'invisible' objects", in E. Wolf (Ed.), *Prog. in Optics*, vol. 45 (Elsevier, Amsterdam, 2003), p. 273.
28. G. Gbur and T.D. Visser, "Can spatial coherence effects produce a local minimum of intensity at focus?", *Opt. Lett.* 28 (2003), 1627.
29. H.F. Schouten, T.D. Visser, G. Gbur, D. Lenstra and H. Blok, "Phase singularities and enhanced transmission at a subwavelength slit", *Optics & Photonics News*, December 2003, p. 23.

30. G.S. Agarwal, G. Gbur and E. Wolf, "Coherence properties of sunlight", *Opt. Lett.* 29 (2004), 459.
31. Y. Li, E. Wolf, G. Gbur and T.D. Visser, "Reply to comment: Optimum depth of the information pit on the data surface of a compact disk", *J. Mod. Opt.* 51 (2004), 779.
32. G. Gbur and E. Wolf, "The information content of the scattered intensity in diffraction tomography", *Information Sciences* 162 (2004), 3.
33. G. Gbur, T.D. Visser and E. Wolf, "'Hidden' singularities in partially coherent wavefields", *J. Opt. A* 6 (2004), S239.
34. H.F. Schouten, T.D. Visser, G. Gbur, D. Lenstra and H. Blok, "The diffraction of light by narrow slits in plates of different materials", *J. Opt. A* 6 (2004), S277.
35. G. Gbur, T.D. Visser and E. Wolf, "Complete destructive interference of partially coherent fields", *Opt. Commun.* 239 (2004), 15.
36. D. Shi, M.A. Anastasio, Y. Huang and G. Gbur, "Half-scan and single-plane intensity diffraction tomography for phase objects", *Phys. Med. Biol.* 49 (2004), 2733.
37. H.F. Schouten, T.D. Visser, G. Gbur, D. Lenstra and H. Blok, "Connection between phase singularities and the radiation pattern of a slit in a metal plate", *Phys. Rev. Lett.* 93 (2004), 173901.
38. G. Gbur, M.A. Anastasio, Y. Huang and D. Shi, "Spherical-wave intensity diffraction tomography", *J. Opt. Soc. Am. A* 22 (2005), 230.
39. H.F. Schouten, N. Kuzmin, G. Dubois, T.D. Visser, G. Gbur, P.F.A. Alkemade, H. Blok, G.W. 't Hooft, D. Lenstra and E.R. Eliel, "Plasmon-assisted two-slit transmission: Young's experiment revisited", *Phys. Rev. Lett.* 94 (2005), 053901.
40. G. Gbur, H.F. Schouten and T.D. Visser, "Achieving superresolution in near-field optical data readout systems using surface plasmons", *Appl. Phys. Lett.* 87 (2005), 191109.
41. M.A. Anastasio, D. Shi, Y. Huang and G. Gbur, "Image reconstruction in spherical-wave intensity diffraction tomography", *J. Opt. Soc. Am. A* 22 (2005), 2651.
42. G. Gbur and T.D. Visser, "Phase singularities and coherence vortices in linear optical systems", *Opt. Commun.* 259 (2006), 428.

43. C.H. Gan and G. Gbur, "Strategies for employing surface plasmons in near-field optical readout systems", *Opt. Exp.* 14 (2006), 2385.
44. M.A. Anastasio, D. Shi and G. Gbur, "Multispectral intensity diffraction tomography reconstruction theory: quasi-nondispersive objects", *J. Opt. Soc. Am. A* 23 (2006), 1359.
45. G. Gbur, "Simulating fields of arbitrary spatial and temporal coherence," *Opt. Exp.* 14 (2006), 7567.
46. G.S. Agarwal and G. Gbur, "Rotational frequency shifts for electromagnetic fields of arbitrary states of coherence and polarization," *Opt. Lett.* 31 (2006), 3080.
47. C.H. Gan, G. Gbur and T.D. Visser, "Surface plasmons modulate the spatial coherence in Young's interference experiment," *Phys. Rev. Lett.* 98 (2007), 043908.
48. N. Kuzmin, G.W. 't Hooft, E.R. Eliel, G. Gbur, H.F. Schouten and T.D. Visser, "Enhancement of spatial coherence by surface plasmons," *Opt. Lett.* 32 (2007), 445.
49. G. Gbur and O. Korotkova, "Angular spectrum representation for the propagation of arbitrary coherent and partially coherent beams through atmospheric turbulence," *J. Opt. Soc. Am. A* 24 (2007), 745.
50. D. M. Karabacak, K.L. Ekinici, C.H. Gan, G. Gbur, M. S. Ünlü, S. B. Ippolito, B. B. Goldberg, and P.S. Carney, "Diffraction of evanescent waves and nanomechanical displacement detection," *Opt. Lett.* 32 (2007), 1881.
51. O. Korotkova and G. Gbur, "Angular spectrum representation for propagation of random electromagnetic beams in a turbulent atmosphere," *J. Opt. Soc. Am. A* 24 (2007), 2728.
52. C.H. Gan and G. Gbur, "Strategies for employing surface plasmons in a near field transmission optical readout system," *Appl. Phys. Lett.* 91 (2007), 131109.

PRESENTATIONS

1. G. Gbur, "*Partially coherent sources that generate completely coherent fields outside the source*", Rochester Theory Center Summer Symposium, August 1997, Rochester, NY.
2. G. Gbur and E. Wolf, "*Partially coherent sources which generate completely coherent fields outside the source*", 1997 Optical Society of America (OSA) Annual Meeting in Long Beach, CA.

3. G. Gbur, D.F.V. James, and E. Wolf, “*A new energy conservation law for randomly fluctuating electromagnetic fields*”, 1997 OSA Annual Meeting in Long Beach, CA.
4. G. Gbur and E. Wolf, “*Phase conjugation with random fields and with random scatterers*”, 1998 OSA Annual Meeting in Baltimore, MD.
5. G. Gbur and E. Wolf, “*Determination of density correlation functions from scattering of polychromatic light*”, 1999 OSA Annual Meeting in Santa Clara, CA.
6. G. Gbur and E. Wolf, “*Relation between computed tomography (CAT) and diffraction tomography*”, 2000 OSA Annual Meeting in Providence, RI.
7. “*Statistical beam shaping*”, (presentation on behalf of Emil Wolf) at the 11th Annual AFOSR Electromagnetics Workshop, San Antonio, TX.
8. G. Gbur and E. Wolf, “*Diffraction tomography without phase information*”, 2002 OSA Annual Meeting in Orlando, FL.
9. G. Gbur, “*Diffraction tomography without phase information*”, seminar at Vrije Universiteit, October, 2002.
10. G. Gbur, “*Performing diffraction tomography without phase information*”, poster at Symposium IEEE/LEOS Benelux Chapter, 2002, Amsterdam.
11. G. Gbur, “*New tricks on an old string*”, seminar at University of Rochester at “Photons After Dark”, August 1997.
12. G. Gbur, “*Non-radiating sources and the inverse source problem*”, “Photons After Dark” talk, October 1996.
13. G. Gbur and E. Wolf, “*Singular optics in fields of different states of coherence*”, Singular Optics 2003 talk, Kiev, Ukraine, June 2003.
14. G. Gbur and T.D. Visser, “*Can spatial coherence effects produce a local minimum of intensity at focus?*”, ICO Topical Meeting on Polarization Optics, Joensuu, Finland, July 2003.
15. G. Gbur and T.D. Visser, “*Phase singularities in partially coherent fields*”, Coherence and Polarization Workshop at CREOL, Orlando, August 2003.
16. G. Gbur and T.D. Visser, “*Coherence vortices in partially coherent beams*”, 2003 OSA Annual Meeting in Tucson, AZ.
17. G. Gbur, “*Nonradiating sources and other ‘invisible’ objects*”, seminar at Vrije Universiteit, January, 2004.
18. G. Gbur, “*Tomography and the phase problem*”, seminar at UNC Charlotte, February, 2004.
19. G. Gbur, G.S. Agarwal and E. Wolf, “*Coherence properties of sunlight*”, 2004 OSA Annual Meeting in Rochester, NY.
20. G. Gbur, T.D. Visser and E. Wolf, “*Complete destructive interference of partially coherent fields*”, 2004 OSA Annual Meeting in Rochester, NY.
21. G. Gbur, H.F. Schouten and T.D. Visser, “*Plasmon effects in near-field optical readout systems*”, 2004 Optics in the Southeast meeting in Charlotte, NC.
22. G. Gbur, “*Surface plasmon effects in extraordinary optical transmission*”, seminar at UNC Charlotte, January, 2005.
23. G. Gbur, “*Surface plasmon effects in extraordinary optical transmission*”, seminar at the University of Arizona, May, 2005.

24. G. Gbur, “*Nonradiating sources, nonscattering scatterers, and other ‘invisible’ objects*”, 2005 Inverse Scattering Workshop, Charlotte.
25. G. Gbur, H.F. Schouten and T.D. Visser, “*Surface Plasmon Effects in Near-Field Optical Readout Systems*”, 2005 OSA Annual Meeting in Tucson, AZ.
26. G. Gbur and T.D. Visser, “*Phase Singularities and Coherence Vortices in Linear Optical Systems*”, 2005 OSA Annual Meeting in Tucson, AZ.
27. G. Gbur, “*Partially coherent fields and atmospheric turbulence*”, AFOSR EM Workshop, San Antonio, TX.
28. G. Gbur, “*Developing ‘Superbeams’ for Improved Propagation Through Atmospheric Turbulence*”, Michigan Technological University, March, 2006.
29. G. Gbur, “*Strategies for Employing Surface Plasmons in Near-Field Optical Readout Systems*”, invited talk at NANO 2006, Mohegan Sun, CT.
30. G. Gbur, “*Simulating partially coherent beam propagation in turbulence*”, TCATS meeting, Tucson, AZ, May 2006.
31. G. Gbur and G.S. Agarwal, “*Rotational Doppler shifts for electromagnetic fields of arbitrary state of coherence and polarization*,” 2006 OSA Annual Meeting in Rochester, NY
32. G. Gbur, “*Getting more for less: surface plasmons in nano-optics*,” colloquium at University of Oklahoma, November 2006.
33. G. Gbur, “*Surface plasmon effects in nano-optics*,” The 88th Eastern Forum of Science and Technology, Shanghai, China, January 2007.
34. G. Gbur, “*Simulating partially coherent fields and other special beam classes in turbulence*,” Photonics West 2007 (invited).
35. G. Gbur, “*Getting more with less: surface plasmons in nano-optics*,” seminar at Mississippi State University, April 2007.
36. G. Gbur, “*Optical and coherence vortices and their relationships*,” seminar at Vrije Universiteit, September 2007.
37. G. Gbur, “*Optical and coherence vortices and their relationships*,” Correlation Optics 2007, Chernivtsi, Ukraine, September 2007 (invited).
38. G. Gbur and R.K. Tyson, “*Vortex beam propagation through atmospheric turbulence and topological charge conservation*,” 2007 OSA Annual Meeting in San Jose, CA.

PROFESSIONAL AFFILIATIONS

Optical Society of America, member, 1997-present.

REFERENCES

- Professor Emil Wolf
Department of Physics and Astronomy
University of Rochester
Rochester, NY 14627, USA
Tel: (585) 275-4397
Fax: (585) 473-0687
email: ewlupus@pas.rochester.edu
- Dr. Daniel F. V. James
Theoretical Division T-4
B-283 Los Alamos National Laboratory
Los Alamos, NM 87545, USA
Tel: (505) 667-5436
Fax: (505) 667-1931
email: dfvj@t4.lanl.gov
- Professor Taco D. Visser
Department of Physics and Astronomy
Free University
De Boelelaan 1081
1081 HV Amsterdam, The Netherlands
Tel: +31 (0)20 44 47864
email: tvisser@nat.vu.nl
- Professor Adrian Melissinos
Department of Physics and Astronomy
University of Rochester
Rochester, NY 14627, USA
Tel: (585) 275-2707
email: meliss@pas.rochester.edu