Steven G. Johnson

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Education and Awards

Massachusetts Institute of Technology (MIT), 1995–2001:

- **Ph.D. Physics**: "Photonic Crystals: From Theory to Practice." 5.0/5.0 GPA.

- National Defense Science and Engineering Graduate (NDSEG) Fellowship
- MIT Karl Taylor Compton Fellowship
- National Science Foundation (NSF) Fellowship (declined)
- Hertz Foundation Fellowship (declined)

- 1999 J. H. Wilkinson Prize for Numerical Software (see FFTW, below)
- 1999 Laurels Award in Electronics from *Aviation Week & Space Technology*

MIT, 1991–1995:

- **B.S. Physics**, 5.0/5.0 GPA.
- **B.S. Electrical Engineering and Computer Science**, 5.0/5.0 GPA.
- **B.S. Mathematics**, 5.0/5.0 GPA.

- MIT Orloff Award for scholarship in physics.

Thesis on semi-classical analyses of quantum chaos. *Honor societies:* Phi Beta Kappa (liberal arts), Sigma Pi Sigma (physics), Tau Beta Pi (engineering), and Eta Kappa Nu (electrical engineering).

Illinois Mathematics and Science Academy, 1988–1991.
Eagle Scout, National Merit Scholarship.

Research Experience

Postdoctoral research associate, MIT, May 2001–present:
Collaborating with both theoretical and experimental colleagues to advance the science of photonic crystals and structured optical media.

Tohoku University (Sendai, Japan), Dec. 2002:
Collaborated with Kawakami group in theoretical analysis of autocloned photonic-crystal heterostructure waveguides, exploring the limits of envelope/effective-index approximations as well as studying losses via group theory and other principles.

OmniGuide Communications (Cambridge, MA), Sep. 2000–Jan. 2001–present:
Led theory and simulation group in investigation and theoretical characterization of a new class of hollow optical fibers. I continue there as a consultant to the present day.

Femtosecond Technology Research Association (Tsukuba, Japan), July 2000:
Introduced researchers at FESTA to the theoretical study of photonic crystals, and

computationally characterized the structures fabricated at their laboratory.

MIT Laboratory for Computer Science, 1997–present:
Co-developed the FFTW fast-Fourier-transform library (`www.fftw.org`). 1999 *J. H. Wilkinson Prize for Numerical Software*, awarded every four years by Argonne Natl. Lab., the National Physical Lab. (UK), and the Numerical Algorithms Group (NAG) to the software that "best addresses all phases of the preparation of high-quality numerical software." 1999 *Laurels Award* in "Electronics" from *Aviation Week & Space Technology* for "significant contributions to the global field of aerospace in 1999." (Version 3.0 of FFTW was released in April 2003 with a completely new structure that greatly increases its performance and generality.)

AT&T Bell Laboratories, summers of 1993 and 1994 (MIT VI-A internship program):
Developed real-time visualization software for high-speed optics, built laser-alignment system for free-space optics, and wrote a program for 3d capacitance extraction.

MIT Mathematics Dept. and School of Mgmt., spring 1993 (MIT UROP program):
Numerical studies of options contracts and the Black-Scholes equations.

Fermi Natl. Accelerator Laboratory, summers/winters 1989–1991, 1995:
Developed simulation software for liquid-Helium cryogenics systems.

Teaching Experience

MIT Experimental Study Group, 1994–2000:
Exclusive instructor of freshman physics courses to small groups of 1–3 students, for roughly 6–8 semesters, in this optional alternative program for MIT freshmen.

Invited Talks

"Photonic crystals: Periodic surprises in electromagnetism," S. G. Johnson (*et al.*), Columbia University, New York (April 2003).

"Coupling to photonic-crystal waveguides with adiabatic tapers," S. G. Johnson (P. Bienstman, M. Skorobogatiy, M. Ibanescu, E. Lidorikis, M. Povinelli, J. D. Joannopoulos), MRS Fall Meeting, Boston (December 2002).

"High-Q cavities without a complete photonic band gap," S. G. Johnson (S. Fan, A. Mekis, J. D. Joannopoulos, M. Watts, H. A. Haus), ETOPIM: Electrical Transport and Optical Properties of Inhomogeneous Media, Salt Lake City (July 2002).

"Iterative eigensolver techniques and Maxwell's equations in periodic systems," S. G. Johnson (J. D. Joannopoulos), PIERS: Progress In Electromagnetics Research Symposium, Cambridge MA (July 2002).

"Breaking the glass ceiling: Hollow OmniGuide fibers," S. G. Johnson (M. Ibanescu, M. Skorobogatiy, O. Weisberg, T. Engeness, M. Soljacic, S. Jacobs, J. D. Joannopoulos, Y. Fink), ESPC: European Symposium on Photonic Crystals, Warsaw (April 2002).

"Minimizing scattering losses in photonic-crystal slabs," S. G. Johnson (S. Fan, A. Mekis, J. D. Joannopoulos), Materials Research Society (MRS) meeting, San Francisco, CA (April 2002).

"Breaking the Glass Ceiling: Hollow OmniGuide Fibers," S. G. Johnson (*et al.*), SPIE Optoelectronics 2002, San Jose, CA (January 2002).

"A Novel Photonic-Crystal System for Integrated Optics," S. G. Johnson (M. L. Povinelli, J. D. Joannopoulos), ITCom 2001, Denver, Colorado (August 2001).

"Modeling Linear Waveguides in Photonic Crystals," S. G. Johnson (J. D. Joannopoulos, M. Povinelli, S. Fan, A. Mekis, and P. R. Villeneuve), 9th Intl. Workshop on Optical Waveguide Theory and Numerical Modeling, Paderborn, Germany (April 2001).

"FFTW, FFTs, Portability, and Performance," S. G. Johnson (M. Frigo), Conference for Computational Physics, Australia (December 2000).

"FFTW: An Adaptive Software Architecture for the FFT," S. G. Johnson (M. Frigo), Cornell University, Ithaca NY (February 2000).

"Photonic Crystal Slabs: Hybrid Structures for Integrated Optics," S. G. Johnson (J. D. Joannopoulos, S. Fan, P. R. Villeneuve, L. Kolodziejski), Corning Research, Corning NY (February 2000).

"Designing a Photonic Crystal Slab," S. G. Johnson (S. Fan, P. R. Villeneuve, J. D. Joannopoulos), Sandia Natl. Laboratory, Albuquerque NM (August 1999).

"The Fastest Fourier Transform in the West," S. G. Johnson (M. Frigo), ICIAM '99 (Wilkinson Prize Symposium), Edinburgh, Scotland (July 1999).

"Photonic Crystals: Theory and Applications," S. G. Johnson (J. D. Joannopoulos, D. Abrams, S. Fan, A. Mekis, P. R. Villeneuve, J. N. Winn), Northeastern University, Boston MA (May 1999).

Publications

S. G. Johnson and J. D. Joannopoulos, *Photonic Crystals: The Road from Theory to Practice* (Kluwer, Boston, 2002).

Marin Soljacic, Mihai Ibanescu, Steven G. Johnson, J.D.Joannopoulos, and Yoel Fink, "Optical Bistability in Axially Modulated OmniGuide Fibers," *Opt. Lett.* **27**, 516–518 (2003).

T. D. Engeness, M. Ibanescu, S. G. Johnson, O. Weisberg, M. Skorobogatiy, S. Jacobs, and Y. Fink, "Dispersion tailoring and compensation by modal interactions in OmniGuide fibers," *Opt. Express* **11**, 1175–1198 (2003).

Mihai Ibanescu, Steven G. Johnson, Marin Soljacic, J. D. Joannopoulos, Yoel Fink, Ori Weisberg, Torkel D. Engeness, Steven A. Jacobs, and M. Skorobogatiy, "Analysis of mode structure in hollow dielectric waveguide fibers," *Phys. Rev. E* **67**, 046608 (2003).

C. Luo, S. G. Johnson, J. D. Joannopoulos, and J. B. Pendry, "Negative refraction without negative index in metallic photonic crystals," *Opt. Express* **11**, 746–754 (2003).

M. L. Povinelli, Steven G. Johnson, J. D. Joannopoulos, and J. B. Pendry, "Toward photonic-crystal metamaterials: Creating magnetic emitters in photonic crystals," *Appl. Phys. Lett.* **82** (7), 1069–1071 (2003).

Chiyan Luo, Mihai Ibanescu, Steven G. Johnson, and J. D. Joannopoulos, "Cerenkov Radiation in Photonic Crystals," *Science* **299**, 368–371 (2003).

Steven G. Johnson, Peter Bienstman, M. A. Skorobogatiy, Mihai Ibanescu, Elefterios Lidorikis, and J. D. Joannopoulos, "Adiabatic theorem and continuous coupled-mode theory for efficient taper transitions in photonic crystals," *Phys. Rev. E* **66**, 066608 (2002).

Marin Soljacic, Mihai Ibanescu, Steven G. Johnson, Yoel Fink, and J. D. Joannopoulos, "Optimal bistable switching in nonlinear photonic crystals," *Phys. Rev. E Rapid*

Comm. **66**, 055601(R) (2002).

Maksim Skorobogatiy, Steven A. Jacobs, Steven G. Johnson, and Yoel Fink, "Geometric variations in high index-contrast waveguides, coupled mode theory in curvilinear coordinates," *Opt. Express* **10**, 1227–1243 (2002).

M. Skorobogatiy, M. Ibanescu, S. G. Johnson, O. Weiseberg, T. D. Engeness, M. Soljacic, S. A. Jacobs, and Y. Fink, "Analysis of general geometric scaling perturbations in a transmitting waveguide. The fundamental connection between polarization mode dispersion and group-velocity dispersion," *JOSA B* **19**, 2867–2875 (2002).

M. R. Watts, S. G. Johnson, H. A. Haus, and J. D. Joannopoulos, "Electromagnetic cavity with arbitrary Q and small modal volume without a complete photonic bandgap," *Opt. Lett.* **27**, 1785–1787 (2002).

M. Soljacic, S. G. Johnson, S. Fan, M. Ibanescu, E. Ippen, and J. D. Joannopoulos, "Photonic-crystal slow-light enhancement of nonlinear phase sensitivity," *J. Opt. Soc. Am. B* **19**, 2052–2059 (2002).

C. Luo, S. G. Johnson, and J. D. Joannopoulous, "All-angle negative refraction in a three-dimensionally periodic photonic crystal," *Appl. Phys. Lett.* **81**, 2352 (2002).

S. G. Johnson, M. Ibanescu, M. Skorobogatiy, O. Weisberg, J. D. Joannopoulos, and Y. Fink, "Perturbation theory for Maxwell's equations with shifting material boundaries," *Phys. Rev. E* **65**, 066611 (2002).

C. Luo, S. G. Johnson, J. D. Joannopoulos, and J. B. Pendry, "All-angle negative refraction without negative effective index," *Phys. Rev. B.* **65**, 201104(R) (2002).

S. G. Johnson, M. Ibanescu, M. A. Skorobogatiy, O. Weisberg, T. Engeness, M. Soljacic, S. A. Jacobs, J. D. Joannopoulos and Y. Fink, "Low-loss asymptotically single-mode propagation in large-core OmniGuide fibers," *Opt. Express* **9** (13), 748–779 (2001).

S. Y. Lin, E. Chow, S. G. Johnson, and J. D. Joannopoulos, "Direct measurement of the quality factor in a two-dimensional photonic-crystal microcavity," *Opt. Lett.* **26** (23), 1903–1905 (2001).

S. G. Johnson, A. Mekis, S. Fan, and J. D. Joannopoulos, "Molding the flow of light," *Computing in Science and Engineering* **3** (6), 38–47 (2001).

M. L. Povinelli, S. G. Johnson, S. Fan, and J. D. Joannopoulos, "Emulation of two-dimensional photonic crystal defect modes in a photonic crystal with a three-dimensional photonic band gap," *Phys. Rev. B* **64**, 075313 (2001).

S. G. Johnson, S. Fan, A. Mekis, and J. D. Joannopoulos, "Multipole-cancellation mechanism for high-Q cavities in the absence of a complete photonic band gap," *Appl. Phys. Lett.* **78** (22), 3388–3390 (2001).

S. Fan, S. G. Johnson, J. D. Joannopoulos, C. Manolatou, and H. A. Haus, "Waveguide branches in photonic crystals," *J. Opt. Soc. Am. B* **18** (2), 162–165 (2001).

S. G. Johnson and J. D. Joannopoulos, "Block-iterative frequency-domain methods for Maxwell's equations in a planewave basis," *Optics Express* **8** (3), 173–190 (Focus Issue on Photonic Bandgap Calculations) (2001).

E. Chow, S. Y. Lin, J. R. Wendt, S. G. Johnson, and J. D. Joannopoulos, "Quantitative analysis of bending efficiency in photonic-crystal waveguide bends at $\lambda = 1.55\mu$m wavelengths," *Optics Lett.* **26**, 286–288 (2001).

S. Fan, S. G. Johnson, J. D. Joannopoulos, C. Manolatou, and H. A. Haus, "Waveguide branches in photonic crystals," *J. Opt. Soc. Am. B* **18** (2), 162–165 (2001).

S. G. Johnson and J. D. Joannopoulos, "Three-dimensionally periodic dielectric layered

structure with omnidirectional photonic band gap," *Appl. Phys. Lett.* **77**, 3490–3492 (2000).

E. Chow, S. Y. Lin, S. G. Johnson, P. B. Villeneuve, J. D. Joannopoulos, J. R. Wendt, G. A. Vawter, W. Zubrzycki, H. Hou, and A. Alleman, "Three-dimensional control of light in a two-dimensional photonic crystal slab," *Nature* **407**, 983–986 (2000).

S. G. Johnson, P. R. Villeneuve, S. Fan, and J. D. Joannopoulos, "Linear waveguides in photonic-crystal slabs," *Phys. Rev. B* **62**, 8212–8222 (2000).

S. Y. Lin, E. Chow, S. G. Johnson, and J. D. Joannopoulos, "Demonstration of highly efficient waveguiding in a photonic crystal slab at the 1.5-μm wavelength," *Opt. Lett.* **25**, 1297–1299 (2000).

S. G. Johnson, S. Fan, P. R. Villeneuve, J. D. Joannopoulos, and L. A. Kolodziejski, "Guided modes in photonic crystal slabs," *Phys. Rev. B* **60**, 5751–5758 (1999).

C. Manolatou, S. G. Johnson, S. Fan, P. R. Villeneuve, H. A. Haus, and J. D. Joannopoulos, "High-Density integrated optics," *J. Lightwave Tech.* **17**, no. 9 (Sep. 1999).

S. G. Johnson, C. Manolatou, S. Fan, P. R. Villeneuve, J. D. Joannopoulos, and H. A. Haus, "Elimination of cross talk in waveguide intersections," *Optics Letters* **23**, 1855–1857 (1998).

P. R. Villeneuve, S. Fan, S. G. Johnson, and J. D. Joannopoulos, "Three-dimensional photon confinement in photonic crystals of low-dimensional periodicity," *IEE Proc. Optoelec.* **145**, 384 (1998).

M. Frigo and S. G. Johnson, "FFTW: An adaptive software architecture for the FFT," *Proc. ICASSP 1998* **3**, 1381 (1998).

W. M. Soyars and S. G. Johnson, "Simulating the Tevatron liquid Helium satellite refrigerators," *Advances in Cryogenic Engineering* **39**, 1231–1235 (1994).

Patents

"Quasi-3d photonic crystals," U.S. Patent #6134043.
"Design of optical waveguide crossings," U.S. Patent #6198860.
"Electromagnetic mode conversion in photonic crystal multimode waveguides," U.S. Patent #6563981.
"3d periodic dielectric layered structure with omnidirectional photonic bandgap," accepted for issuance.
"Mach-Zehnder interferometer exploiting certain line defects in photonic band gap crystals," pending.
"Photonic crystals as meta-materials," pending.
"Radiation-free micro-resonators," pending.
"A photonic crystal negative refraction medium employing a positive effective index," pending.
"Electromagnetic cavity with arbitrary lifetime and finite modal volume," pending.
"Shock-wave modulation and control of electromagnetic radiation," pending.
"Optimal bistable switching in nonlinear photonic crystals," pending.
"Waveguide coupling into photonic crystal waveguides," pending.
"Photonic crystals: a medium exhibiting anomalous Cerenkov radiation," pending.
"Towards designing polarization-independent optical networks in 3d photonic crystals," pending.
"Optical waveguide side-monitoring of photonic-crystal fibers," pending.
"Photonic cystal high index contrast fiber waveguides and devices based on axial modulation," pending.
"Co-drawing high index contrast fiber waveguides," pending.
"Photonic crystal waveguides having tailored dispersion profiles," pending.
"Dielectric waveguide with transverse index variation that supports a zero-group velocity mode at a non-zero longitudinal wavevector," pending.
"High-index contrast fiber waveguides," pending.
"OTDR-style monitoring of photonic crystal fibers," pending.
"Low-loss photonic crystal waveguide having large core radius," pending.