

Lalitha Sankar

Department of Electrical Engineering

Engineering Quadrangle, Olden St.
Princeton, NJ 08544-1000
USA

Princeton University

Phone: (908) 410-7657
Fax: (609) 258-3745
Email: lalitha@princeton.edu

RESEARCH INTERESTS:

Resource allocation in wireless networks, information security in wireless relay networks, relay and user-cooperative communications, game-theoretic analysis of wireless networks, network information theory, application of information theory to natural languages

EDUCATION:

Ph.D. in Electrical Engineering, Rutgers University, Piscataway, NJ Oct. 2007
Advisor: **Narayan Mandayam**
Dissertation: *Relay Cooperation in Multiaccess Networks*

M.S. in Electrical Engineering, University of Maryland Baltimore County, Baltimore, MD Aug. 1994

B.Tech. in Engineering Physics, Indian Institute of Technology, Bombay, India May 1992

RESEARCH POSITIONS:

Science and Technology Postdoctoral Fellow Princeton University, Princeton, NJ
Advisor: **H. Vincent Poor** Jun. 2007–Present

Graduate Research Assistant WINLAB, Rutgers University, North Brunswick, NJ
Advisor: **Narayan Mandayam** Sep. 2003–May 2007

Senior Member of Technical Staff AT&T Shannon Labs, Florham Park, NJ
Aug. 1996–Mar. 2002

Member of Technical Staff AT&T Microelectronics, Allentown, PA
Sep. 1995–Aug. 1996

Advanced Engineer Engineering R&D, Polaroid Corporation, Cambridge, MA
Sep. 1994–Aug. 1995

Graduate Assistant University of Maryland Baltimore County, Baltimore, MD
Sep. 1992–Aug 1994

HONORS AND AWARDS:

Science and Technology Postdoctoral Fellowship Princeton University, Princeton, NJ, 2007-2010

Graduate Academic Excellence Award Rutgers University, Piscataway, NJ, 2007-2008

AT&T Continuing Education Award AT&T Shannon Labs, 1998-2002

Tau Beta Pi Inducted, 1994

TEACHING POSITIONS:

Co-Instructor Princeton University, Princeton, NJ
Freshman Seminar Course: 'Fundamental Ideas of the Information Revolution: Insights into Technology, Language, and Biology' Spring 2008

Lalitha Sankar (2 of 7)

Developed and taught (with Prof. H. V. Poor) a seminar course for freshmen on the fundamental contributions of Claude Shannon to the information revolution. The ideas of quantifying information sources using entropy, compression, and coding were developed using examples and hands-on experiments.

Co-Instructor

Rutgers University, North Brunswick, NJ

Information Theory and Coding (graduate level)

Spring 2007

Co-taught the graduate level course with Profs. Roy Yates and Predrag Spasojevic.

Teaching Assistant

Rutgers University, North Brunswick, NJ

Digital Signal Processing Course & Laboratory (junior level)

Spring 2003

Linear Signals and Systems Course & Laboratory (junior level)

Fall 2002

Teaching Assistant

University of Maryland Baltimore County, Baltimore, MD

Principles of Electrical Engineering (sophomore level)

Fall 1992

Probability and Random Processes (graduate level)

Fall 1993

RECENT RESEARCH PROJECTS:

Fading Wireless Networks: Sum-capacity and Resource Allocation

Developing sum-capacity optimal signaling and scheduling policies for several multi-terminal fading wireless networks such as relay, compound multi-access, and interference channels.

Information Security in Relay Networks

Developing the secrecy capacity of a class of orthogonal half-duplex relay channels in the presence of a passive eavesdropper who has access to one or both orthogonal channels.

Relay and User Cooperative Networks

Proposing new relaying and user cooperative models for multiuser wireless uplink communications, characterizing fundamental performance limits for these networks, and establishing optimal resource allocation strategies for relay networks.

Network Information Theory

Advancing the state-of-art on two long-standing open problems: establishing the capacity region for a class of fading interference channels and establishing new capacity theorems for some classes of multiaccess relay channels.

Cooperative Game Theory and Wireless Networks

Using the theory of cooperative games to determine the effectiveness of user cooperation in multi-access and interference networks.

Entropy and Redundancy of American Sign Language

Charactering the entropy and redundancy of American sign language using the information-theoretic techniques developed by Claude Shannon.

PUBLICATIONS:

Journal Publications: (available from <http://www.princeton.edu/~lalitha/>)

1. **L. Sankar**, Y. Liang, N. B. Mandayam, and H. V. Poor. "Opportunistic communications in fading Gaussian multiaccess relay channels," submitted to *IEEE Trans. Information Theory*, Feb. 2009.
2. V. Aggarwal, **L. Sankar**, A. R. Calderbank, and H. V. Poor. "Secrecy capacity of a class of orthogonal relay eavesdropper channels," submitted to *EURASIP Journal on Wireless Communication and Networking: Special Issue on Wireless Physical Layer Security*, Nov. 2008.
3. A. Chong, **L. Sankar**, and H. V. Poor. "Frequency of occurrence and information entropy of American Sign Language," to be submitted to *Cognition*.
4. **L. Sankar**, G. Kramer, and N. B. Mandayam. "User vs. relay cooperation in time-duplexed multiaccess networks," submitted to *IEEE Trans. Wireless Communications*, under revision.
5. **L. Sankar**, N. B. Mandayam, and H. V. Poor. "On the sum-capacity of degraded Gaussian multiaccess relay channels," submitted to *IEEE Trans. Information Theory*, under revision.
6. S Mathur, **L. Sankar**, and N. B. Mandayam. "Coalitions in Cooperative Wireless Networks," *IEEE J. Special Areas in Communication, Special Issue on Game Theory in Communication Networks*, vol. 26, no. 7, pp. 1104-1115, Sep. 2008.
7. **L. Sankar**, G. Kramer, and N. B. Mandayam. "Offset Encoding for Multiple-access Relay Channels," *IEEE Trans. Information Theory, Special Issue on Models, Theory, and Codes for Relaying and Cooperation in Communication Networks*, vol.53, no. 10, pp. 3814-3821, Oct. 2007.

Conference Papers/Presentations:

8. V. Aggarwal, **L. Sankar**, A. R. Calderbank, and H. V. Poor. "Secrecy capacity of a class of orthogonal relay eavesdropper channels," *Proc. of the 3rd Annual Information Theory and Applications Workshop*, La Jolla, CA, Feb. 8-13, 2009 (*invited*).
9. **L. Sankar**, X. Shang, E. Erkip and H. V. Poor. "Ergodic fading two-user interference channels: is separability optimal", *Proc. of the 46th Annual Allerton Conference on Communication, Control, and Computing*, Monticello, IL, Sep. 23-26, 2008.
10. **L. Sankar**, E. Erkip and H. V. Poor. "Sum-capacity of ergodic fading interference and compound multiaccess channels," *Proc. of IEEE International Symposium on Information Theory*, Toronto, CA, Jul. 7-11 2008.
11. S. Mathur, **L. Sankar**, and N. B. Mandayam. "Coalitions in Cooperative Wireless Networks," *Proc. of the 2nd Annual Information Theory and Applications Workshop*, La Jolla, CA, Jan. 28-Feb 1, 2008 (*invited*).
12. **L. Sankar**, G. Kramer and N. B. Mandayam. "User vs. relay cooperation in multiaccess networks," *Proc. of 45th Annual Allerton Conference on Communication, Control, and Computing*, Monticello, IL, Sep. 26-28, 2007.
13. **L. Sankar**, Y. Liang, H. V. Poor, and N. B. Mandayam. "Opportunistic communications in an orthogonal multiaccess relay channel," *Proc. of IEEE International Symposium on Information Theory*, Jun. 24-29, 2007.
14. **L. Sankar**, G. Kramer and N. B. Mandayam. "Sum-Capacity of Degraded Gaussian Multiple-Access Relay Channels," *Proc. of the 1st Annual Information Theory and Applications Workshop*, La Jolla, CA, Jan. 29-Feb 2, 2008 (*invited*).

Lalitha Sankar (4 of 7)

15. S. Mathur, **L. Sankaranarayanan**, and N. B. Mandayam. “Coalitional games in cooperative radio networks,” *Proc. of 40th Annual Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Oct. 29-Nov. 1, 2006.
16. S. Mathur, **L. Sankaranarayanan**, and N. B. Mandayam. “Coalitional games in Gaussian interference channels,” *Proc. of IEEE International Symposium on Information Theory*, Seattle, WA, Jul. 9-14, 2006.
17. S. Mathur, **L. Sankaranarayanan**, and N. B. Mandayam. “Coalitional games in receiver cooperation for spectrum sharing,” *Proc. of 40th Annual Conference on Information Sciences and Systems*, Princeton, NJ, Jul. 9-14, 2006.
18. **L. Sankaranarayanan**, G. Kramer, and N. B. Mandayam. “Cooperative diversity in wireless networks: a geometry-inclusive analysis,” *Proc. of 43rd Annual Allerton Conference on Communication, Control, and Computing*, Monticello, IL, Sep. 28-30, 2005.
19. **L. Sankaranarayanan**, G. Kramer, and N. B. Mandayam. “Cooperation vs. hierarchy: an information-theoretic comparison,” *Proc. of IEEE International Symposium on Information Theory*, Sep. 4-9, 2005.
20. **L. Sankaranarayanan**, G. Kramer, and N. B. Mandayam. “Hierarchical wireless networks: capacity theorems and cooperative strategies using the multiple-access relay channel model,” *Proc. of 38th Annual Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 7-10, 2004.
21. **L. Sankaranarayanan**, G. Kramer, and N. B. Mandayam. “Hierarchical sensor networks: capacity theorems and cooperative strategies using the multiple-access relay channel model,” *Proc. of 1st IEEE Conference on Sensor Networks (SECON)* Pacific Grove, CA, Oct. 4-7, 2004.
22. **L. Sankaranarayanan**, G. Kramer, and N. B. Mandayam. “Hierarchical wireless networks: capacity theorems and cooperative strategies using the multiple-access relay channel model,” *Proc. of 38th Annual Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 7-10, 2004.
23. **L. Sankaranarayanan**, G. Kramer, and N. B. Mandayam. “Capacity theorems for the multiple-access relay channel,” *Proc. of 42nd Annual Allerton Conference on Communication, Control, and Computing*, Monticello, IL, Sep. 29-Oct. 1 2004.
24. R. Erving and **L. Sankaranarayanan**. “Combining channel codes for data rate maximization in DMT-based DSL systems,” *Proc. of 36th Annual Conference on Information Sciences and Systems*, Princeton, NJ, March 20-22, 2002.
25. J. M. Morris, S. Balasubramanian, M. Guo, and **L. Sankaranarayanan**. “A detection algorithm for gaseous pollutants using signal processing techniques on FTIR interferograms,” *Proc. of SPIE*, Washington, DC, Nov. 9-11, 1994.

Patents:

1. R. Erving and **L. Sankaranarayanan**. *Efficient reduced complexity windowed time domain equalizer for discrete multitone-based DSL modem*, U.S. patent no. 7248648, Jul. 2007.
2. R. Erving and **L. Sankaranarayanan**. *Multi-frequency data transmission channel power allocation*, U.S. patent no. 7139323, Jul. 2006.
3. **L. Sankaranarayanan** and R. Sonalkar. *Method and apparatus for allocating data for transmission via discrete multiple tones*, U.S. patent no. 6134274, Oct. 2000.

PROPOSAL PARTICIPATION:

Helped write NSF Theoretical Foundations grant CCF-0634973 “Cooperation and Conflict: Coalitional Games in Spectrum Sharing,” (\$100,000) Sep. 2006. PI: Narayan Mandayam

Lalitha Sankar (5 of 7)

STUDENT COLLABORATION AND ADVISING:

Vaneet Aggarwal Graduate Student, Princeton University, May 2008 - present
Topic: Secrecy Capacity of Orthogonal Relay Networks

Andrew Chong Undergraduate Student, Princeton University, May 2008 - present
Topic: Entropy and Redundancy of American Sign Language

Suhas Mathur Graduate Student, WINLAB, Rutgers University, Sep. 2005 - Jun. 2007
Masters thesis: Coalitional Games in Cooperative Networks

Amit Mahadevan Summer Intern, AT&T Shannon Labs, Jun. 2001 - Aug. 2001
Project: Algorithm Implementation for Next-generation DSL Systems

Sanjay Joshi Summer Intern, AT&T Shannon Labs, Jun. 1999 - Aug. 1999
Project: Bit-Loading for Multicarrier DSL Systems

INDUSTRIAL RESEARCH PROJECTS:

Next-generation DSL modems

AT&T Shannon Labs

Designed algorithms and led end-to-end software and firmware design of a next-generation full-duplex high-speed digital subscriber line (DSL) prototype system. Contributions include (patented) algorithms for a time equalizer, bit and power loading, and a coding and modulation combined approach to bit loading.

Software-defined Radios

AT&T Shannon Labs

Developed and optimized fixed-point implementations of IS136 speech coders for a dual band software radio prototype. Innovation was in optimizing cycle count and memory constraints while meeting the perceptive speech requirements.

Algorithms for New DSP Architectures

AT&T Microelectronics

Developed GSM speech processing algorithms for the first joint AT&T-Motorola VLIW (very long instruction word) processor that is a precursor to the present-generation dual-MAC DSPs.

Signal Processing for Digital Cameras

Polaroid Corporation

Designed and implemented end-to-end image processing algorithms for the first generation digital camera prototype at the Polaroid R&D Labs.

INVITED SEMINARS:

1. "Fading Interference Channels: Capacity and Separability," *Department of Electrical and Computer Engineering, University of California-Berkeley*, Berkeley, CA, Nov. 21, 2008.
2. "Fading Wireless Networks: The Interference case," *Department of Electrical and Computer Engineering, University of California-Santa Cruz*, Santa Cruz, CA, Nov. 20, 2008.
3. "Fading Interference Channels: Capacity and Separability," *Department of Electrical and Computer Engineering, Stanford University*, Palo Alto, CA, Nov. 19, 2008.
4. "Fading Interference Channels: Capacity and Separability," *Information Theory Group, HP Laboratories*, Palo Alto, CA, Nov. 19, 2008.
5. "Fading Wireless Networks: The Interference case," *Department of Electrical and Computer Engineering, Lehigh University*, Bethlehem, PA, Nov. 12, 2008.
6. "Information Revolution: Who, Why, What?" *Wilson College Faculty Fellows Program, Princeton University*, Princeton, NJ, Oct. 1, 2008.

Lalitha Sankar (6 of 7)

7. “Coalitions in Cooperative Networks,” *Department of Electrical and Computer Engineering, University of Southern California*, Los Angeles, CA, Nov. 7, 2007.
8. “Coalitions in Cooperative Networks,” *Department of Electrical and Computer Engineering, University of California-San Diego*, San Diego, CA, Nov. 2, 2007.
9. “User vs. Relay Cooperation in Time-Duplexed Multiaccess Relay Networks,” *Information Sciences and Systems (ISS) Seminar, Department of Electrical Engineering, Princeton University*, Princeton, NJ, Sep. 20, 2007.
10. “Capacity Bounds and Cooperative Strategies for a Multiaccess Relay Channel,” *Mathematical and Algorithmic Sciences, Bell Laboratories, Alcatel-Lucent*, Murray Hill, NJ, Oct. 31, 2006.
11. “Capacity Bounds and Cooperative Strategies for a Multiaccess Relay Channel,” *Department of Electrical Engineering, Rice University*, Houston, TX, Oct. 11, 2006.

PROFESSIONAL ACTIVITIES AND SOCIETIES:

Reviewer/Referee:

Journals:

IEEE Transactions on Information Theory, IEEE Transactions on Wireless Communications, IEEE Transactions on Communications, IEEE Journal Special Areas of Communications, ACM Mobile Computing and Communications Journal

Conferences:

IEEE International Symposium on Information Theory (ISIT) [2006-2008], IEEE Information Theory Workshop (ITW) [2007, 2008], IEEE Globecom [2004-2008], Conference on Information Sciences and Systems (CISS), 2008, IEEE Wireless Communications and Networking Conference (WCNC), [2004, 2005], IEEE Vehicular Technology Conference (VTC), [2004]

Conference Sessions Chaired:

Chair of Session on “Sensor Networks,” *IEEE International Symposium on Information Theory (ISIT)*, Toronto, CA, July 2008.

Chair of Session on “Information Theory,” *42nd Annual Conference on Information Sciences and Systems (CISS)*, Princeton, NJ, March 2008.

TPC member for the track on “Adhoc and Sensor Networks,” *Vehicular Technology Conference (VTC)* 2009.

Other Professional Services and Information:

Panel Member on “Freshman Orientation: Women in Science, Math, and Engineering,” Princeton University, Princeton, NJ, Sep. 17, 2008.

Panel Member on “Work-Family Balance” at the IEEE Symposium on Information Theory, Toronto, CA, Jul. 10, 2008.

Student Volunteer Coordinator for the IEEE Information Theory Student Society, Oct. 2005-Sep. 2008.

Organizer of six week course on “Network Information Theory” by Dr. Gerhard Kramer, Bell Laboratories, at WINLAB, Rutgers University, Feb-May 2006.

Graduate Seminar Coordinator, WINLAB, Rutgers University, Sep. 2002-Sep. 2007.

Mentornet Volunteer, May 1999 -Mar. 2002 – mentored an undergraduate, a graduate, and a postdoctoral student over this period via Mentornet, a multi-corporate sponsored e-mentoring program.

US citizen (last name shortened from **Sankaranarayanan** to **Sankar** at the time of naturalization).

REFERENCES:

H. Vincent Poor

Dean, School of Engineering and Applied Sciences
Princeton University, E-Quad, Olden St, Princeton, NJ 08544.
email: poor@princeton.edu (phone): (609) 258-2260

Narayan B. Mandayam

Professor, WINLAB, Department of Electrical Engineering
Rutgers University, Technology Center of NJ, 671 Route 1 S, North Brunswick, NJ 08902.
email: narayan@winlab.rutgers.edu (phone): (732) 932-6857 x642

Gerhard Kramer

Professor, Department of Electrical Engineering
University of Southern California, 3740 McClintock Avenue, Los Angeles, CA 90089.
email: gkramer@usc.edu (phone): (201) 953-2035

Andrea Goldsmith

Professor, Department of Electrical Engineering
Stanford University, Packard 371, Mail Code 9515, Stanford, CA 94305.
email: andrea@ee.stanford.edu (phone): (650) 725-6932

Robert Calderbank

Professor, Department of Electrical Engineering
Princeton University, E-Quad, Olden St, Princeton, NJ 08544.
email: calderbk@princeton.edu (phone): 609-258-6303

Roy D. Yates

Professor, WINLAB, Department of Electrical Engineering
Rutgers University, Technology Center of NJ, 671 Route 1 S, North Brunswick, NJ 08902.
email: ryates@winlab.rutgers.edu (phone): (732) 932-6857 x641