Signal and Information Processing Laboratory

Prof. A. Lapidoth, Prof. H.-A. Loeliger, K. Heutschi

ANNUAL REPORT

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Foreword

The first highlight of the year was the reunion of all former ISI members in February, on the occasion of both Prof. George Moschytz and Prof. Jim Massey celebrating their 75th anniversary in 2009. Almost 70 former PhD students, staff members, and professors participated in this memorable event, which concluded with a splendid dinner.

Another highlight was the appearance of Amos Lapidoth's book on digital communication, which, I believe, sets a new standard of clarity and precision in the field.

As always, we had a number of visitors. In particular, we had the pleasure of having Yossi Steinberg at our institute for several months.

The first news of 2009, however, were sad: Max Dünki, our former system administrator, died in January 2009 after a long illness. Several other partings followed in the course of the year: both Mr. Amatore and Thomas Schärer from our workshop retired (although the latter still helps us part-time), and at the end of the year my valued secretary, Bernadette Röösli, retired as well. We are immensely grateful to all of them and wish them well!

April 2010   Hans-Andrea Loeliger

Contents

1. Personnel

Professor for Information Theory:

        Prof. Amos Lapidoth

Professor for Signal Processing:

        Prof. Hans-Andrea Loeliger

Adjunct Lecturer: **Dr. Kurt Heutschi**

Secretaries:	**Bernadette Röösli**	left on 31.12.2009
	Rita Hildebrand	
Senior Researcher:	**Dr. Nikolai Nefedov**	

Research Assistants:	**Jonas Biveroni**	Dipl.El.Eng.	
	Lukas Bolliger	MSc ETH	
	Murti Devarakonda	Dipl.El.Eng	
	Tobias Koch	Dipl.El.Eng.	left on 31.10.09
	Mehdi Molkaraie	Postdoc	
	Maja Ostojic	Dipl.El.Eng.	
	Christoph Reller	MSc ETH	
	Stephan Tinguely	Dipl.El.Eng.	left on 30.4.09
	Ligong Wang	MSc ETH	
	Michèle Wigger	Dipl.El.Eng.	left on 31.3.09
	Georg Wilckens	MSc ETH	
	Jiun-Hung Yu	MSc.NCTU Taiwan	

Technical Staff:	**Francesco Amatore**	left on 31.3.09
	Thomas Schärer	
	Patrik Strebel	El.Eng.HTL

Academic Guests: (see 6.1 for report of activities)

Prof. Abraham Wyner	University of Pennsylvania, Philadelphia, USA	12.07.-16.07.09
Prof. Alek Kavcic	University of Hawaii, Honolulu Hawaii	19.07.–23.07.09
Prof. Andrew Eckford	York University of Toronto, Toronto, Canada	20.10.–23.10.09
Prof. Yossef Steinberg	Technion – Israel Institute of Technology Haifa, Israel	01.08.09 -31.01.10

2. Teaching

2.1 Lectures

Sem.	Instructors	Title	ETH-No.
5th	Prof. H.-A. Loeliger	Discrete-Time and Statistical Signal Processing	227-0101
7th	Prof. H.-A. Loeliger	Signal and Information Processing	227-0427
8th	Prof. H.-A. Loeliger	Algebra and Error Correcting Codes	227-0418
7th	Prof. A. Lapidoth	Applied Digital Information Theory I	227-0417
6th	Prof. A. Lapidoth	Information Transfer	227-0104
8th	Dr. H.P. Schmid	Analog Signal Processing and Filtering	227-0468
7th	Dr. K. Heutschi	Acoustics I	227-0477
8th	Dr. K. Heutschi	Acoustics II	227-0478

2.2 Practica

Sem.	Instructors	Title	ETH-No.
5/6th	Practica	Laboratory for "Fundamentals in Electrical Engineering"	227-0095
1st/2nd	M. Davarakonda L. Wang	Coding and Cellular Automata in Matlab	PPS
3rd/4th	L. Bolliger, G.	Blackfin DSP	PPS
2nd/3rd	Th. Schaerer	EMG Biofeedback Device	PPS

2.2 Semester Projects and Diploma Theses

During the spring semester 2009 and fall semester 2009, 6 Semester Projects (6 candidates) and 3 Diploma Theses (3 candidates) were carried out.

Candidates	Title	Supervisor
Semester Projects FS 2009		
Boming Jin	Multi-Rate Random Network Coding for Minimum-Cost Multicasting	Tobias Koch
Juan Pablo Marin Diaz	Random Matrices and Information Theory	Ligong Wang
Dominique Uebersax Stefan Scheidegger	Pulse Localization with Hypothesis Testing	Lukas Bolliger Christoph Reller
Semester Projects HS 2009		
Samuel Gaehwiler	Reconstruction of Continuous-Time Filtered White Noise given Discrete-Time Observation	Lukas Bolliger
Juan Pablo Marin Diaz	Movement Detection with a 3D-Camera: A Factor Graph Approach	Lukas Bolliger Christoph Reller
Diploma Theses FS 2009		
Adrian Bärlocher	Signal Class Filter with 2nd-Order Gaussian Models	Christoph Reller
Christian Schürch	The Multiple-Access Channel with Feedback and a Common Message	Ligong Wang
Giovanni Sabato	Simulation-Based Techniques to Study Two-Dimensional ISI Channels and Constrained Systems	Mehdi Molkaraie

3. Research

3.1 Research Areas

The Signal and Information Processing Lab focusses on research and teaching in the following areas:

Information Theory and Coding

Information theory, error correcting codes, and their application to communication systems.

Current topics:

- Combined source-channel coding for multi-access networks
- Multi-access channels with noisy feedback
- Network coding
- Capacity of fading channels
- Broadcasting correlated sources
- Multi-path channels
- Interference networks
- Optical channels

Digital Signal Processing

Current topics:

- Fundamentals and applications of graphical models (factor graphs)
- Model-based detection & estimation
- Digital calibration of analog circuits

Analog and Hybrid Signal Processing

Current topics:

- Digital-to-analog conversion and analog-to-digital conversion
- Joint synchronization and decoding

3.2 Current Research Projects

Information Theory and Coding

Prof. Dr. Amos Lapidoth

The Free-Space Optical Intensity Channel at Low SNR

Free-space optical intensity channels are used to model infrared communication in an environment with strong ambient light. Hence of particular interest is the capacity at low SNR. We derive the asymptotic growth of the channel capacity at low SNR under average and/or peak power constraints.

On Multipath Fading Channels at High SNR

We study a discrete-time, non-coherent, multipath fading channel where the number of paths is finite. The focus is on capacity at high signal-to-ratios (SNR). In particular, we investigate the capacity pre-loglog, defined as the limiting ratio of capacity to loglog SNR as SNR tends to infinity.

Multipath Channels of Unbounded Capacity

We investigate the capacity of discrete-time, non-coherent, multipath fading channels. We study conditions under which channel capacity is unbounded in the allowed transmit power.

The Poisson Channel at Low Input Powers

We study the asymptotic capacity at low input powers of an average-power limited or an average- and peak-power limited discrete-time Poisson channel. We consider channels whose dark currents are proportional to the input powers as well as channels whose dark currents are constant.

Wyner´s Interference Network with Side-Information at Transmitters and Receivers

We consider a linear interference network modeling the communication in wireless cellular systems. For this network we explore a duality regarding transmitter side-information (cognition of other transmitters`messages) and receiver side-information (observation of other receivers`signals).

The Poisson Channel with Side Information

We study the capacity of the peak-limited Poisson channel with spurious counts whose positions are given a-causally as side-information to the transmitter but not to the receiver.

Coding for a Noisy Feedback Link

We study communication in the presence of a NOISY feedback link. We assume that the feedback is active, so the noise on the feedback link can be combatted

using coding. We study specific coding schemes as well as fundamental limits that hold for all coding schemes.

The Multiple Access Channel with Causal State Information

We study a state-dependent two-to-one multiple access channel (MAC), where the state sequence is available as side-information to the transmitters but not to the receiver. We consider two scenarios depending on whether the state sequence is known strictly causally or causally.

Digital Signal Processing

Prof. Dr. Hans-Andrea Loeliger

Fundamentals and Applications of Graphical Models

Most of our research is somehow related to graphical models (factor graphs) and to message passing algorithms on such graphs. Topics include adaptation and learning, applied signal processing, modeling physical systems, and more.

Digital Calibration of Analog Circuits

We study they use of digital calibration techniques to reduce the area and the power consumption of analog circuits such as, e.g., analog-to-digital converters and digital-to-analog converters.

Joint Demodulation, Synchronization, and Decoding

We study signals, algorithms, and circuits for joint demodulation, synchronization, and decoding.

Multitree Decoding

We study near-maximum-likelihood decoding of error correcting codes including LDPC codes and other codes by generalizations of sequential decoding.

Computational Information Theory

We use Monte-Carlo methods to compute information rates of source/channel models with a nontrivial Markov structure.

Modeling and Denoising Almost-Periodic Signals

We use time-varying Fourier series for modeling and denoising almost-periodic signals.

Robust Analog Circuits

We investigate large-scale analog circuits that can be built with small (high-mismatch) transistors.

3.3 Completed Projects

KOCH Tobias Mirko

On Heating Up and Fading in Communication Channels

ETH-Diss. Nr. 18339 (Referee Prof. Dr. Amos Lapidoth)
This dissertation studies two phenomena that affect the transmission of data: heating up and fading. In particular, the effect of these phenomena on channel capacity, which is the largest rate at which data transmission with arbitrarily lower error probability is possible, is investigated.

Heating up is relevant in on-chip communication, where multiple terminals that are located on the same microchip wish to communicate with each other. It accounts for thermal coupling of data and noise. Indeed, the data to be transmitted are corrupted by thermal noise, whose variance depends on the local temperature of the chip. Furthermore, the transmission of data is associated with dissipation of energy into heat and raises therefore the local temperature of the chip. This gives rise to a channel model where the variance of the additive noise is data-dependent. The capacity of this channel is studied at low and at high transmit powers. At low transmit powers, the slope of the capacity-vs-power curve at zero is computed, and it is shown that the heating-up effect is beneficial. At high transmit powers, it is demonstrated that the heating-up effect is detrimental. In fact, if the heat dissipates slowly then the capacity is even bounded in the transmit power, i.e., the capacity does not tend to infinity as the allowed average power tends to infinity. A sufficient condition and a necessary condition for the capacity to be bounded is derived.

The results of the above analyses suggest that at low transmit powers heat sinks are not only unnecessary, but they even reduce the capacity by dissipating heat, which contains information about the transmitted signal. The results further accentuate the importance of an efficient heat sink at large transmit powers. Fading occurs in wireless communication channels. In such channels the transmitted signal is not only corrupted by additive noise, but also by multiplicative noise, which accounts for the variation of the signal's attenuation. This multiplicative noise is referred to as fading. In contrast to many other information-theoretic studies, where it is assumed that the receiver has perfect knowledge of the fading, in this dissertation it is assumed that the transmitter and the receiver only know the statistics of the fading but not its realization.

First, the capacity of multiple-input multiple-output (MIMO) Gaussian flat-fading channels with memory is considered. Nonasymptotic upper and lower bounds on the capacity are derived, and their asymptotic behavior is analyzed in the limit as the signal-to-noise ratio (SNR) tends to infinity. In particular, upper bounds on the fading number (which is defined as the second-order term in the high-SNR expansion of capacity) and on the capacity pre-log (which is defined as the limiting ratio of capacity to log SNR as SNR tends to infinity) are computed. Furthermore, an approach to derive lower bounds on the fading number is

proposed. This lower bound is applied to derive a lower bound on the fading number of spatially IID, zero-mean, MIMO Gaussian fading channels with memory. The derived upper and lower bounds on the fading number demonstrate that when the number of receive antennas does not exceed the number of transmit antennas, fading number of spatially IID, zero-mean, slowly-varying, Gaussian fading channels is proportional to the number of degrees of freedom, i.e., to the minimum of the number of transmit and receive antennas.

Second, the capacity pre-log of single-input single-output (SISO) flat-fading channels with memory is studied. It is shown that, among all stationary and ergodic fading processes of a given spectral distribution function and whose law has no mass point at zero, the Gaussian process gives rise to the smallest pre-log. It is further demonstrated that the assumption that the fading law has no mass point at zero is essential in the sense that there exist stationary and ergodic fading processes of some spectral distribution function (and whose law has a mass point at zero) that give rise to a smaller pre-log than the Gaussian process of equal spectral distribution function. These results are then extended to multiple-input single-output (MISO) fading channels with memory.

Finally, the capacity of multipath (frequency-selective) fading channels is studied. It is shown that if the delay spread is large in the sense that the variances of the path gains decay exponentially or slower, then the capacity is bounded in the SNR. Thus, in this case the capacity does not grow to infinity as the SNR tends to infinity. In contrast, if the variances of the path gains decay faster than exponentially, then the capacity is unbounded in the SNR. It is further demonstrated that if the number of paths is finite, then the capacity pre-loglog, which is defined as the limiting ratio of capacity to log log SNR as SNR tends to infinity, is 1, irrespective of the number of paths.

The conclusions that can be drawn from the above described analyses of fading channels are manifold. First, the presence of multiple antennas at the transmitter and receiver is very beneficial, even if the receiver does not know the realization of the fading. Second, the Gaussian fading assumption in the analysis of fading channels at high SNR is conservative in the sense that for a large class of fading processes the Gaussian process gives rise to the smallest capacity pre-log. Third, at high SNR multipath fading channels with an infinite number of paths should not be approximated by multipath fading channels with a finite number of paths, since these channels possess completely different capacity behaviors at high SNR. And last but not least, the high-SNR asymptotic behavior of the capacity of fading channels is very sensitive to the employed channel model. Thus, in the information-theoretic analysis of fading channels at high SNR and in the evaluation of the results thereof, one should attach great importance to the channel model.

3.4 Completed Dissertations

KOCH Tobias Mirko

On Heating Up and Fading in Communication Channels

ETH-Diss. Nr. 18339

Referee:	Prof. Dr. Amos Lapidoth
Co-referees:	Prof. Dr. Helmut Bölcskei
	Prof. Dr. Emre Telatar

4. Conferences, Meetings and Committees

4.1 Conference Organization

Prof. Loeliger

> Member TPC, ISIT 2009

Prof. Lapidoth

> Co-Chair, IZS 2010

4.2 Participation in Congresses and Meetings

Devarakonda Murti	IEEE Information Workshop, Taormina, Italy, 11.-16.10.2009
El Mechat M.-A.	17th European Signal Processing Conf.erence (EUSIPCO), Glasgow, Scotland, 24.-28.8.2009
Lapidoth Amos	2nd International Workshop on Advances in Communications, Boppard am Rhein, Germany, 13.-15.5.2009
Lapidoth Amos	IEEE International Symposium on Information Theory (ISIT), Seoul, Korea, 28.6. – 3.7.2009
Lapidoth Amos	IEEE Information Theory Workshop, Taormina, Italy, Oct. 11.-16.2009
Lapidoth Amos	Path Ahead in the Science of Information and Decision Systems; Massachusetts Institute of Technology (Cambridge, USA), Nov. 11.-14.112009
Loeliger H.-A.	Information Theory and Applications Workshop (ITA), UCSD, La Jolla, CA., 8.-13.2.2009
Loeliger H.-A.	IEEE International Symposium on Information Theory (ISIT), Seoul, Korea, 28.6. – 3.7.2009
Molkaraie Mehdi	IEEE Information Theory Workshop, Taormina, Italy, 11.-16.10.2009
Nefedov Nikolai	2nd International Workshop on Nonlinear Dynamics and Synchronization, Klagenfurt, Austria, 20.7.2009
Reller Christoph	17th European Signal Processing Conference (EUSIPCO), Glasgow, Scotland, 24.-28.8.2009
Trajkovic Ivo	17th European Signal Processing Conference (EUSIPCO), Glasgow, Scotland, 24.-28.8.2009
Wang Ligong	IEEE International Symposium on Information Theory (ISIT), Seoul, Korea, 28.6.-3.7.2009

4.3 Service Activities and Society Memberships

Prof. Lapidoth

Fellow of the IEEE

Member of the IMS Institute of Mathematical Statistics, Bethesda, USA

Co-Chair, 2009 International Zurich Seminar on Communications

Research Affiliate in the Research Laboratory of Electronics (RLE) at the Massachusetts Institute of Technology (MIT)

Member of the Center for Communication and Information Technologies (CCIT), Technion, Haifa, Israel

Prof. Loeliger

Fellow of the IEEE

Associate Editor, IEEE Transactions on Information Theory

Chair, IEEE Switzerland Chapter on Digital Communication

Member, Board of Governors, IEEE Information Theory Society

Studiendelegierter D-ITET, ETH Zurich

Dr. Heutschi

Member, Acoustical Society of America

Member, Audio Engineering Society

Member, Swiss Acoustical Society (SGA)

Member, German Acoustical Society (DEGA)

4.4 Presentations by Institute Members

Devarakonda Murthy	"Continous-time matched filtering and decoding without synchronization", IEEE Information Theory Workshop, Taormina, Italy, 11.-16.10.2009
El Mechat M.-A.	"Maximum likelihood range estimation for 3D-imaging based on pseudo-noise optical modulation", 17th European Signal Proc. Conf. (EUSIPCO), Glasgow, Scotland, 24.-28.8.2009
Lapidoth Amos	"The Power Spectral Density of Quadrature Amplitude Modulation Done Right", 2nd International Workshop on Advances in Communications (on the occasion of the 60th birthday of Professor Han Vinck), Boppard am Rhein, Germany, 13.-15.5.2009
Lapidoth Amos	"Error Exponents for the Gaussian Channel with Noisy Active Feedback", The Technion-Israel Institute of Technology, Haifa, Israel, 24.12.2009
Lapidoth Amos	"Error Exponents for the Gaussian Channel with Noisy Active Feedback, Ben Gurion University, Beer Sheva, Israel, 28.12.2009
Lapidoth Amos	"A cognitive network with clustered decoding", IEEE International Symposium, Seoul, Korea, 28.6.–3.7.2009
Loeliger H.-A.	"Localizing, forgetting, and likelihood filtering in state-space models", Information Theory and Applications Workshop (ITA), UCSD, La Jolla, CA., 8.-13.2.2009
Loeliger H.-A.	"Model-based signal processing and the brain", ZNZ Symposium, ETH, 11.9.2009
Molkaraie Mehdi	"Estimating the partition function of 2-D fields and the capacity of constrained noiseless 2-D channels using tree-based Gibbs Sampling", IEEE Information Theory Workshop, Taormina, Italy, 11.-16.10.2009
Nefedov Nikolai	"Distributed Estimation and Synchronization in Wireless Networks: Coupled Dynamical Systems Approach", 2nd Int. Workshop on Nonlinear Dynamics and Synchronization, Klagenfurt, Austria, 20.7.2009
Trajkovic Ivo	"Modelling and filtering almost periodic signals by time-varying Fourier series with application to near infrared spectroscopy, 17th European Signal Proc., Conf, (EUSIPCO), Glasgow, Scotland, 24.-28.8.2009
Wang Ligong	"Simple Channel Coding Bounds", IEEE International Symposium on Information Theory, Seoul, Korea, 28.6.–3.7.2009

Wang Ligong   "The poisson Channel with Side Information", Forty-Seventh Annual Allerton Conference, Allerton IL, USA, 30.9.2009-2.10.2009

4.5 Organization of Lectures, Seminars, and Colloquia

Speakers invited by Prof. Lapidoth:

18.03.09   **Prof. Gerhard Kramer,** USC Los Angeles, USA
"Outer Bounds on the Admissible Source Region for Broadcast
Channels with Dependent Sources".

17.06.09   **Dr. Parastoo Sadeghi,** Australian National University, Canberra,
Australia,
"Adaptive Network Coding for Decoding Delay Minimization in
Broadcast Erasure Channels".

13.07.09   **Prof. Abraham Wyner,** University of Pennsylvania, USA
"A Statistical Analysis of Multiple Temperature Proxies: Are
reconstrutions of Surface Temperatures over the last 1000 years
reliable?"

17.08.09   **Prof. Edmund Yeh,** Yale University, New Haven, USA
"Percolation Theory and Large-Scale Wireless Networks:
Connectivity".

24.07.09   **Prof. Alexander Vardy,** Univeersity of California, San Diego, USA
"Multivariate Interpolation Decoding or Closing the Gap between
Shannon and Hamming".

Invited by Prof. Loeliger:

22.07.09   **Prof. Alek Kavcic,** University of Hawaii, Honolulu, USA
"2-D Magnetic Recording".

07.10.09   **Prof. Pascal Vontobel,** Hewlett-Packard Laboratories, Palo Alto, USA
"The Sum-Product Algorithm: News and Views".

08.10.09   **Prof. Pascal Vontobel,** Hewlett-Packard Laboratories, Palo Alto, USA
"Persolation Theory and Large-Scale Wireless Networks:
Connectivity and Transmission Delay".

Colloquium Speakers for the Colloquium "Acoustics" were:

Invited by Dr. Heutschi:

01.04.09   **Ruedi Büttikofer,** Dipl.-Ing ETH. EMPA, Dübendorf, Switzerland,
Abteilung Akustik/Lärmminderung
"Gehschall auf schwimmend verlegten Hartböden: Modellierung und
Messung".

13.05.09   **Beat W. Hohmann,** Dr. sc. techn. ETH, Luzern, Switzerland
"SOUNDSCAPES – eine kritische Zwischenbilanz".

14.10.09   **Hervé Lissek,** Dr., Laboratoire. d'Electromagnétisme et d'Acoustique, EPFL, Lausanne, Switzerland
             "Advanced microphone techniques for sound source identification"

25.11.09   **Frits van den Berg,** Dr., Public Health Service of Amsterdam, Niederlande
             "Characteristics and perception of wind turbine sound".

16.12.09   **Dirk Noy,** Dipl. Phys., Walters-Storyk Design Group, Basel Switzerland
             "Tiefe Frequenzen in der Raumakustik – Rechnerische Prognose und Optimierung mittels aktiver und passiver Absorption"

5. Publications

Bross S., Lapidoth A., Wang L. — "The Poisson channel with side information", Proceedings 47th Annual Allerton Conference on Communication, Controll and Computing, Monticello, Il, USA, Sept.30–Oct.2. 200

Devarakonda Murthy Loeliger H.-A. — "Continuous-time matched filtering and decoding without synchronization", Proc. IEEE Information Theory Workshop, Taormina, Italy, Oct. 11-16, 2009, pp. 139-143.

El Mechat M.-A. Loeliger H.-A. — "Maximum likelihood range estimation for 3D-imaging based on pseudo-noise optical modulation", Proceedings 17th European Signal Proc. Conf. (EUSIPCO), Glasgow, Scottland, Aug. 24-28. 2009, pp. 2082-2086.

Koch T., Lapidoth A., Sotiriadis P.P. — "Channels that heat up", IEEE Transactions on Information Theory, IT-55, 2009, No. 8, pp. 3594 - 3612

Kurkoski B.M., Dauwels J. Loeliger H.-A. — "Power-constrained communications using LDPC lattices", Proc. 2009 IEEE Int. Symposium on Information Theory, Seoul, Korea, June 28 – July 3, 2009, pp. 739-743

Lapidoth A. — "A Foundation in Digital Communication", Cambridge University Press

Lapidoth A., Moser S. — "On the capacity of the discrete-time Poisson channel", IEEE Transactions on Information Theory, IT-55, 2009, No. 1, pp- 303 - 322

Lapidoth A., Moser S., Wigger M. — "On the Capacity of Free-Space Optical Intensity Channels", IEEE Transactions on Information Theory, IT-55, No. 10, 2009, pp. 4449-4461

Lapidoth A., Levy N., Shaimai (Shitz) S., Wigger M. — "A Cognitive Network with Clustered Decoding"., IEEE Int. Symposium on Information Theory, Seoul, Korea, June 28–July 3, 2009, pp. 596 - 600

Loeliger H.-A. Bolliker Lukas Korl Sascha Reller Christoph — "Localizing, forgetting, and likelihood filtering in state-space models", 2009 Information Theory and Applications Workshop (ITA), UCSD, La Jolla, CA, Feb. 8-13, 2009.

Loeliger H.-A. Molkarai Mehdi — "Estimating the partition function of 2-D fields and the capacity of constrained noiseless 2-D channels using tree-based Gibbs sampling", Proc. 2009 IEEE Information Theory Workshop, Taormina, Italy, Oct. 11-16, 2009, pp. 228-232.

Nefedov Nikolai — "Distributed estimation and synchronization in sireless networks: coupled dynamical systems approach", 2nd Int. Workshop on Nonlinear Dynamics and Synchronization, Klagenfurt, Austria, 2009.

Nefedov Nikolai — "Quantum-like computations using coupled nano-scale oscillators", Lecture Notes of Institute for Computer

	Science and Telecom. Ingenieering (LNICST), 2009, Springer, pp. 64-69.
Sethuraman V., Wang L., Hajek B., Lapidoth A.	"Low-SNR Capacity of Noncoherent Fading Channels", IEEE Transations on Information Theory, IT- 55, 2009, No. 4, pp. 1555-1574
Trajkovic Ivo Reller Christoph Wolf Martin Loeliger H.-A.	"Modelling and filtering almost periodic signals by time-varying Fourier series with application to near infrared spectroscopy", Proceedings 17th European Signal Proc. Conf. (EUSIPCO), Glasgow, Scottland, Aug. 24-28. 2009, pp. 632-636.
Wang L., Colbeck R., Renner R.	"Simple Channel Coding Bounds", Proceedings of IEEE Int. Symposium on Information Theory, Seoul, Korea, June 28–July 3, 2009

6. Guests, Visitors

6.1 Activies of Academic Guests at the Institute

Guests of Prof. Lapidoth:

Prof. Abraham Wyner,
University of Pennsylvania, Philadelphia, USA   12.07-16.07.09

Prof. Yossef Steinberg,
Technion, Israel Institut of Technology, Technion City,
Haifa, Israel   1.8.09–31.1.2010

Guest of Prof. Loeliger:

Prof. Alek Kavcic
University of Hawaii, Honolulu, USA
Held a talk on "2-D Magnetic Recording"   19.07-23.07.09

Prof. Andrew Eckford
York University of Toronto, Toronto, USA   20.10-23.10.09