Algebraic Structure in Network Information Theory
August 14-19, 2011

Organizers:
Michael Gastpar (UC Berkeley, USA, and Ecole Polytechnique Fédérale, Lausanne, Switzerland)
Frank Kschischang (University of Toronto, Canada)

MEALS

*Breakfast (Buffet): 7:00–9:30 am, Sally Borden Building, Monday–Friday
*Lunch (Buffet): 11:30 am–1:30 pm, Sally Borden Building, Monday–Friday
*Dinner (Buffet): 5:30–7:30 pm, Sally Borden Building, Sunday–Thursday
Coffee Breaks: As per daily schedule, 2nd floor lounge, Corbett Hall
***Please remember to scan your meal card at the host/hostess station in the dining room for each meal.**

MEETING ROOMS

All lectures will be held in Max Bell 159 (Max Bell Building accessible by walkway on 2nd floor of Corbett Hall). LCD projector, overhead projectors and blackboards are available for presentations. Note that the meeting space designated for BIRS is the lower level of Max Bell, Rooms 155–159. Please respect that all other space has been contracted to other Banff Centre guests, including any Food and Beverage in those areas.

SCHEDULE

Sunday

16:00	Check-in begins (Front Desk - Professional Development Centre - open 24 hours)
	Lecture rooms available after 16:00 (if desired)
17:30–19:30	Buffet Dinner, Sally Borden Building
20:00	Informal gathering in 2nd floor lounge, Corbett Hall (if desired)
	Beverages and a small assortment of snacks are available on a cash honor system.

Monday

7:00–8:45	Breakfast
8:45–9:00	Introduction and Welcome by BIRS Station Manager, Max Bell 159
9:00	9-9:30 Michael Gastpar / Frank Kschischang OPENING REMARKS
	9:30-10:30 Ram Zamir
	Coffee Break, 2nd floor lounge, Corbett Hall - 10:30-10:50
	10:50-11:20 Uri Erez
11:30–13:00	Lunch
13:00–14:00	Guided Tour of The Banff Centre; meet in the 2nd floor lounge, Corbett Hall
	14:20-14:50 Sandeep Pradhan
	14:55-15:25 Alex Vardy
	Coffee Break, 2nd floor lounge, Corbett Hall - 15:30-15:50
	15:50-16:05 Katie Morrison
	16:10-16:25 Anna-Lena Trautmann
	16:30-17:00 Nigel Boston
17:30–19:30	Dinner

Tuesday

7:00–9:00	Breakfast
9:00	9-10 Shlomo Shamai
	Coffee Break, 2nd floor lounge, Corbett Hall - 10-10:15
	10:15-10:45 Bobak Nazer
	10:50-11:20 Urs Niesen
	11:25-11:55 Krishna Narayanan
12:00–13:30	Lunch
	14:00-14:30 Sae-Young Chung
	14:35-15:05 Gerhard Kramer
	Coffee Break, 2nd floor lounge, Corbett Hall - 15:05-15:30
	15:30-16:00 Natasha Devroye
	16:05-16:35 Liang-Liang Xie
17:30–19:30	Dinner
19:30-21:00	Open Problems

Wednesday

7:00–9:00	Breakfast
9:00	9:00-9:30 Alex Dimakis
	9:35-10:05 Viveck Cadambe
	Coffee Break, 2nd floor lounge, Corbett Hall - 10:10-10:25
	10:30-11:00 Sriram Vishwanath
	11:05-11:35 Aylin Yener
	11:40-11:55 Guy Bresler
	12:00-12:15 Chen Feng
12:20	Group Photo; meet on the front steps of Corbett Hall
12:30–13:30	Lunch
	Free Afternoon
17:30–19:30	Dinner

Thursday

7:00–9:00	Breakfast
8:30	8:30-9:00 Joachim Rosenthal
	9:05-9:35 Frederique Oggier
	9:40-10:10 Emanuele Viterbo
	Coffee Break, 2nd floor lounge, Corbett Hall - 10:15-10:30
	10:30-11:00 Babak Hassibi
	11:05-11:20 Matthew Nokleby
	11:25-11:40 Yiwei Song
	11:45-12:00 Jiening Zhan
12:05–13:30	Lunch
	14:00-14:30 Danilo Silva
	14:35-15:05 Tracey Ho
	Coffee Break, 2nd floor lounge, Corbett Hall - 15:05-15:30
	15:30-16:00 Aaron Wagner
	16:05-16:35 Prakash Ishwar
	16:40-17:10 Mohammad Ali Maddah-Ali
17:30–19:30	Dinner
19:30-21:00	Open Problems

Friday	
7:00–9:00	Breakfast
9:00	9:00-9:30 Slawomir Stanczak 9:35-10:05 Ashish Khisti Coffee Break, 2nd floor lounge, Corbett Hall - 10:10-10:25 10:25-11:30 CLOSING and (of?) OPEN PROBLEMS
11:30–13:30	Lunch
Checkout by 12 noon.	

** 5-day workshops are welcome to use BIRS facilities (2nd Floor Lounge, Max Bell Meeting Rooms, Reading Room) until 3 pm on Friday, although participants are still required to checkout of the guest rooms by 12 noon. **

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ABSTRACTS
(in alphabetic order by speaker surname)

Speaker: **Nigel Boston** (University of Wisconsin, Madison, USA)
Title: *Trellises and Pseudocodewords*
Abstract: Trellises and their pseudocodewords are studied via new algebraic tools, such as their path-adjacency matrices and characteristic polynomials. These behave well with respect to products of trellises and allow invariant theory to shed light on the pseudocodewords. If time permits, I shall mention new results on minimal trellises. This is joint work with David Conti.

Speaker: **Guy Bresler** (University of California, Berkeley, USA)
Title: *Feasibility of interference alignment for the MIMO interference channel: the symmetric square case*
Abstract: Determining the feasibility conditions for vector space interference alignment in the K-user MIMO interference channel with constant channel coefficients has attracted much recent attention yet remains unsolved. The main result of this talk is restricted to the symmetric square case where all transmitters and receivers have N antennas, and each user desires d transmit dimensions. We prove that alignment is possible if and only if the number of antennas satisfies $N \geq d(K+1)/2$. We also show a necessary condition for feasibility of alignment with arbitrary system parameters. An algebraic geometry approach is central to the results.

This is joint work with Dustin Cartwright and David Tse.

Speaker: **Viveck Cadambe** (University of California, Irvine, USA)
Title: *Common Invariant Subspaces and Tensor Products for Interference Alignment in Wireless Communications and Distributed Storage*
Abstract: The idea of interference alignment has profound impact on wireless communications and distributed storage systems. In this talk, we will formulate a variant of the common invariant subspace problem in linear algebra with connections to interference alignment. We will describe applications of the problem to wireless communications and distributed storage. Finally, we present a novel tensor product based solution to the problem which is of particular relevance to development of codes in distributed storage.

Speaker: **Sae-Young Chung** (KAIST, South Korea)
Title: *How helpful is algebraic structure in network information theory?*
Abstract: In this talk, we discuss the benefits of algebraic structure in network information theory using the Gaussian two-way relay channel as an example. We show that using nested lattice codes it is possible to achieve the capacity of the channel to within $\frac{1}{2}$ bit per user and to within $\log\frac{3}{2} \sim 0.58$ bits for the sum rate. Somewhat surprisingly, however, we can also show that the capacity can be achieved to within $\frac{1}{2}$ bit per user and to within 1 bit for the sum rate using noisy network coding, which does not have any algebraic structure. Therefore, algebraic structure is not essential for designing good achievable schemes at least for the channel. We discuss why this is the case using some intuitive examples.

Speaker: **Natasha Devroye** (University of lllinois at Chicago, USA)
Title: *Lattice codes for Gaussian relay channels*
Abstract: The derivation of achievable rate regions for general networks including relays has classically used random-coding based techniques. Only in recent years have structured codes, rather than random codes, been used in networks with relays. The benefit of using structured codes in networks lies not only in a somewhat more constructive achievability scheme, but also in actual rate gains which exploit the structure of the codes usually their linearity in Gaussian channels to decode combinations of codewords in networks, as in the Nazer-Gastpar Compute-and-Forward framework. While past work has focussed mainly on specific scenarios in which structured or lattice codes are particularly beneficial, missing is the demonstration lattice codes may actually be used to achieve the same rate as known random coding based schemes in Gaussian relay networks, in addition to going above and beyond random codes in certain scenarios. We demonstrate generic nested-lattice code based schemes for achieving Decode-and-Forward and Compress-and-Forward based rates in Gaussian relay channel which achieve at least the same rate as the corresponding random coding based regions. In the longer term, we believe these strategies may be combined with strategies which exploit the structure of lattice codes to obtain structured coding schemes for arbitrary Gaussian relay networks. Towards this goal, we illustrate how these DF and CF based lattice strategies may be combined with strategies which exploit the linearity of lattice codes in three examples of networks: the two-way relay channel with direct links, the multiple- access relay channel, and various multi-hop relay channels with state.

Speaker: **Alex Dimakis** (University of Southern California, USA)
Title: *Interference Alignment for Network coding and Distributed Storage*
Abstract: Distributed storage schemes for data centers and peer-to-peer networks often use traditional erasure codes to introduce redundancy for robustness. Following recent developments, we will show that interference alignment is fundamental for distributed storage repair problems and demonstrate equivalence of interference alignment to a rank minimization problem. This allows the interpretation of interference alignment schemes as solutions to an optimization problem. The optimization framework allows the design of new storage codes and beamforming matrices.

Speaker: **Uri Erez** (Tel Aviv University, Israel)
Title: *Lattice coding problems: The easy and the hard*
Abstract: Lattices appear in numerous problems in information and communication theory, in a variety of distinct contexts. In some cases, the lattice is generated by nature: for instance, the received signal in a MIMO communication problem where a PAM constellation is used for transmission lies in an induced lattice. In such problems, the lattice is generic and does not possess any additional special structure. Accordingly, while requiring less complexity than for random (non-lattice) constellations, nearly all tasks of interest require highn complexity (are NP hard).

The focus of this talk will be be on scenarios where the lattice may be judiciously designed, with the aim of being both nearly optimal for a given task (e.g., quantization, channel coding, etc.), yet at the same time allowing for efficient encoding/decoding. In such a context, lattices are used as a form of (linear) coded modulation. In other words, lattices are the Euclidean space counterparts of linear codes over finite groups. An important construction of lattices is known as Construction A, where a linear codes defined over a finite alphabet is lifted to Euclidean space. Beyond allowing for a simple proof that lattices are at least as good as random codes for virtually any task (and indeed, Construction A lies at the heart of most proofs of the Minkowski-Hlawka theorem), when a lattice is generated via Construction A, one can relate its "goodness" to the properties of the underlying linear code, and in particular to the latter's alphabet size. In this light, we review some basic problems where lattices are used in communication and discuss the associated encoding/decoding complexity, the interplay between the underlying alphabet size, and discuss the implications of whether an infinite (unbounded) lattice is considered or a lattice restricted to a finite region. We observe that while for the quantization problem, the distinction is of little consequence, the situation for channel coding is quite different. In particular, we observe that form an operational standpoint duality does not hold between channel and source coding problems, and the role of the underlying alphabet size plays a very different role in these problems.

Speaker: **Chen Feng** (University of Toronto, Canada)
Title: *An Algebraic Approach to Physical-Layer Network Coding*
Abstract: Compute-and-forward (C&F) relaying strategy is a promising new approach to physical-layer network coding (PNC). Nazer and Gastpar demonstrated its asymptotic gain using information-theoretic tools. In this talk, we will take an algebraic approach to show its potential in practical, non-asymptotic, settings. We first develop a general framework for studying lattice-partition- based PNC schemes—called lattice network coding (LNC) schemes for short—by making a direct connection between C&F and module theory. Based on this framework, we provide several generalized constructions of LNC schemes. We then analyze the error performance of LNC schemes, with a particular focus on hypercube-shaped LNC schemes. From this analysis, we derive several design criteria both for choosing receiver parameters and for optimizing lattice partitions. Finally, we present some concrete design examples.

Joint work with Frank Kschischang and Danilo Silva.

Speaker: **Babak Hassibi** (California Institute of Technology, USA)
Title: *Network Codes and Groups*
Abstract: TBA

Speaker: **Tracey Ho** (California Institute of Technology, USA)
Title: *On coding for networks with errors*
Abstract: Network error correction coding for single-source multicast networks with a uniform error model (where links or packets have equal capacity and any z of them may be erroneous) has been well studied, with a number of existing algebraic code constructions. In this talk, we describe the differences and new coding schemes needed for multiple-source multicast, special cases of non-multicast, and non-uniform link error models. We also discuss connections with erasure correction coding.

Speaker: **Prakash Ishwar** (Boston University, USA)
Title: *Exploring Function and Distribution Structure in Interactive Computing Through Examples*
Abstract: The efficiency of network function computation is ultimately governed by the complex interplay of function structure, distribution structure, and network structure. While we are far from unraveling this complex interplay, insights can be gained along certain axes through examples. This talk will explore the interplay between function and distribution structure through simple examples to highlight interesting possibilities that open up when interaction is thrown into the mix.

Speaker: **Ashish Khisti** (University of Toronto, Canada)
Title: *Prospicient Source-Channel Codes for Real-Time Streaming*
Abstract: Real-time streaming applications involve encoders that process an incoming source stream causally and a delay-constrained receiver. We study the underlying *streaming capacity* of such systems and observe that careful code constructions that guarantee the recovery of just the right packet by its deadline are necessary. We call such structures prospicient source-channel codes.

In this talk we will focus on a simple burst-erasure channel model and study two problems: streaming data with exact recovery and streaming a Markov source with an error-propagation constraint. In both cases we propose some fundamental limits, new converse techniques, and also establish need for prospicient structures to achieve these limits.

Speaker: **Gerhard Kramer** (Technische Universität München, Germany)
Title: *Message Lengths for Noisy Network Coding*
Abstract: TBA

Speaker: **Mohammad Ali Maddah-Ali** (Bell Laboratories Lucent Technologies, USA)
Title: *Distributed Source Coding: Using Lattices to Eliminate Unneeded Layers of Source*
Abstract: In this talk, we investigate the problem of distributed Gaussian source coding for more than two sources. To be specific, we focus on "two–help–one problem" where three isolated encoders observe the sources and report indices to a central decoder. The decoder requires reconstructing one of the sources with certain distortion. We use the binary expansion model as a simple tool to show that for certain range of parameters, none of the known schemes can achieve within bounded gap of the capacity. Considering each source as a multi-layer input, we have this surprising observation that some higher and lower layers of the sources are required at the decoder, while some middle layers are not needed. Relying on lattices to eliminate the middle-layers without affecting the lower–layers of the sources, we develop a new signaling scheme to achieve within bounded gap of the capacity region.

Speaker: **Katie Morrison** (University of Nebraska, Lincoln, USA)
Title: *Properties of Rank-Metric and Matrix Codes with Applications to Network Coding*
Abstract: Subspace codes have become widely studied since Koetter and Kschischang first proposed their use in error correction for random network coding. One common construction for subspace codes is the lifting of linear codes whose codewords are either matrices over $\mathbb{F}_q$ or vectors over $\mathbb{F}_{q^m}$ with the rank metric; both matrix codes, also known as space-time codes over a finite field, and rank-metric codes have been utilized to create efficient subspace codes. Thus, as we seek to understand various properties of subspace codes, we are led to investigate corresponding properties of rank-metric and matrix codes. In particular, we will examine the notion of equivalence for rank-metric and matrix codes and use this to characterize the automorphism groups of these codes. We will also analyze some aspects of a duality theory for these codes with an aim toward developing a duality theory for more general constructions of subspace codes as well.

Joint work with Judy Walker.

Speaker: **Krishna Narayanan** (Texas A&M University, USA)
Title: *Coding for Parallel Gaussian Bi-Directional Relay Channels: A Deterministic Approach*
Abstract: We study the design of good coding schemes and the achievable exchange rates for parallel Gaussian bi-directional relay channels. We first consider the corresponding linear deterministic model and propose two different schemes that can achieve the exchange capacity for this linear deterministic model. The insights obtained from this are used to design coding schemes for the original parallel Gaussian bi-directional relay channels. The first coding scheme uses superposition-based coding at both nodes and reorders codewords that cannot be transmitted within their own sub-channels to the sub-channels that can support the transmission at the relay. The second coding scheme employs lattice partition chains proposed by Nam et al. in the multiple access phase and then performs coding across sub-channels in the broadcast phase. While both schemes are optimal for the linear deterministic model, the performance of their Gaussian counterparts are different in general and which one performs better depends on the operating SNR and channel coefficients. Numerical results show that both schemes substantially outperform the decode-and-forward scheme and also provide non-trivial gains over other recently proposed schemes. Moreover, it is shown that the performance of both schemes is close to that of the cut-set bound and that the second scheme is asymptotically optimal.

Speaker: **Bobak Nazer** (Boston University, USA)
Title: *Lattice Techniques in AWGN Networks: What's missing?*
Abstract: It is now well-known that, in certain network settings, structured random codes can achieve better rates than i.i.d. random codes. However, in many of these settings, we still do not know the capacity region. This either means that the coding argument can be improved or that the outer bound can be tightened. In particular, this phenomenon highlights the fact that several of the techniques taken for granted in random i.i.d. coding, such as joint typicality decoding, are not fully understood in the context of

structured random codes. In this talk, we will overview some of these challenges, as well as recent progress towards them, through the lens of the compute-and-forward strategy.

Speaker: **Urs Niesen** (Bell Laboratories Lucent Technologies, USA)
Title: *The Degrees of Freedom of Compute-and-Forward*
Abstract: We analyze the asymptotic behavior of compute-and-forward relay networks in the regime of high signal-to-noise ratios. We consider a section of such a network consisting of K transmitters and K relays. The aim of the relays is to reliably decode an invertible function of the messages sent by the transmitters. An upper bound on the capacity of this system can be obtained by allowing full cooperation among the transmitters and among the relays, transforming the network into a $K \times K$ multiple-input multiple- output (MIMO) channel. The number of degrees of freedom of compute-and- forward is hence at most K. We then analyze the degrees of freedom achieved by the lattice coding implementation of compute-and- forward proposed recently by Nazer and Gastpar. We show that this lattice implementation achieves at most $2/(1 + 1/K) < 2$ degrees of freedom, thus exhibiting a very different asymptotic behavior than the MIMO upper bound. This raises the question if this gap of the lattice implementation to the MIMO upper bound is inherent to compute- and-forward in general. We answer this question in the negative by proposing a novel compute-and- forward implementation achieving K degrees of freedom.

This is joint work with Phil Whiting.

Speaker: **Matthew Nokleby** (Rice University, USA)
Title: *Cooperative Computation over Multiple-access Channels*
Abstract: Motivated by recent work applying lattice codes to physical-layer network coding, we study a system in which the receiver computes a finite-field linear combination of users' messages. Previous lattice techniques require that the linear combination be closely matched to the channel coefficients in order to achieve a non-trivial computation rate. To overcome this issue, we present a cooperative computation scheme based on a lattice-coding approach to block Markov encoding. In addition to improving

Speaker: **Frederique Oggier** (Nanyang Technological University, Singapore)
Title: *An Error Probability Approach to Wiretap Code Design*
Abstract: We consider the problem of designing wiretap codes for Gaussian, fading and MIMO channels, for all of which we use a common approach: analyzing the probability that an eavesdropper Eve is able to decode the confidential message that Alice sends to Bob. We show that when Alice performs lattice coset encoding, minimizing the probability of Eve's correct decision yields a code design criterion, indicating which lattices should be used to increase Eve's confusion. In the case of Gaussian channels, this code design criterion is characterized by a new lattice invariant called the secrecy gain expressed in terms of the theta series of a lattice, while for MIMO channels, the study of the Alamouti code in particular makes use of the Epstein zeta function of a lattice.

Joint work with J.-C. Belfiore.

Speaker: **Sandeep Pradhan** (University of Michigan at Ann Arbor, USA)
Title: *Asymptotically Good Nested Linear Codes: Toward algebraic network information theory*
Abstract: In the last decade, for several specific examples of multi-user communication problems, it has been shown that the performance of random linear code ensembles can be better than that of the random unstructured code ensembles. However, it is well-known that linear codes do not achieve even the Shannon performance limits for point-to-point communication in the general discrete memoryless case both for source coding and channel coding. In this work we show that the above deficiency of such a class of algebraic codes can be overcome by nesting one code in another. In particular we show that nested linear codes can achieve the Shannon performance limits in the point-to-point setting. We will also show that nested linear codes can be used as building blocks toward a unified approach to multiuser communication.

Speaker: **Joachim Rosenthal** (Universität Zürich, Switzerland)
Title: *Schubert Calculus and its Relation to Network Coding*
Abstract: Hermann Schubert developed in the second part of the 19th century a symbolic method to deal with a large variety of enumerative problems. The answers he derived with his 'Schubert calculus' were remarkable but could not be verified rigorously by the mathematics community of the time. Hilbert devoted the 15th of his famous 23 problems to the verification of Schubert calculus. In our talk we will provide a tutorial for the non-specialist into Schubert calculus. We will then show how the construction of constant dimensional linear network codes is naturally linked to questions of Schubert calculus.

Speaker: **Shlomo Shamai** (Technion-Israel Institute of Technology, Israel)
Title: *Lattice Based Structuring to Combat Interference in Simple Wireless Networks*
Abstract: In this talk we demonstrate the advantage of the inherent algebraic structure of lattice codes in simple wireless networks. First, we consider the uplink channel in a simple Wyner type cellular model, with adjacent out of cell interference. A compute-and-forward relaying is employed, where cell sites decode equations of the transmitted bits by exploiting the channel interference. The penalty for non-integer channel coefficients is mitigated by a superposition strategy, which in certain regimes outperforms decode-and-forward, compress-and-forward, and standard compute-and-forward.

The second part of the talk focuses on mitigation of interference in a distributed, relay assisted network. The model includes one transmitter communicating to a remote destination via two strongly interfered relays, which forward messages to the destination through reliable links with finite capacities. We study different settings of distributed processing, and find the scaling (pre-log) behavior. The upper bounds are based on cut-set arguments, combined with a multiple letter bounding technique, while in the lower bounds, Lattice based structures are in some cases advantageous to random coding arguments. It is demonstrated that in most interesting cases, alleviating interference (in terms of scaling), requires forwarding a definite amount of information about the interference along with the desired message,

The talk is based on joint studies with Amichai Sanderovich, Michael Gastpar, Bobak Nazer and Michael Peleg.

Speaker: **Danilo Silva** (Federal University of Santa Catarina, Brazil)
Title: *Error control and security for noncoherent network coding*
Abstract: It is known that schemes based on rank-metric codes can provide asymptotically optimal (as well as practical) solutions to certain problems in noncoherent network coding, such as error control against an omniscient adversary and security against an eavesdropper. In this talk, we will consider two related problems: (1) error control when source and and destination(s) share common randomness that is hidden from the adversary; and (2) providing security in conjunction with error control. In both scenarios we describe how algebraic structure (in terms of rank-metric codes and extension fields) can be exploited to construct improved schemes.

Speaker: **Yiwei Song** (University of lllinois at Chicago, USA)
Title: *Further comments on lattices for Gaussian relay networks*
Abstract: Two problems may be covered in this talk: 1) Lattice list decoding is the critical technique used in various examples of Gaussian relay channels in "Lattices for Gaussian relay networks". In this talk, further comments and some interesting observations on lattice list decoding are given. Compared with the unique decoding, list decoding is rarely talked about but it can be important in the network information theory. 2) Two-way multi-relay channel. In the AWGN two-way and two-way relay channel, two transmitter can transmit at the same time without (or nearly without) interfering each other. How about two-way multiple-relay channel? The possibility and difficulty of using lattice codes in this model are discussed. Joint work with Natasha Devroye.

Speaker: **Slawomir Stanczak** (Technische Universität Berlin, Germany)
Title: *Applications of the Perron-Frobenius theory of nonnegative matrices in communications and information theory*
Abstract: The talk presents an overview of well-known and more recent lesser-known results in the Perron-Frobenius theory of nonnegative matrices. The focus is on topics that naturally appear in the design of strategies for resource allocation and interference management in wireless networks. When developing such strategies, different characterizations of the Perron root of nonnegative matrices and characterizations of positive solutions of linear equations with nonnegative coefficients turn out to be vital to better understanding of fundamental tradeoffs between diverse optimization objectives; in particular they provide a basis for the development of power control algorithms. Applications that involve systems of linear equations with nonnegative coefficients are numerous, ranging from the physical and engineering sciences to other mathematical areas like graph theory and optimization.

Speaker: **Anna-Lena Trautmann** (Universität Zürich, Switzerland)
Title: *Cyclic Orbit Codes*
Abstract: Cyclic orbit codes are orbits on a point of the Grassmannian over a finite field under the action of a cyclic subgroup of the general linear group, used for random network coding. In this talk we will present how these codes can be classified and how one can compute the cardinality and minimum distance of them. Moreover, we introduce a syndrome-like decoding setting for orbit codes.

Speaker: **Sriram Vishwanath** (University of Texas at Austin, USA)
Title: *Structured Transmission Schemes for Interference Networks*
Abstract: In this talk, we will discuss various structured coding strategies for interference networks. The coding schemes include lattice based schemes for both linear and non-linear interference networks. Of particular interest are the cases when there are more than 2 interfering users, and when there are multiple antennas at each of the users.

Speaker: **Alexander Vardy** (University of California, San Diego, USA)
Title: *Algebraic List Decoding of Subspace Codes*
Abstract: TBA

Speaker: **Emanuele Viterbo** (Monash University, Australia)
Title: *Wireless network coding over finite rings*
Abstract: We consider a wireless network coding scenario based on compute and forward. We show how to design invertible network equations over finite rings of size 2^m matched to the finite QAM or HEX constellations.

Speaker: **Aaron Wagner** (Cornell University, USA)
Title: *When do structured codes help in distributed compression?*
Abstract: For some distributed compression problems, structured codes offer better performance than unstructured codes. For other problems, they do not. I will discuss some old and new results that serve to partially delineate these two cases. In particular, for the quadratic Gaussian case, whether structured code help seems to be intimately linked with the question of whether the source variables can be embedded in a Gauss-Markov tree.

Speaker: **Liang-Liang Xie** (University of Waterloo, Canada)
Title: *On the Optimal Compress-and-Forward Relay Scheme*
Abstract: Although many efforts have been spent on developing new compress-and-forward relay schemes, the original one introduced by Cover and El Gamal (1979) still achieves the highest rate in the single relay case. However, whether it is already optimal still remains undetermined. In order to answer this question, we take a non-traditional approach and use lattice codes for our arguments. We will discuss the insight that can be gained, and try to answer this question generally.

Speaker: **Aylin Yener** (Pennsylvania State University, USA)
Title: *Interference, Structured Random Codes and Secrecy: Lessons Learned from Information Theory*
Abstract: In this talk, we will provide an overview of our recent results in information theoretic secrecy in networks with interference. Of particular interest are Gaussian models where the existence of interference can be turned into advantage for the legitimate nodes whose communication needs to be kept secret from eavesdropping nodes. These include models where the use of structured random codes offers a performance advantage as compared to Gaussian signaling. In particular, structured random codes can be used both for secret message transmission and structured cooperative jamming providing favorable alignment of interference at legitimate and eavesdropping nodes for multi-transmitter models, as well as multi-hop transmission with secrecy.

Speaker: **Ram Zamir** (Tel Aviv University)
Title: *Lattice Codes in Information Theory (and Anti-Structure Problems)*
Abstract: While the coding theorist cares about explicit design and encoding-decoding algorithms, the information theorist is naturally interested in questions of existence: are there asymptotically ”good” lattice codes? are they as good as their random counterparts? Interestingly, as recently observed by several researchers (and this explains the blooming interest in the area), linear/lattice codes sometimes beat the ”best known” random code. Many open questions remain, however, which I will try to explore in the talk. Another issue to be discussed are the limits of structure: can the code structure always match the channel (or source) structure? It will be shown that sum-product channels (in the context of multi-user problems) resist a solution by a structured (and in fact by any) code.