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ISIT 2011

#1569420605: *The Dispersion of Infinite Constellations*

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Conference and *track*		**2011 IEEE International Symposium on Information Theory** - *2011 IEEE International Symposium on Information Theory*

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Property	Change Add	Value
Presenter		presenter not specified
Registration		
Category		Eligible for ISIT Student Paper Award
Title		*The Dispersion of Infinite Constellations*

Abstract

THIS PAPER IS ELIGIBLE FOR THE STUDENT PAPER AWARD The setting of a Gaussian channel without power constraints is considered. In this setting, proposed by Poltyrev, the codewords are points in an n-dimensional Euclidean space (an infinite constellation). The channel coding analog of the number of codewords is the density of the constellation points, and the analog of the communication rate is the normalized log density (NLD). The highest achievable NLD with vanishing error probability is known (which can be thought of as the capacity), as well as error exponents for the setting. In this work we are interested in the optimal NLD for communication when a fixed, nonzero error probability is allowed. In classical channel coding the gap to capacity is characterized by the channel dispersion (and cannot be derived from error exponent theory). In the unconstrained setting, we show that as the codeword length (dimension) n grows, the gap to the highest achievable NLD is inversely proportional (to the first order) to the square root of the block length. We give an explicit expression for the proportion constant, which is given by the inverse Q-function of the allowed error probability, times the square root of 1/2. In an analogy to a similar result in classical channel coding, it follows that the dispersion of infinite constellations is given by 1/2 [nat^2] per channel use.We show that this optimal convergence rate can be achieved using lattices, therefore the result holds for the maximal error probability as well. Connections to the error exponent of the power constrained Gaussian channel and to the volume-to-noise ratio as a figure of merit are discussed.

Property	Change Add	Value
Keywords		Infinite constellations; Channel dispersion; Finite blocklength; Error exponent
Topics		Shannon theory
Session		The program is not yet visible (tpc)
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Review manuscript

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Personal notes

Reviews

You are a TPC member for this conference.

2 Reviews

Review 1 (Reviewer B)

Importance	Technical Level	Novelty	Presentation	Recommendation
Average Importance (3)	Good technical level (4)	Very Novel (4)	Excellent (5)	Strongly Recommend (5)

Strengths (What are the key strengths of this paper?)

This paper is a summary of a longer paper on finite-length analysis of infinite (Poltyrev-type) constellations on the AWGN channel. Its main result is an extension of the channel dispersion theorem of Polyanskiy et al. to this setting; it develops an analogous result that shows that the optimal "dispersion" is 1/2. It gives a good discussion of why this makes sense. Other connections to error-exponent theory and to AWGN channel coding theory are discussed.

The paper is very well written.

In summary, this is a nice and well-presented piece of research on a subject close to the heart of classical information theory.

Weaknesses (What are the major weaknesses of this paper?)

I didn't notice any weaknesses.

Comments and Recommendation (Please give the reasoning for your overall recommendation and any additional comments you wish to add.)

This seems like a very solid piece of work, and a plausible candidate for one of the student paper awards.

Student Paper Award (This paper is eligible for the student paper award. Do you think it would rank among the top ten papers out of the 500 submitted papers in that category? If so, explain why.)

Yes, it might.

Review 2 (Reviewer C)

Importance	Technical Level	Novelty	Presentation	Recommendation
Very Important (4)	Extremely high technical level (5)	Very Novel (4)	Excellent (5)	Strongly Recommend (5)

Strengths (What are the key strengths of this paper?)

It refines Poltyrev's analysis of the capabilities of lattices in AWGN channels
by providing a Gaussian approximation analysis.

Weaknesses (What are the major weaknesses of this paper?)

The description of the contribution of [6] (see below).

Comments and Recommendation (Please give the reasoning for your overall recommendation and any additional comments you wish to add.)

"In classical channel coding the gap to capacity is characterized by the channel dispersion"
is a rather surprising statement in view of the fact that channel dispersion was defined in [6], which appeared in 2010. The relevance of [6] to the present paper is described as
"More details and extensions can be found in [6]." However, would this submission have been
written without [6]?

"This property, which is attributed to Shannon (see [6, Fig. 18])," is a misunderstanding
of what is in Shannon's unpublished comment where he claims that the behavior of E(R)
near capacity is a parabola divided by the variance of the information density.
That that has anything to do with channel dispersion was shown in [6] for a variety of channels including the AWGN.

Miscellaneous comments.

It would be preferable to give complete proofs of Theorems 1 and 2 than to devote any space to the proof of Lemma 1 (a direct consequence of Berry-Esseen)

It is odd to entitle Section III "Preliminaries"

A repetition code was used in "than the the the technical"

The caption of Figure 1 should refer to (5).

Give a reference for the limiting value of \mu_n (epsilon) = 2 pi e

I dislike the notation "delta" for the fundamental limit. (Is this due to Poltyrev?)

1 Summary review by TPC member

Review 1 (Reviewer A)

TPC recommendation
Strong accept (5)

TPC Recommendation Justification (Please give a justification for your recommendation, especially if the review scores vary widely or your recommendation differs significantly from those of the reviewers.)

Very nice and well written paper.

Student Paper Award (This paper is eligible for the student paper award. The TPC needs to identify 10-15 semifinalists for the award from among the 500 submitted eligible papers. Later the IT Society Awards committee will select up to three winners. If you think this paper is worthy of the award, please send a one page nomination to the TPC cochairs at isit2011@eng.tau.ac.il with "STUDENT AWARD NOMINATION" in the subject header. The TPC co-chairs and IT Society Awards committee will have access to the papers, reviews (including your TPC summary review) and the nominations of the finalists. (You need not write anything in the box here.))

I think this paper should be consider for the student paper award.
It has nice math behind it, and provides a characterization of
the dispersion for a Gaussian channel without power constraints.

Discussion
