

## Metric Diophantine approximation and Hausdorff dimension on manifolds

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(Received 1 February 1988; revised 7 July 1988)

### 1. Introduction

In this paper we discuss homogeneous Diophantine approximation of points on smooth manifolds  $M$  in  $\mathbb{R}^k$ . We begin with a brief survey of the notation and results. For any  $\mathbf{x}, \mathbf{y} \in \mathbb{R}^k$ , let

$$\mathbf{x} \cdot \mathbf{y} = \sum_{i=1}^k x_i y_i, \quad \|\mathbf{x}\|_2 = (\mathbf{x} \cdot \mathbf{x})^{1/2}, \quad \|\mathbf{x}\|_\infty = \max\{|x_i| : i = 1, \dots, k\}.$$

For convenience, when there is no risk of confusion, we will usually write  $\|\mathbf{x}\|$  rather than  $\|\mathbf{x}\|_\infty$ . For any set  $X \subseteq \mathbb{R}^k$ ,  $\dim X$  will denote its Hausdorff dimension and  $|X|$  its Lebesgue measure or, when  $X \subseteq M$ , its induced Lebesgue measure on  $M$ . For any  $t \in \mathbb{R}$ , let  $\|t\| = \inf\{|t - p| : p \in \mathbb{Z}\}$ . Throughout,  $\mathbf{q}$  will denote an integer vector in  $\mathbb{Z}^k$ . For each  $\mathbf{x}$  in  $\mathbb{R}^k$  we denote by  $w(\mathbf{x})$  the supremum of all positive  $w$  such that the inequality

$$\|\mathbf{q} \cdot \mathbf{x}\| < \|\mathbf{q}\|^{-w}$$

has infinitely many solutions  $\mathbf{q}$  in  $\mathbb{Z}^k$ . It follows from Dirichlet's pigeonhole principle that  $w(\mathbf{x}) \geq k$  for all  $\mathbf{x}$  in  $\mathbb{R}^k$  (see [7, 17]) and from Groshev's extension of Khintchine's Theorem (see [19], p. 33) that  $w(\mathbf{x}) = k$  for almost all  $\mathbf{x}$  in  $\mathbb{R}^k$  (in the sense of Lebesgue measure). Points  $\mathbf{x}$  for which  $w(\mathbf{x}) > k$  are called *well approximable*; clearly the set of well approximable points has measure zero. To refine the notion of well approximable points let

$$W(r) = \{\mathbf{x} \in \mathbb{R}^k : w(\mathbf{x}) \geq r\}, \quad W'(r) = \{\mathbf{x} \in \mathbb{R}^k : w(\mathbf{x}) = r\}$$

for all  $r \in \mathbb{R}$ . By the above results,  $W(r) = \mathbb{R}^k$  for  $r \leq k$ ,  $|W(r)| = 0$  for  $r > k$ ,  $W'(r) = \emptyset$  for  $r < k$ ,  $|W'(r)| = 0$  for  $r > k$  and  $W'(k)$  has full measure. When  $r > k$ , the Hausdorff dimension of  $W(r)$  is  $k-1 + (k+1)/(r+1)$ ; the case  $k=1$  was proved by Jarnik [12] and Besicovitch [5] and the case  $k > 1$  is treated in [6] and [8] (the sets considered in these papers differ slightly from  $W(r)$  and  $W'(r)$  but the dimensions are the same).

In this paper we consider the Diophantine approximation of points  $\mathbf{x}$  lying on a submanifold of  $\mathbb{R}^k$ . A manifold  $M$  in  $\mathbb{R}^k$  is said to be *extremal* when, in the induced measure on  $M$ , almost all points in  $M$  are not well approximable. Thus  $\mathbb{R}^k$  is extremal.

# Metric Diophantine Approximation On Manifolds

**RJ Alexander**

## **Metric Diophantine Approximation On Manifolds:**

Metric Diophantine Approximation on Manifolds V. I. Bernik,M. M. Dodson,1999-10-14 This book is concerned with Diophantine approximation on smooth manifolds embedded in Euclidean space and its aim is to develop a coherent body of theory comparable with that which already exists for classical Diophantine approximation In particular this book deals with Khintchine type theorems and with the Hausdorff dimension of the associated null sets All researchers with an interest in Diophantine approximation will welcome this book

Metric Diophantine Approximation on Manifolds by Algebraic Points

Alessandro Pezzoni,2020 **Number Theory Meets Wireless Communications** Victor Beresnevich,Alister Burr,Bobak Nazer,Sanju Velani,2021-01-08 This volume explores the rich interplay between number theory and wireless communications reviewing the surprisingly deep connections between these fields and presenting new research directions to inspire future research The contributions of this volume stem from the Workshop on Interactions between Number Theory and Wireless Communication held at the University of York in 2016 The chapters written by leading experts in their respective fields provide direct overviews of highly exciting current research developments The topics discussed include metric Diophantine approximation geometry of numbers homogeneous dynamics algebraic lattices and codes network and channel coding and interference alignment The book is edited by experts working in number theory and communication theory It thus provides unique insight into key concepts cutting edge results and modern techniques that play an essential role in contemporary research Great effort has been made to present the material in a manner that is accessible to new researchers including PhD students The book will also be essential reading for established researchers working in number theory or wireless communications looking to broaden their outlook and contribute to this emerging interdisciplinary area

**Limit Theorems**

**in Probability, Statistics and Number Theory** Peter Eichelsbacher,Guido Elsner,Holger Kösters,Matthias Löwe,Franz Merkl,Silke Rolles,2013-04-23 Limit theorems and asymptotic results form a central topic in probability theory and mathematical statistics New and non classical limit theorems have been discovered for processes in random environments especially in connection with random matrix theory and free probability These questions and the techniques for answering them combine asymptotic enumerative combinatorics particle systems and approximation theory and are important for new approaches in geometric and metric number theory as well Thus the contributions in this book include a wide range of applications with surprising connections ranging from longest common subsequences for words permutation groups random matrices and free probability to entropy problems and metric number theory The book is the product of a conference that took place in August 2011 in Bielefeld Germany to celebrate the 60th birthday of Friedrich G tze a noted expert in this field

**Mathematics of Complexity and Dynamical Systems** Robert A. Meyers,2011-10-05 Mathematics of Complexity and Dynamical Systems is an authoritative reference to the basic tools and concepts of complexity systems theory and dynamical systems from the perspective of pure and applied mathematics Complex systems are systems that comprise many interacting

parts with the ability to generate a new quality of collective behavior through self organization e g the spontaneous formation of temporal spatial or functional structures These systems are often characterized by extreme sensitivity to initial conditions as well as emergent behavior that are not readily predictable or even completely deterministic The more than 100 entries in this wide ranging single source work provide a comprehensive explication of the theory and applications of mathematical complexity covering ergodic theory fractals and multifractals dynamical systems perturbation theory solitons systems and control theory and related topics Mathematics of Complexity and Dynamical Systems is an essential reference for all those interested in mathematical complexity from undergraduate and graduate students up through professional researchers

**Number Theory, Analysis and Geometry** Dorian Goldfeld,Jay Jorgenson,Peter Jones,Dinakar Ramakrishnan,Kenneth Ribet,John Tate,2011-12-20 In honor of Serge Lang s vast contribution to mathematics this memorial volume presents articles by prominent mathematicians Reflecting the breadth of Lang s own interests and accomplishments these essays span the field of Number Theory Analysis and Geometry

**Acta Arithmetica** ,2013 **Dynamics and Analytic Number Theory**

Dzmitry Badziahin,Alexander Gorodnik,Norbert Peyerimhoff,2016-11-10 Written by leading experts this book explores several directions of current research at the interface between dynamics and analytic number theory Topics include Diophantine approximation exponential sums Ramsey theory ergodic theory and homogeneous dynamics The origins of this material lie in the Dynamics and Analytic Number Theory Easter School held at Durham University in 2014 Key concepts cutting edge results and modern techniques that play an essential role in contemporary research are presented in a manner accessible to young researchers including PhD students This book will also be useful for established mathematicians The areas discussed include ubiquitous systems and Cantor type sets in Diophantine approximation flows on nilmanifolds and their connections with exponential sums multiple recurrence and Ramsey theory counting and equidistribution problems in homogeneous dynamics and applications of thin groups in number theory Both dynamical and classical approaches towards number theoretical problems are also provided

**Metric Theory of Diophantine Approximations** Vladimir Gennadievich Sprindzhuk,1979

This monograph is a systematic presentation of a branch of number theory known as the metric theory of Diophantine approximation The main emphasis is on extremal problems i e problems involving approximations that are best in a certain sense

**Pure and Applied Mathematics Quarterly** ,2008 **Mathematical Reviews** ,2006 **Reviews in Number Theory, 1984-96** ,1997 These six volumes include approximately 20 000 reviews of items in number theory that appeared in Mathematical Reviews between 1984 and 1996 This is the third such set of volumes in number theory The first was edited by W J LeVeque and included reviews from 1940 1972 the second was edited by R K Guy and appeared in 1984

**Reviews in Number Theory 1973-83** Richard K. Guy,1984 **Russian Mathematical Surveys** ,1997 **Number Theory for the Millennium II** Michael A. Bennett,2002-05-09 Building on the tradition of an outstanding series of conferences at the University of Illinois at Urbana Champaign the organizers attracted an international group of scholars to open the new

Millennium with a conference that reviewed the current state of number theory research and pointed to future directions in the field. The conference was the largest general number theory conference in recent history featuring a total of 159 talks with the plenary lectures given by George Andrews, Jean Bourgain, Kevin Ford, Ron Graham, Andrew Granville, Roger Heath-Brown, Christopher Hooley, Winnie Li, Kumar Murty, Mel Nathanson, Ken Ono, Carl Pomerance, Bjorn Poonen, Wolfgang Schmidt, Chris Skinner, K. Soundararajan, Robert Tijdeman, Robert Vaughan, and Hugh Williams. The Proceedings Volumes of the conference review some of the major number theory achievements of this century and to chart some of the directions in which the subject will be heading during the new century. These volumes will serve as a useful reference to researchers in the area and an introduction to topics of current interest in number theory for a general audience in mathematics. Tatra Mountains Mathematical Publications, 1992    **Nagoya Mathematical Journal**, 2008 Issue for Mar 1970 dedicated to Professor Katuzi Ono on his 60th birthday with portrait sketch of his life and list of mathematical papers. *Israel Journal of Mathematics* Mo'atsah ha-le'umit le-meḥkar ule-fituah (Israel), 2005    Proceedings, 2004    **Referativnyi zhurnal**, 1976

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